

Dr. Rajendra Prasad Central Agricultural University Samastipur (Bihar)-848125



Annual Report

2018-19

Annual Report (2018-19)
Dr. Rajendra Prasad Central Agricultural University
Samastipur (Bihar)-848125

Foreword from the Vice- Chancellor

It is my proud privilege to present the third Annual Report of Dr. Rajendra Prasad Central Agricultural University, Pusa for the year 2018-19, which highlights the achievements of past one year. This university feel proud to organize 1st convocation on 15th November, 2018 in the gracious presence of Hon'ble President of India as Chief Guest in which 511 students of UG, PG and Ph.D. Programme were awarded their degree. The university has established PanditDeendayalUpadhaya College of Horticulture & Forestry and introduced six new post-graduate programmes viz. Fruit Science, Farm Machinery & Power Engineering, Microbiology, MBA (Rural Management), Aquaculture and Fisheries Resource Management. At present the University has undergraduate programme in 06 disciplines , Post Graduate Programme in 24 disciplines and Ph.D. in 09 disciplines.

The university is contributing to the overall agricultural development of the region and the nation as a whole by way of developing quality professionals in the areas of agriculture and allied sciences, conducting research for developing crop variety and technology, updating technologies and capacity building of farmers to facilitate adoption of the technology. The University has also started new initiatives for doubling farmers' income and natural resources management with properly accelerated Extension activities in conformity with Government of India policy.

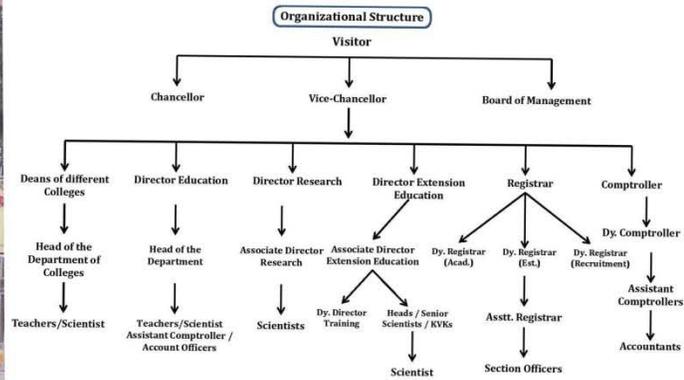
I express my sincere gratitude to Hon'ble President of India, His Excellency ShriRamnathKovind, Visitor of University, Prof. P. K. Mishra, Hon'ble Chancellor of the University and ShriRadha Mohan Singh JiHon'ble Minister of Agriculture and Farmers' Welfare, Government of India for their unflinching support and guidance. I am highly thankful to Dr. T. Mohapatra, Secretary, DARE, Ministry of Agriculture & Farmers' Welfare, and Government of India for his encouragement and support.

I compliment all Deans, Directors, Registrar, Associate Deans, Chairpersons of departments, PIs of projects, PCs of KVKs, Scientists and other administrative, technical and supporting staffs the University and others for providing valuable information for the report.

R. C. Srivastava
Vice-Chancellor

Executive Summary

University is emerging as vibrant organization with its focus on quality education, ecologically sustainable agriculture and decent livelihood to the farming community. The initiation of six new post-graduate programmes viz. Fruit Science, Farm Machinery & Power Engineering, Microbiology, MBA (Rural Management), Aquaculture and Fisheries Resource Management) and one under-graduate programme in Horticulture and Forestry ; augmentation of the total intake capacity of students to 609 in 06 disciplines of UG, 24 disciplines of PG ; and 09 disciplines of Ph.D.; up-gradation of hostel facilities; revival of placement unit having soft skill and wage employment development; qualifying of 65 students for ARS/SRF/JRF/GATE/NET, up-gradation and automation of library facilities; introductions of academic management software in collaboration with IASRI and strengthening the faculty positions (34) in all the colleges/faculty of the university justified our movement in vibrant mode. University also organized 1st convocation on 15th November, 2018 with gracious presence of Hon'ble President of India in which 511 students of UG, PG and Ph.D. Programme were awarded their degree. Release of Rajendra Kauni (Foxtail millet) and Rajendra Neelam aerobic rice, by CVRC, Rajendra Saraswati of Rice by SVRC and Rajendra Gehun-1 Variety by university for different agro climatic conditions, value addition of the agricultural produce, revenue generation through house hold and campus waste management programme, supplementation of power through solar system, solar cart for fish vendors and protection technology up-gradation for various crops through 32 AICRP, 03 international projects, 11 Govt. of India funded projects, 04 Govt. of Bihar funded projects and 27 university funded projects and establishment of banana research centre at Goraul (Vaishali) are major achievements in research. Establishment of four new KVKs, organizing three *KisanMela* at different places and capacity building programme of farming community along with dissemination of modern agricultural technology amongst **43330** farming community by way of training, demonstration, field visit and *kisangosthi* etc. lead to better technology transfer and adoption among the farming community and other stake holders. University has also generated a sum of Rs.6.41 crores from agricultural inputs and other resources. Administrative reforms have been introduced by implementing Technical Service Rule, Administrative Service Rule and division of the non-teaching staff into supporting, technical and administrative categories and approval of the CAS scheme.



About the University

Dr. Rajendra Prasad Central Agricultural University, Pusa, established on 7th October, 2016, owes legacy of Rajendra Agricultural University, Pusa (1970) and Agricultural Research Institute and college, Pusa (1905). The jurisdiction and responsibility of the University with respect to teaching, research and programmes of extension education at the university level, in the field of agriculture and allied subjects is extended to the whole country with special reference to the State of Bihar.

Journey of Agricultural education and Research at Pusa, Bihar : 18th to 21st Century

The inception of agricultural and allied research can be traced back to 18th Century when breeding operations of many types of horses by East India Company was established on July 1764. However, all stud operation were closed in 1874 and in 1875 a model farm was established in Pusa estate having area of 1350 acres with a targeted cultivation of rice and tobacco. The most important experiment was that of investigating whether the *Gerpiadhan* of Dacca can be made to grow in high lands of Tirhut as it does in lower Bengal. The agriculture Research Institute and College, Pusa, owed its inception in 1903 to the generosity of Mr. Henry Phips, an American philanthropist and the far sighted vision of Lord Curzon to diminish the severity of famine and to place the people in better position to meet it. In July, 1908 Lord Curzon laid foundation of Agricultural Research Institute and college which became operational with intake capacity of forty four students in the discipline of Mycology, Agricultural Chemistry, Botany, Entomology (Post-graduate programme of two years) and short courses in Agricultural Bacteriology and Agriculture.

The Agricultural research institute and college, Pusa had a very good linkage with six provincial Agricultural colleges of India which were established during 1906-1910 including Bihar Agricultural College, Sabour established on 17th August' 1908 in which undergraduate programme started in 1910 and the Post-graduate education in 1955 in Horticulture, Agronomy, Plant Pathology, Entomology and Extension Education in addition to research, extension and seed multiplication activities. This was followed by the establishment of Bihar Veterinary College, Patna on 2nd April, 1927, Sugarcane Research Institute in 1932; shifting of Imperial Agricultural Institute, Pusa to New Delhi in 1936 and Tirhut College of Agriculture, Dholi on 18th August. Rajendra Agricultural University, Bihar was established on December 3rd 1970 with the pacing of all the agriculture and Veterinary college /Institute of undivided Bihar. However, in the year 1981, the areas comprising Chhotanagpur and Santhalparganas were carved out and separate Agricultural University named as Birsa Agricultural University came into existence having headquarters at Ranchi and On 5th August' 2010, Rajendra Agricultural University, Pusa had another division with

the establishment of Bihar Agriculture University, Sabour. Finally Rajendra Agricultural University was converted to CAU and rechristened as “Dr.Rajendra Prasad Central Agricultural University” on 7th October, 2016 having jurisdiction all over India with special reference to Bihar. However, conversion of SAU to CAU is not only change in nomenclature but it has already initiated some action in this direction with the establishment of PanditDeenDayalUpadhyay College of Horticulture and Forestry, MBA (Rural Management) and starting PG courses in Fisheries, Microbiology, Farm Machinery and Power Engineering, Horticulture (Fruit Science); establishing three centres on Water Management, Climate Change and Banana Research Centre and also 50% increase in intake capacity in all disciplines resulting existing strength of 1078 students .

Mission :

- Promote experiential high quality learning environment and creation of integrated approach that develops an appreciation and understanding of the socio-economic and environmental significance of soil-plant-animal-people interface.
- Shaping agricultural stakeholders into self sustaining mode through innovative centric education, cutting edge research, entrepreneurship/ start up skill development and dissemination of appropriate agricultural technology.
- Nurture national/ global needs of sustainable food production through advance interventions of research and development.
- Making Eastern India agriculture climate resilient and mitigating pressure on agricultural land through higher productivity.

Vision:

Augmenting/Advancing professional competency for pursuing excellence in agriculture and allied education, research and entrepreneurship with ethical values to meet the Regional National and Global needs and offering specialized services to the farmers for decent livelihood.

Mandate:

- To impart education in different branches of agriculture and allied fields
- To undertake basic, strategic and applied research for developing technologies to enhance productivity and quality of agricultural and animal produce.
- To disseminate scientific information to farmers.
- To help the state government in supplying breeder seeds towards production and multiplication of foundation and certified seeds.

- To provide consultancy services and expertise in the agricultural research and development to the industries, NGOs and others.

Executive Body:

- (a) Board of Management:
- (b) Research Council
- (c) Extension Education Council
- (d) Academic Council
- (e) Senior level officers committee



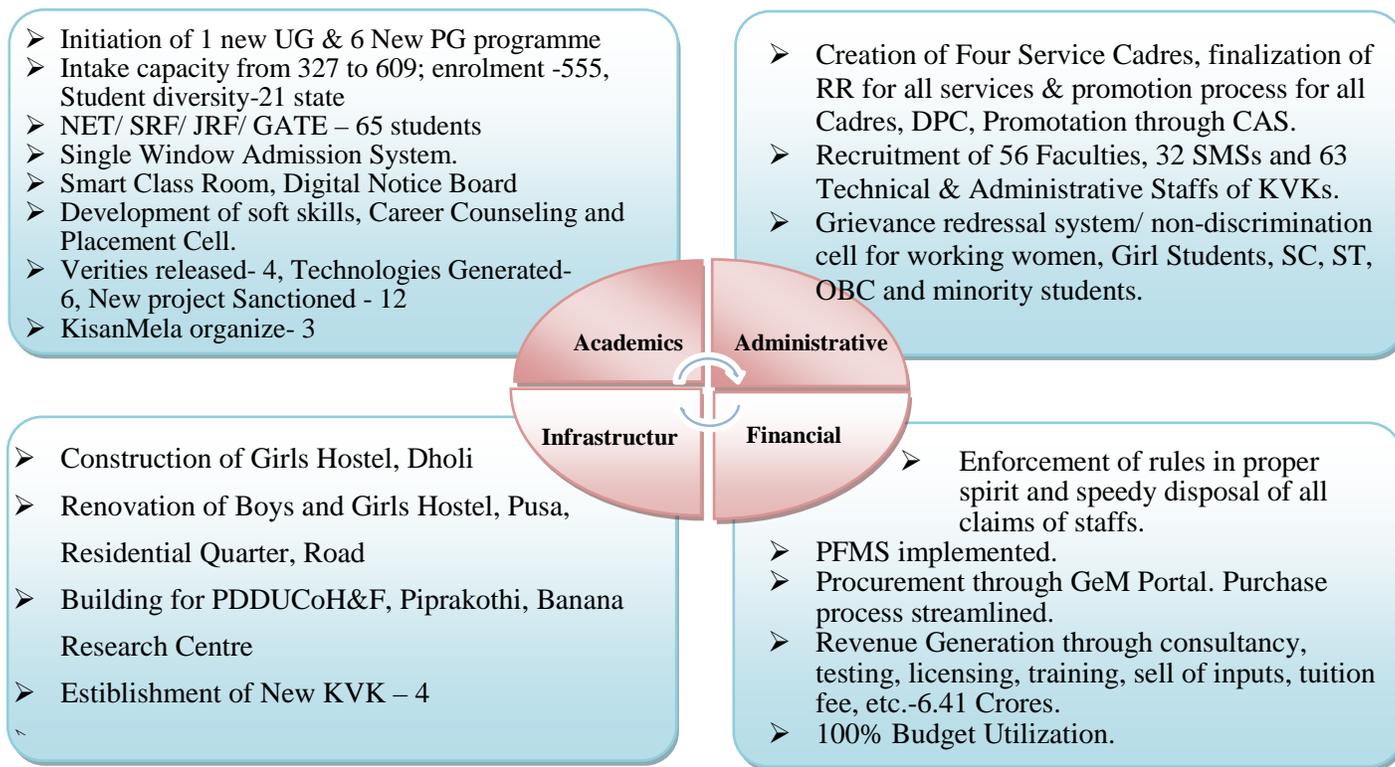
University Administration:

Visitor	:Shri Ramnath Kovind, Hon'ble President of India
Chancellor	:Prof. P. K. Mishra
Vice Chancellor	:Dr. Ramesh Chandra Srivastava
Registrar	:Dr.Ravinadan
Director Education	: Dr. M.N. Jha
Director Research	:Dr. Mithilesh Kumar
Director Ext. Edn.	:Dr. K.M. Singh
Director Students Welfare	:Dr. A. K. Mishra
Comptroller	:Mr. Radhakrishna

Dean's of the Colleges:

Dr. S.K. Varshney	Dean,PG College of Agriculture, RPCAU,Pusa,Samastipur
Dr. Harsh Kumar	Dean,College of Basic Sciences& Humanities, RPCAU,Pusa,Samastipur
Dr. (Mrs.) Meera Singh	Dean, College of Community Science RPCAU,Pusa,Samastipur
Dr. K.M. Singh	Director, School of Agribusiness & Rural Management, RPCAU,Pusa,Samastipur
Dr. L.M. Yadav	Dean,Pt.DDU College of Horticulture & Forestry (PipraKothi, Motihari), RPCAU,Pusa,Samastipur
Dr. R.S. Verma	Dean, College of Agricultural Engineering, RPCAU,Pusa,Samastipur
Dr. S.C. Rai	Dean, College of Fisheries (Dholi), RPCAU,Pusa,Samastipur
Dr. Devendra Singh	Dean, Tirhut College of Agriculture,Dholi, RPCAU,Pusa, Samastipur

Salient Achievements:



- (a) **Education:** The university initiated six new post-graduate programmes in Fruit Science, Farm Machinery & Power Engineering, Microbiology, MBA (Rural Management), Aquaculture and Fisheries Resource Management) and one under-graduate programme in Horticulture and Forestry, so the total intake capacity of students has now been increased from 327 to 609 in 06 disciplines of UG, 24 disciplines of PG and 09 disciplines of Ph.D. up-gradation of hostel facilities; revival of placement unit having soft skill and wage employment development; up-gradation and automation of library facilities; introductions of academic management software in collaboration with IASRI and strengthening the faculty positions in all the colleges/faculty of the university justified our movement in vibrant mode. In the year 2018-19 total 555 new students were admitted in various UG, PG and Ph.D. Programme on all India basis representing 21 states of the country. The students of the university appeared at different competitive examination and 65 students qualified in various competitive examination like NET/ SRF/ JRF/ GATE. The 1st convocation of the University was held on 15th November, 2018 in which Hon'ble President of India His Excellency graced the occasion as Chief Guest, in which 511 students of UG, PG and Ph.D. Programme were awarded their

degree including 33 Gold Medal out of which 22 Gold Medals were awarded to girl students. During reporting period all together 174 students (Under Graduate 99, Post Graduate 70 and Ph.D. 05) were obtained their respective degree. In the session 2018-19; 97 percent Under Graduate seats (282 out of 290), 94 percent Post Graduate (247 out of 264) and 96 percent Ph.D. (26 out of 27) seats were filled by the students of 21 states and the student retention percent in different programme were in tunes of 93, 94 and 100 for UG, PG and Ph.D., respectively which reflects the sound academic atmosphere of the University. The university is moving towards its modernization through infrastructure development, Automation and Digitization and introduction of Academic Software Management System. The university has already introduced centralized cashless, hassle free, digital, single window admission system for the all UG, PG and Ph.D. programme.



Centralized Admission System



Students of B.Sc.(Agriculture), TCA Dholi conducted survey on solar based irrigation system in Chakhaji village under RAWE Programme. (7 March 2019)

Name of programme	Intake capacity	Admitted		Retention		Passed out
UG	290	282	(97%)	262	(93%)	99
PG	264	247	(94%)	231	(94%)	70
Ph.D.	27	26	(96%)	26	(100%)	05

- No. of JRF/ SRF/ GATE/NET : 65

Convocation

Dr. Rajendra Prasad central Agricultural University, Pusa witnessed one of most notable events in the year 2018-19 by organizing the first Convocation on 15th November, 2018 under the chairmanship of Shri Ram Nath Kovind, Hon'ble President of India. The dignitaries consisting of Sri Nitish Kumar, Hon'ble Chief Minister (Bihar), Sri Lalji Tandon, Hon'ble Governor of Bihar, Sri Radha Mohan Singh, Hon'ble Minister of Agriculture & Food Processing Industries, Govt. of India, Sri. Prem Kumar, Hon'ble Agriculture Minister of Bihar, Public representatives, government officials, renowned professionals as well as parents of the graduating students. The Honourable Vice-Chancellor, Dr. R.C. Srivastava welcomed the dignitaries and guest to the first convocation. During the convocation 511 students of UG, PG and Ph.D. Programme were awarded their degree including 33 Gold Medal out of which 22 Gold Medals were awarded to girl students. All the dignitaries, faculty members and student community extended their good wishes to the graduates who began a new chapter of their professional lives with their academic degree.

OUR PROUD MOMENT- CONVOCATION 2018





Placement of Students

Establishment of placement and career development unit with its mandate on soft skill development including communication skill resulted better placement of students in the reputed firms of the country.

The Placement Cell, RPCAU, Pusa, Samastipur has invited major reputed recruiters of the country including Rallis India, Du-Pont Pioneer, Technoserve, TAFE, Escort, Matix Fertilisers and Chemicals Ltd., Axis Bank, Jeevika etc. out of the our several courses the percentage of placement is given as under :

S. N.	Course Name	Percentage Unitwise	Overall Percentage
1	MBA (Agribusiness)	70.00	40.82
2	M.Sc. (Ag.)	40.91	
3	B.Sc. (Ag.)	100.00	
4	B.F. Sc. (Fisheries)	7.69	
5	B. Tech. (Agril. Engg.)	17.24	
TOTAL		40.82	





Resource Generation :

The University has made significant progress in revenue generation in the year 2018-19 through various services and earned 58.0 lakh through consultancies, 1.14 crore through testing , 1.6 crore through tuition fee, 4.5 lakh through licensing, 5.2 lakh through training and 2.9 Crore through sale of inputs. In Seed Production Programme of the University Harley 4.5% were categories as non-seed and the total seed produced in the reporting period was 3905 quintals. Non Thus the total revenue earned by the University in the year 2018-19 was 6.40 crore approximately.

Research:

The university is making every effort to develop technology and varieties of different crops suitable for different agro-ecological condition as per need of farmers belonging to different socio-economic group through different research projects i.e.

Sl.No.	Name of funding agency/project	No. of projects
1	All India Coordinated Research Projects	32
2	Foreign aided projects	03
3	Govt. of Bihar projects	4
4	University projects	27

- A. New Project Sanctioned : 12
- B. Project above 1 crore : 05
- C. Project above 50 lakhs and less than 1 crore : 06
- D. New research project submitted for sanction : 15

Varieties Released

Rajendra Kauni (Foxtail) and Rajendra Neelam aerobic rice, released by CVRC, Rajendra Saraswati by SVRC and Rajendra Gehun-1 by university for different agro climatic conditions, value addition of the agricultural produce, production and protection technology development for various crops through various research projects are the major achievements of the year. The university is making every effort to develop climate resilient, high yielding varieties and sustainable, modern, need based technologies to achieve the goal of doubling farmer's income.



Rajendra Gehun-1



Rajendra Kauni-1



Rajendra Nilam



Rajendra Saraswati

Technologies generated/ released

1. Development of low cost refrigerated cart for transportation of fish named as

SOLAR BASED MATSYA BANDHU

- This helps fish retailers to avoid distress sale in late hours of day as well a hygienic way of storing fish on roadside and it can also be used for fish selling going around city mohalla. Government of Bihar has ordered first lot of 25 such cart which can go upto 1000 depending upon response.



Storage Capacity : 30-40 Kg.
Approx cost: 1,10,000/-

2. Boat Mounted Solar Pumping System

Boat Mounted Solar Pumping System



Solar modules capacity : 1800 W_p
Submersible Pump power rating: 2 HP
Discharge Recorded: upto 5.75 lps At the head of about 15m
Daily out put: 1 lakh litres

Power :2HP
Suitable for Tal &Diara Area
Mounted on normal Tractor Trolley
Irrigation Potential: 5-6 Acre
Approx Cost: 4.0 Lakh

Solar modules capacity : 1800 W_p
Submersible Pump power rating : 2 HP
Discharge Recorded : upto 5.75 lps At the head of about 15m
Daily out-put : 1 lakh litres

4. Research System for Ground Water

Design and Evaluation of Drainage cum Recharge structure under North



- Recharge Rate with various filter combination varied between 1.1 L/sec to 2.6 L/sec with various filter combination.
- The Filter combination consisting of Gravel, Sand and Charcoal was having highest recharge rate and 2nd lowest Total suspended Solids (TSS) value.
- Initial Result indicates that Total suspended Solids can be reduced from 1250mg/L to 150-250 mg/L.

5. House hold waste management

“University Campus Waste Management Strategies”





Compostable waste are utilized for vermicomposting, plastic waste, after recycling, will be disposed through vendors and other waste will be disposed off as landfills.

6. Technology for management of Papaya diseases in agro-ecological conditions of Bihar

- Planting time-Papaya should be planted in the month of October after rainy season.
- Seedling raising-Papaya seedlings should be raised under Nylon net (40-60 mesh) and spraying of Acephate @ 1.5g / litre, 3 days before planting should be given.
- Use of border crop-Two rows Sesbania as a border crop should be grown.
- Use of nutrient- Urea @ 10g/liter combined with Zinc sulphate @ 1.5g and Boron @ 1.0g per litre should be applied as spray at monthly intervals up to 8 months.



Technology details

Technologies filed for the award of patent: 5

Publications:

Total Research Publications– 161

Important Research Publications (2018-19):

Kumar, Rajesh; Singh, Chandra Mohan; Arya, Madhuri; Kumar, Rahul; Mishra, S.B.; Singh, U.K. and Paswan, Sudhir (2018): Investigating stress indices to discriminate the physiologically efficient heat tolerant genotypes of mungbean (*Vigna radiata* L.); Legume Research;Published online:LR-3950:1-7

Ahmad, Mohammad Abbas; Agnihotri, Meena; Khan, M.S.; Dubey, Ashutosh; Tyagi, Bhawana; Kumar, Rajesh and Prakash, Nilmani (2018): Biochemical basis of resistance in chickpea varieties against *Callosobruchus chinensis* linn. (coleopteran: bruchidae); Legume Research; Published online: LR-3848:1-5

Sattar, A., Khan, S.A. and Banerjee, S. (2018) Assured rainfall analysis for enhanced crop production under rainfed condition in Bihar. *J. Agrometeorology*, 20(4): 332-335.

Sattar, A., Khan, S.A. and Banerjee, S. and Nanda, M.K. (2018). Assessing sowing window and water availability of rainfed crops in the eastern Indian state of Bihar for climate smart agricultural production. *Theor. App. Climatology*. <https://doi.org/10.1007/s00704-018-2741-9>.

Sinha, D.K., Singh, K.M, Ahmad, Nasim, Chahal V.P., and Meena M.S. 2018. Natural resource management for enhancing farmer's income: An optimal crop planning approach in Bihar, *Ind. J. Agril. Sci.* 88 (4): 641–6, April 2018

Meena, M.S., Singh, K.M. and Meena, H.M. 2018. Participation and Perception Towards Changing Farming Practices in Eastern India: A Study of Women Headed Households. July 2018. *National Academy Science Letters* 41(4):1-3 DOI:10.1007/s40009-018-0656-8

Chaudhary, S. K, Singh, S. P., Jha, Shankar and Singh, Y. 2018. Management of *Sesbania aculeata* Incorporation and Nitrogen on the Performance of Transplanted Rice in Calcareous Soil, *Comm. in Soil Sci. Plant Analysis*, 49:14, 1739-1749.

Jat, M. L., Gupta, R., Singh, R. G., Sutaliya, J. M., Parihar, C., Kumar, M., Karkraliya, S. K., Bijarniya, D., Parihar, M. D. and Jat, M. K. 2019. Ten years of conservation agriculture in a rice-maize rotation of Eastern Gangaetic Plains of India: Yield trends, water productivity and economic profitability. *Field Crops Research*. 232: 1-10.

Kumar, Vijay; Kumar, Mukesh; Singh, Santosh Kumar and Jat, R. K. 2018. Impact of conservation agriculture on soil physical properties in Rice-wheat system of eastern Indo-Gangetic plains. *The J. Animal & Plant Sci.* 28 (5): 1432-1440.

Laik, R., Singh, Santosh Kumar, Kumar, V., Singh, S. P., Shukla, A., Nidhi and Yadav, R. C. 2019. Zinc fertilization in rice-wheat cropping system under upland calcareous soil. DOI: 10.1080/01904167.2018.1482916.

Kumar, V., Sharma, J. C., Kumar, M., Singh, S. K. and Kumar, A. 2019. Mulches and nutrients affect the soil environment, crop performance and profitability of cauliflower. *The J. Animal & Plant Sci.*, 29(1):194-204.

Rima Kumari, Pankaj Kumar, V. K. Sharma and Harsh Kumar (2019) Seedling stage salt stress response specific characterization of genetic polymorphism and validation of SSR markers in rice. *Physiol. Mol. Biol. Plants*, 25 (2): 407-419. <https://doi.org/10.1007/s12298-018-0623-3>.

Punya, V. K. Sharma and Pankaj Kumar (2018) Microsatellite marker dependent genetic divergence assessment within and among heterotic groups of tropical maize inbred lines. *Maydica*, 63(M23): 1-13.

Sugandh Suman, Bibha Rani; V. K. Sharma, H. Kumar and V. K. Shahi (2018) SSR marker based profiling and diversity analysis of mungbean [*Vigna radiata* (L.) Wilczek] genotypes. *Legume Research*, <https://doi.org/10.18805/LR-3918>.

Pankaj Kumar, Rima Kumari and V. K. Sharma (2018) Choice of microsatellite markers for isolation of fertility restorers of wild abortive (WA) type cytoplasmic male sterility in rice. *Indian J. Genet.*, 78: 202-210.

Patel, T., Pranav, P.K. and Biswas, M., 2018. Nonfatal agricultural work-related injuries: A case study from Northeast India. *WORK: A Journal of Prevention, Assessment, and Rehabilitation*, 59 : 367–374.

Biswas, M., Pranav, P. K., Nag, P. K., 2018. Spirometry Prediction Equations for North-eastern Indian Population. *Ind. J Physiol Pharmacol*, 62 (4) : 431-438.

Important Research Highlights:

1. RICE

IVT-E (DS), AVT 1-E(DS) : In IVT-E (DS) entries R2237-1141-1-403-1 (4792kg/ha.) and RCPR17-IR83929-B-B-291-3-1-1 (4791.7kg/ha.) were significantly superior over national check Shabhagi Dhan (2417 kg/ha.) and local check Rajendra Bhagwati (3958 kg/ha).

In AVT 1-E(DS) seventeen entries were tested, among them entries CRR708-1-B-2-B-B-1(3666.7 kg/ha), R1779-321-1-12-1(3000 kg/ha) and CRR747-12-3-B(2533.3 kg/ha) were significantly superior over national check Shabhagi Dhan (2000 kg/ha.) and local check Prabhat (1200 kg/ha).

In NSDWSN entries CR3903-1611-2-1-2(3752 kg/ha.) and RP6175-HHZ8-DT10-SAL3-Sub 1 (3750 kg/ha.) were significantly superior over both national check Sabita (2604 kg/ha.) and local check Sudha (2250 kg/ha).

IVT-DW: In IVT-DW entry CR 3993- (2154 kg/ha.) was significantly superior over national check Jalmagna (1846 kg/ha.) and local check Sudha (1692 kg/ha.)

IVT-MS, AVT1-MSAVT2-MS: In IVT-MS entries WGL-821 (4063 kg/ha.) and NLR 3350 (3750 kg/ha.) were significantly superior over national check WGL-14 (2396 kg/ha.) and local check BPT5204 (2292 kg/ha.)

IVT-NPT, AVT1-NPT, AVT2-NPT: In IVT-NPT entries CR 3561-3-2-1-1-1-1 (5556 kg/ha.) and GNV-13-01(4583 kg/ha.) were significantly superior over national check Jaya (3472 kg/ha.) and local check R.Mahsuri-1 (3472 kg/ha.)

IVT-Aerobic,AVT1-Aerobic, AVT2-Aerobic : In IVT- Aerobic entries RP6263-GSR IR1-5-Y3-Y1-D1 (4833 kg/ha.) and RP6191-HHZ1-Y4-Y1-Y1(4666 kg/ha.) were significantly superior over national check Jaya (3472 kg/ha.) and local check R. Neelam (2334 kg/ha.)

IVT-Aerobic, AVT1- Aerobic, AVT2- Aerobic: In IVT- Aerobic entries RP6263-GSR IR1-5-Y3-Y1-D1 (4833 kg/ha.) and RP6191-HHZ1-Y4-Y1-Y1(4666 kg/ha.) were significantly superior over national check Jaya (3472 kg/ha.) and local check R. Neelam (2334 kg/ha.)

AVT1 NIL-SUB : In AVT-1 NIL-SUB entry RP 5941-29-2-1-1-B (2339 kg/ha.) was significantly superior over recurrent check RP-CO43 (1988 kg/ha.) and donor check IR81896-B-B-195(2462 kg/ha.)

UVT-BORO: 34 entries including tolerant check Gautam were screened for cold tolerance at seedling stage. Nine entries out of 34 showed significant higher survival % than the tolerant check. The entry Boro 3-11-12-5-3-8 showed 100% survival followed by RAU 1451-66-1-1-5-1(95%) and RAU1421-12-1-7-4-4(90%). Among 34 entries none of the entries showed significant superiority over local check Gautam (4.65 t/ha) but three entries RAU 1415-12-7-6-4-5(5.75 t/ha), RAU 722-14-20(5.25 t/ha) and RAU 1428-12-6-7-3-6(5.23 t/ha) were significantly superior over another local check R. Bhagwati(3.80 t/ha).

IVT-BORO: 38 entries were screened for cold tolerance at seedling stage.four entries i.e. entry no.203(100%), entry no.216(100%), 217(100%) and 231(90%) showed 90% or more survival percentage from cold at seedling stage. Entry no.231(5.45 t/ha) and 229 (5.25 t/ha) showed significant superiority over local check (4.80 t/ha).

UVT-1: Among 34 entries RAU 141-18-1-1(5158 kg/ha) and RAU1421-15-3-2-5-7-3(4524 kg/ha) showed significant superiority over checks Richharia (2540 kg/ha.) and Prabhat (2778 kg/ha).

UVT-2: One entry RAU 1397-3(5932 kg/ha) was superior over local check Sahbhagidhan (4532 kg/ha) and national check R. Bhagwati (4465 kg/ha).

UVT-3: Two entries RAU 1425-10 (6247 kg/ha.) and RAU 1397-4 (6213 kg/ha each) were significantly superior over local checks Sita (5181 kg/ha) and Kanak (5081 kg/ha).

UVT-4: Among 24 entries RAU 716(5788kg/ha), RAU1463-11(5774kg/ha) and RAU 1415-12-7-6-4-8-3(5719kg/ha) were superior over local check R. Mahsuri-1(4608 kg/ha.)

UVT-5: Entry RAU 1472-17(4899 kg/ha.) was significantly superior over local checks Rajshree (3719 kg/ha.) and Swarna Sub-1(3748 kg/ha).

AYT-Shallow: In AYT-Shallow only one entry OR 2413-9(5893 kg/ha) was superior over National check IRRI 119(5536 kg/ha).

OYT-Shallow: In OYT-Shallow eight entries were superior over five checks put in augmented design.

Anaerobic germination: Three entries IR 15 D 1080 (0.240 kg/plot), IR 16 D 1062 (0.203 kg/plot), IR 15 D 1042 (0.201 kg/plot), were significantly superior over checks IR64 Sub1 AG 1(0.14kg/ha) and IR64 (0.11kg/ha).

Host Plant Resistance (Screening for Brown Spot Resistance) NSN1, NSN2, NHSN, DSN: Up to score 3 (5%) Promising entries: NSN1 -Br. No. 6202, 6002, IR-64, Benibhog, Ajaya, Rasi, Swarnadhan NSN2 -Br. No. 501, 502, 507, 611, 4546, 6112, 6156, 5832, 5019, 5033, 5038, 4238, 4261, 3901, 3617, 3925, 3946, 3641, 5521, 4622, 4623, HR-12, IR-64, Ajaya, Swarnadhan NHSN -IHRT-M-4, Ajaya, IR-50 DSN - Improved sample Mashuri, IR-64, Ajaya, CO-39, IR-50

Host Plant Resistance (Screening for Sheath Rot Resistance): Up to score 3 (5%) Promising entries: NSN1 -IR-64, Benibhog, Rasi, Ajaya, HR-12, CH-45, RP-BIO-226, Swarnadhan, Br. No. 4111, 6005, 6012, 6024, 6424, 5914, 5313, TN (I), Vikramarya, Nidhi, IR-50, NSN2 -Br. No. : 621, 5217, 5218, 5220, 5235, 5236, 507, 508, 4512, 4513, 4519, 6111, 6156, 5832, 5019, 5020, 5022, 5033, 4212, 4238, 4245, 4261, 3901, 3946, 3614, 3617, 5521, 6302, 4636, HR-12, IR-64, Benibhog, Ajaya, CO-39, RP-Bio-226, IR-50, Rasi, Swarnadhan, NHSN -T (N1), IR-50, IHRT-M-8, IHRT MS-1, HR-12, IR-64, T (N1), Vikramarya, CH-45, Benibhog, Ajaya, RP-Bio-226, IR-50, Rasi, Swarnadhan, Tetep. DSN - Improved sample Mashuri, IR-64, Ayaja, CO-39, IR-50, HR-12, Benibhog, Ajaya, Swarnadhan, Tetep, Ngonoslasha, Phougak

Disease Observation Nursery (To observe the intensity of prevailing disease status and new disease emergence): Date of sowing had marked effect on the development of Brown Spot disease of rice. R. Bhagwati (moderately resistant) and Pankaj (susceptible) were sequentially sown on three dates – early (D/S-12.06.2017, D/T- 06.07.2017), normal (D/S-30.06.2017, D/T- 22.07.2017) and late (D/S- 15.07.2017, D/T-14.08.2017). Brown spot disease severity recorded moderately (28.5%) in normal sown crop of Bhagwati and Pankaj (25.5%). However Brown spot disease was severe (65.0%) in late sown crop of Pankaj (50%) and Bhagwati.

Multiple Resistance Screening Trial (MRST): Out of twenty five entries evaluated against two major insect pests of rice (Stem borer and Leaf Folder), only three entries viz. *KNM-113*, *Suraksha* and *Varalu* were found promising against stem borer damage at both vegetative and heading stage of crop with <5% DH and WE damage. However, entries: *PR 124*, *Ranjeet*, *RC Mainiphou -11* and *Suraksha* were found promising against leaf folder with <5% damaged leaf at 50 DAT.

National Screening Nursery-1 (NSN-1): Out of 360 entries evaluated against two major insect pests of rice (Stem borer and Leaf folder), 22 entries bearing no(s) 12,18,21, 47,57,84, 110, 121, 129, 180, 200, 213, 220, 225,226, 252, 260, 262, 263,269, 303 and 322 were found promising against stem borer damage at both vegetative and heading stage of crop with <5% DH and WE damage. However, only six entries bearing no(s) 03, 16, 53, 95, 165, and 344 were found promising against leaf folder with <5% damaged leaf at 50 DAT.

Pesticide Compatibility Trial (PCT) : The efficacy of eight insecticides on stem borer and consequent impact on grain yield were evaluated. Spinetoram 6 % + methoxyfenozide 30% + Contaf performed well against stem borer (3.95 % DH), (1.13% WE) with 49.5 kg/24m² grain yield and at par with, DPX-RAB 55 + Contaf. Rest of the treatments were at par, maximum damage (10.13% DH, 3.30% WE) and minimum yield (35.4 kg/24 m²) were recorded in untreated control.

Effect of planting dates on insect pest incidence (EPDP): The incidence of stem borer(12.3,6.5 and 19.5%), leaf folder (5.5,4.0 and 7.5%) and gundhibug(3.5,9.0 and 21.5%) with grain yield 34.4, 31.6 and 24.8 q/ha were recorded in early, normal and late plantings of Rajendra Mahsuri respectively.

Evaluation of different crop establishment methods on puddled soil: DSR technique helps in shortening the crop duration (7-10 days). The maximum grain yield was recorded under transplanted condition which was significantly superior over all other methods like- wet DSR (line), wet DSR (broadcasting) and random transplanting. The per cent increase in grain yield in transplanted method was 9.4, 7.8 and 19.5 over wet DSR (line), random transplanting and wet DSR (broadcasting), respectively.

Evaluation of different crop establishment methods on unpuddled soil: DSR needs only 34% of the total labour requirement of transplanted rice. DSR allows early establishment of the succeeding crop. Maximum grain yield was recorded under Dry-DSR when crops were shown in line and maintained statistical superiority over other methods. The per cent increase in grain yield under Dry-DSR (line) was 19.9, 9.1 and 25.4 over Dry-DSR (broadcasting), Aerobic and Semi-Dry broadcasting, respectively.

Evaluation of weed management practices in different rice establishment methods: Weeds are one of the major constraints to DSR cultivation as dry tillage favours weed growth. Among different methods of establishment, transplanting registered 7.8 and 10.7 per cent higher grain yield over wet and dry DSR, respectively. Extent of yield reduction was 17.5% in transplanting, 21% in wet DSR and 53.6% in dry DSR as compared to the treatment pre-emergence herbicides followed by two hand weeding. Application of two post-emergence (Pyrazosulfuron@30gai/ha 15DAS and Bispyribac sodium@30gai/ha 30DAS) proved next best alternative.

Evaluation of nitrogen management practices in different rice establishment methods: Out of three methods of establishment, transplanting with SRI principles recorded significantly maximum grain yield and it was 7.4 & 10.9% higher over DSR-wet and conventional transplanting, respectively. Among different nitrogen management options, LCC based N management practice (135kgN/ha in 5-splits) recorded significantly maximum grain yield while remaining comparable with 150%RDN (180kgN/ha with 3-splits).

Nutrient use efficiency and soil productivity under early and late sown/transplanted rice (2nd Crop): Both time of transplanting and nutrient management practices significantly influenced the rice productivity, nutrient uptake and availability. Very late transplanting (after 5th August) decreased the number of filled grains per panicle, 000' Grain wt., nutrient availability and uptake leading to a reduction in grain and straw yield by 14.6% and 21.3%, respectively. Grain and straw yields recorded under 100%RDF (N - 1/2+1/4+1/4) and 100% NKZn + 150%P (N- 1/3+1/3+1/3) were at par to 150% RDF. The nutrient use efficiency under 150% RDF (N - 1/2+1/4+1/4) and 100% RDF (N- 1/3+1/3+1/3) were higher as compared to other treatments

Monitoring soil quality and crop productivity under emerging rice production systems (2nd Crop): The grain and straw yield was significantly affected by the different nutrient management systems and not by the method of crop establishment. The highest grain and straw yield was recorded in 100% RDF + 50% through organics while 100% RDF through organics recorded the lowest. DSR (wet) and DSR (dry) methods recorded significantly higher nitrogen uptake. The NPK uptake by grain and straw was significantly higher under the nutrient management system 100% RDF + 50% through organics. The method of crop establishment, DSR (wet) and TPR recorded significantly higher available nitrogen.

Yield maximization of rice through Site Specific Nutrient Management (2nd Crop): The grain and straw yield, as well as NPK uptake was significantly higher in SSNM treatment based on Nutrient Expert. Significantly higher values were recorded for the yield components such as number of filled grains panicle⁻¹, number of panicles m⁻² and 000' grain wt. under the treatment, SSNM based on Nutrient Expert. The soil parameters such as, percent organic carbon, available N & K were also significantly higher in SSNM treatment based on Nutrient Expert, followed by 100% RDF and SSNM based on LCC.

2. MAIZE

To evaluate the Performance of Late maturity Experimental Hybrid in NIVT Trial No TR 61 A (NIVT – L): Seed yield differences were found among the test entries but not significantly superior to the best check. An entry SYN 617328 from Syngenta seeds Ltd. & X 6 from Star Agrotech Ltd. gave higher yield 81.57 q/ha & 81.28 q/ha, respectively and are higher to best check PMH -1 (79.48 q/ha).

To evaluate the Performance of Late maturity experimental hybrid in NIVT Trial No. 61 B (NIVT - L): None of entries were found significantly superior to the best check. But An entry JH 15011 from PAU Ludhiana gave the highest grain yield 94.43 q/ha follow by IMH1547 (88.61 q/ha) from IIMR New Delhi and IMH 1602 gave 88.07 q/ha. As compared to the best check CMH 08-287 (87.55 q/ha).

To evaluate the Performance of Medium maturity Experimental Hybrid in NIVT. Trial No. 62 A (NIVT - M) in Co-ordinated trial. : In IVT first year of medium maturity group there is

significant difference in seed yield was found among the all the test entries but not significantly superior to the best check CMH 08292 (64.01 q/ha).

To evaluate the Performance of Medium maturity Experimental Hybrid in NIVT. Trial No. 62 B (NIVT - M) in Co-ordinated trial Kharif 2016: One entry from IIMR New Delhi IMH 1605 gave significantly superior yield of 73.99 q/ha as compared to the best check CMH08292 (64.63 q/ha).

To evaluate the Performance of Early & extra early maturity Hybrids in Early-ex-early NIVT E & Ex Trial No. 63, 64: An entry KH 102 from KGSC PVT LTD gave significantly higher yield 47.27 q/ha. As compared to the best check Vivek hybrid 45(38.70 q/ha).

To evaluate the Performance of Late maturity Experimental Hybrids in AVT-I Tr. 66 Z3 (AVT – 1-M-NEPZ) during Kharif in (Co-ordinated)) Trial: Two entries DKC 8161 (86.61 q/ha) and DKC 9163 (72.74 q/ha) were found significantly superior to the best check Seedtech 2324(65.19 q/ha).

To evaluate the performance of QPM experimental hybrids in Trial No QPM 123 during Kharif 2017 (Co-ordinated) Trial: Two entries QPM MH 27 (60.59 q/ha) and AQH 8 (60.57 q/ha) were found significantly superior to the best check HM 8, which yielded 52.56 q/ha.

To evaluate the performance of Pop Corn experimental hybrids in Trial No Pop corn during Kharif 2017 (Co-ordinated) Trial. : Entry MPC – 1-15 of Dholi centre promoted in AVT-1.

To evaluate the performance of Sweet Corn experimental hybrids in Trial No Sweet corn during Kharif 2017 (Co-ordinated) Trial. : In sweet corn trial, total 13 entries were evaluated, in which significantly differences were observed among the genotypes. An entry BSCH-6 yielded 65.28 q/ha followed by an entry Bio 4043, which yielded 65.0 q/ha were significantly superior to the best check Madhuri (59.7 q/ha).

To evaluate the performance of Baby Corn experimental hybrids in Trial No Baby corn during Kharif 2017 (Co-ordinated) Trial: Entry MBC – 1-15 of Dholi centre promoted in AVT-1.

To evaluate the performance of NIVT Late maturity hybrids (NIVT-L) Coordinated: Maximum grain yield was recorded in the entry no 1109 (14.8 ton/ha) followed entries no. 14.0 ton/ha, 1021 (13.7 ton/ha) 1074 (13.1/ha) are entry no 1053 (12.7 ton/ha).

To evaluate the performance of NIVT medium maturity hybrids (NIVT-M) Coordinated: Out of 35 entries, maximum grain was recorded by the entry no. 2140 (9.7 ton/ha) followed by the entry no. 1188 (9.5 ton/ha) entry no. 1182 (9.0 ton/ha) and entry no. 1221 (8.5 ton/ha).

To evaluate the performance of AVT Late maturity hybrids (AVT-L) Coordinated: Twelve Entries were evaluated in which maximum grain yield was recorded by the entry no. 1272 (11.6 ton/ha) followed by entry no. 1281 (10.9 ton/ha), entry no. 1282 (10.6 ton/ha) entry no. 1258 (10.3 ton/ha) and entry no. 1271 (10.0 ton/ha).

To evaluate the performance of AVT medium maturity hybrids (AVT-M) Coordinated: 7 entries were evaluated in which maximum grain yield was recorded by the entry no. 1313 (10.6 ton/ha) followed by entry no. 1311 (10.0 ton/ha) entry no. 1299 (9.7 ton/ha) and entry no 1304 (9.5 ton/ha).

To evaluate the performance of AVT-II Late maturity hybrids (AVT II-L) Coordinated: Seven entries were evaluated in which maximum grain yield was obtained by the entry no. 1337 (11.0 ton/ha followed by entry no. 1323(10.6 ton/ha) and entry no. 1335 (10.4 ton/ha).

To evaluate the performance of AVT medium maturity hybrids (AVT II-M) Coordinated: 8 entries were tested in which maximum grain yield was obtained by the entry no. 1372 (11.6 ton/ha) followed by entry no 1351 (10.6 ton/ha) and entry no. 1359 (10.4 ton/ha)

To evaluate the performance of QPM I-II-III hybrid in Co-ordinated: In QPM experimental trial, 7 entries were evaluated in which maximum grain yield was recorded by the entry no. 1397 (9.7 ton/ha) followed by entry no. 1383 (9.4 ton/ha) and entry no. 1398 (9.0 ton/ha)

To evaluate the Performance of Newly developed hybrid in station trail 301 : In station trial 301 highest and significant grain yield was of MH 11-17 (119.8 q/ha) MH 16-17 (117.4 q/ha), and MH 03-17 (114.2 q/ha) as compare to the best check SM- 5 which yielded (105.5 q/ha).

Plan of work for the ensuing season: To be continued

Evaluation and Maintenance of Inbred lines : Altogether 376, Indigenous 65 and Exotic 311 inbreds maintained and evaluated during *Rabi* 2017-18. In exotics CIMMYT materials 150 advanced inbred lines (White + Yellow), Winter nursery Hyderabad 127 advanced inbred lines (White + Yellow) and 34 New CIMMYT QPM Yellow inbred Lines have been maintained. In

Indigenous group, in White colour, AB (w) Pool (from 40 white lines 10 advanced inbred lines), Jorgia local (from 30 white lines 5 advanced inbred lines), Dewki (from 20 white lines 6 advanced inbred lines), Hemant x Drought tolerant (from 15 white lines 4 advanced inbred lines), Vaishali Local (from 50 white lines 10 advanced inbred lines), Dholi pool-65 (from 25 white lines 10 advanced inbred lines), National pool-4 (from 30 white lines 8 advanced inbred lines) whereas, in yellow colour, Suwan composite, from 25 yellow lines 12 advanced inbred lines have been identified.

Optimization of Potassium Fertilizer for Eastern India. : Application of 90 Kg K₂O/ha with 120 Kg N and 60 Kg K₂O/h recorded significantly higher yield and B:C ratio than lower dose of K. however K levels 90, 120 and 150 Kg/ha were found to be non significant among each other.

Nutrient Management in Maize - Wheat Cropping System under different Tillage Practices. : Under zero tillage, conventional till permanent bed method of sowing of maize nutrient application FFP (200:60:50 NPK /ha) yielded significantly higher grain yield.

Effect of planting density and nutrient management practices on the performance of hybrids in Kharif Season. : Shaktiman 2 genotype recorded significantly higher yield than shaktiman 5 plant population 60 x 20 cm and application of nutrients through STCR gave significantly higher yield.

Weed Management in Maize Systems: Application of Atrazine @1.5 Kg/ha pre emergence gave significantly higher yield, net return and B: C ratio which was at par to T2 (Weed free condition) and T10 (Atrazine @ 1.5 Kg/ha pre emergence *fbtembotryn laudis* 120 g/ha POE at 25 DAS.)

Performance of Pre-release baby corn genotype in Kharif season under varying planting density and nutrient levels: In the experiment of baby corn plant population of 125000 with application of 150:50:60 Kg/ha gave significantly higher yield. However, among the 4 genotype of baby corn no significant differences was noticed between the genotype.

Optimization of Potassium Fertilizer for Eastern India: Different Potassium fertilizer treatment 90 Kg/ha potassium gave significantly higher MEY 109.0 q/ha and B:C ratio followed by 120 Kg/ha Potassium among the all six treatment.

Evaluation of New Bio-Fertilizers in Maize : The result indicated the MEY & B:C Ratio is higher in 30 kg P₂O₅/ha + PSB I followed by all 11 treatments of Bio fertilizer .

Nutrient Management in Maize-Wheat Cropping System under different Tillage Practices : Both treatment Permanent Bed and Zero Tillage were equally superior over Conv. tillage and at par between them in respect of MEY & B:C Ratio. Higher MEY & B:C Ratio was noticed in SSNM.

Effect of planting density and nutrient management practices on the performance of hybrids in Kharif Season : Both cultivar Shaktiman 2 & Shaktiman 5 was equally performed of MEY, Plant density 60 x 20 cm recorded higher MEY (97.22 q/ha) over 50 x 20 cm (96.89 q/ha) under fertility treatments the application of SSNM is higher MEY followed by STCR & RDF.

Weed Management In Maize Systems : Different weed management in Maize and wheat system. Treatment Atrazine @ 1.5* kg/ha re-emergence highest MEY 94.73 q/ha and at par to weed free. Which is superior over other treatment?

Effect of planting density and Nutrient management practices on performance of hybrids in Rabi : The result indicates that MEY & B:C ratio between two different cultivars NK 6702 showed higher yield followed by NK 7720 respectively. Under different density 50 x 20 cm shows higher MEY & B:C Ratio followed by 60 x 20 cm. under different fertility levels STCR showed higher MEY SSNM showed higher B:C Ratio.

Nutrient management in rice-maize cropping system under different tillage practices : MEY & B:C Ratio was higher under permanent bed over remaining treatments zero tillage & conventional tillage while SSNM & RDF are equally superior over FFP and at par between then in respect of MEY & B:C Ratio.

Performance of pre release medium maturity Genotype in Rabi season under varying planting density & Nutrient levels : Performance of pre release medium maturity genotype IMH 305 and IMH 304 gave highest yield at par 96.29 and 94.68 q/ha respectively and net return also at par Rs. 78700 and 76560 respectively and under fertility levels 200:65:80 gave higher yield 83.78 q/ha and higher net return Rs. 62.12 thousand/ha. In respect of distance 60 x 15 cm gave highest yield 83.16 q/ha and net return Rs. 61.29 thousand/ha.

Ecological intensification for climate resilient maize based cropping systems : Among the all eight treatment EI minus nutrient management (Absolute control for nutrient in all crops) noticed highest MEY 152.78 q/ha and B:C Ratio 1.98 followed by treatment ecological infestation 136.09 q/ha and B:C ratio EI minus Disease and insect management (No management in all crops).

Screening of maize hybrids of the coordinated trials against Maydis leaf blight under artificial inoculated conditions:

NIVT- (Late) :- Out of 84 entries, no entry was found resistant whereas, seven (7) entries were found moderately resistant against Maydis leaf blight disease of maize. Thirty-five (35) entries

showed moderately susceptible and 44 entries including susceptible check CML 186 showed susceptible reaction against Maydis leaf blight disease.

NIVT - (Medium):- Out of 100 entries, no entry was found resistant whereas, twenty (20) entries were found moderately resistant against Maydis leaf blight disease of maize. Thirty-one (31) entries showed moderately susceptible and 50 entries including susceptible check CML 186 showed susceptible reaction against Maydis leaf blight disease.

NIVT - (Early + Ex. Early):- Out of 40 entries, one (1) entry namely WH-2212 was found resistant whereas, ten (10) entries were found moderately resistant against Maydis leaf blight disease of maize. Twenty (22) entries showed moderately susceptible and 8 entries including susceptible check CML 186 showed susceptible reaction against Maydis leaf blight disease.

75 Late (AVT-I-II):- Out of 24 entries, two (2) entries were found resistant whereas, three (3) entries were found moderately resistant against Maydis leaf blight disease of maize. Fifteen (15) entries showed moderately susceptible and 5 entries including susceptible check CML 186 showed susceptible reaction against Maydis leaf blight disease.

76 Medium (AVT- I-II):- Out of 26 entries, no entry was found resistant whereas, three (3) entries were found moderately resistant against Maydis leaf blight disease of maize. Twelve (12) entries showed moderately susceptible and 12 entries including susceptible check CML 186 showed susceptible reaction against Maydis leaf blight disease.

77 Early (AVT- I-II):- Out of 15 entries, one entry namely FH 3771 was found resistant whereas, five (5) entries were found moderately resistant against Maydis leaf blight disease of maize. Six (6) entries showed moderately susceptible and 4 entries including susceptible check CML 186 showed susceptible reaction against Maydis leaf blight disease.

QPM- I-II-III:- Out of 45 entries, no entry was found resistant whereas, nine (9) entries were found moderately resistant against Maydis leaf blight disease of maize. Twenty-six (26) entries showed moderately susceptible and 11 entries including susceptible check CML 186 showed susceptible reaction against Maydis leaf blight disease.

Sweet Corn- I-II-III:- Out of 15 entries, only single entry namely ASKH-61 was found resistant whereas, seven (7) entries were found moderately resistant against maydis leaf blight disease of maize. Five (5) entries showed moderately susceptible and 3 entries including susceptible check CML 186 showed susceptible reaction against maydis leaf blight disease.

Baby Corn- I-II-III: - Out of 11 entries, no any entry found resistant and two (2) entries were found moderately resistant against Maydis leaf blight disease of maize. Five (5) entries showed

moderately susceptible and 5 entries including susceptible check CML 186 showed susceptible reaction against maydis leaf blight disease.

Pop Corn- I-II-III:- Out of 14 entries, no entry was found resistant and single (1) entry namely BPOCH 415042 found moderately resistant against Maydis leaf blight disease of maize. Six (6) entries showed moderately susceptible and 8 entries including susceptible check CML 186 showed susceptible reaction against Maydis leaf blight disease.

Rainfed AVT-I :- Out of 11 entries, single entry viz. CMH 08-282 (C) was found resistant and five (5) entries were found moderately resistant against Maydis leaf blight disease of maize. Four (4) entries showed moderately susceptible and single entry susceptible check CML 186 showed susceptible reaction against Maydis leaf blight disease.

Occurrence of maize diseases in trap nursery trial. - Out of 14 entries of Trap Nursery Trial of maize Maydis leaf blight disease appeared in 3 to 8 disease rating scale. Other than Maydis leaf blight on any other diseases like TLB, Rust, BLS or BSR appeared in trap nursery trial.

Screening of Phenotyping trials for Maydis leaf blight (MLB):- Out of 150 entries, single entry No. 420 was found resistant and thirty one (31) entries were found moderately resistant against Maydis leaf blight disease of maize. Seventy – five (75) entries showed moderately susceptible and 43 entries including susceptible check CML 186 showed susceptible reaction against Maydis leaf blight disease.

Screening of maize inbred lines for Maydis leaf blight (M15):- Out of 218 entries, eleven (11) entries were found resistant and forty six (46) entries were found moderately resistant against maydis leaf blight disease of maize . Eighty two (82) entries showed moderately susceptible and 77 entries including susceptible check CML 186 showed susceptible reaction against Maydis leaf blight disease

Screening of maize inbred lines for Maydis leaf blight (M 16):- Out of 277 entries, seventeen (17) entries were found resistant and thirty four entries were found moderately resistant against Maydis leaf blight disease of maize. 105 entries showed moderately susceptible and 77 entries including susceptible check CML 114 showed susceptible reaction against Maydis leaf blight disease

Disease survey & surveillance in different maize growing areas .: Surveyed Muzaffarpur, Samastipur, Vaishali and East Champaran districts covering 30 farmer fields (20 ha) from 14 different places. Only Maydis leaf blight was noticed in sever to moderate intensity in almost all

the field surveyed. Maximum disease incidences were noticed in Muzaffarpur district of Mohamadpur village and Samastipur district of Bhagawatpur village.

Screening of NIVT Normal maize genotypes against *Turcicum* leaf blight (*Helminthosporium turcicum*) disease under artificial inoculated conditions:

IVT- Late : Out of (35) coded entries (13) coded entries in RI were found resistant to *Turcicum* leaf blight disease of maize. Susceptible check CML 186 rated as susceptible reaction to *Turcicum* leaf blight.

Screening of NIVT Medium maize genotypes against *Turcicum* leaf blight (*Helminthosporium turcicum*) disease under artificial inoculated conditions :

IVT- Medium: Out of (35) coded entries (9) coded entries in RI and (10) coded entries in RII namely were found resistant to *Turcicum* leaf blight disease of maize. Susceptible check CML 186 rated as susceptible reaction to *Turcicum* leaf blight.

Screening of AVT-I-II- Normal maize genotypes against *Turcicum* leaf blight (*Helminthosporium turcicum*) disease under artificial inoculated conditions:

AVT-I-II- Normal maize: Out of (30) coded entries (8) coded entries in RI and (20) coded entries in RII namely (20) were found resistant to *Turcicum* leaf blight disease of maize. Susceptible check CML 186 rated as susceptible reaction to *Turcicum* leaf blight.

Screening of AVT-I-II- Normal maize genotypes against *Turcicum* leaf blight (*Helminthosporium turcicum*) disease under artificial inoculated conditions :

AVT-I-II- Normal maize : Out of (11) coded entries (5) coded entries in RI and (4) coded entries in RII were found resistant to *Turcicum* leaf blight disease of maize. Susceptible check CML 186 rated as susceptible reaction to *Turcicum* leaf blight.

Screening of QPM maize genotypes against *Turcicum* leaf blight (*Helminthosporium turcicum*) disease under artificial inoculated conditions :

QPM maize : Out of (7) coded entries (3) coded entries in RI 01 coded entry viz. IIMR 22057 in RII and (1) coded entries in RIII namely IIMR 22105 was found resistant to *Turcicum* leaf blight disease of maize. Susceptible check CML 186 rated as susceptible reaction to *Turcicum* leaf blight.

Use of Botanical Pesticide for management of *Turcicum* leaf blight under artificially created epiphytotic conditions :

QPM maize: The result revealed that PDI ranged in protected plot were 11.11 to 44.44 and in unprotected plot 11.11 to 88.88. The grain yield was recorded (48.52 q/ha) in protected plot and (36.87 q/ha) in unprotected plot. Botanical pesticide was found effective in

checking of *Turcicum* leaf blight which gave 50.0 per cent disease control with 31.59 per cent increase in yield.

Effect of insecticides on damage caused by maize stem borer, *Chilo partellus* in maize during Kharif 2017: The minimum and maximum percent plant infestation were found in treatments Chlorantraniliprole 20 SC @ 0.3 ml/l followed by Carbofuran 3G @ 7kg/ha (2.20%) and untreated control (72.60%). The foliar application of Chlorantraniliprole 20 SC @ 0.3 ml/l, Novaluron 10 EC @ 0.1 ml/l, Flubendiamide 480 SC @ 0.2 ml/l and Deltamethrin 2.8 EC @ 0.4 ml/l recorded 10.60, 27.62, 10.40 and 13.75 percent infestation, respectively.

Evaluation of maize Genotypes against climbing cutworm under artificial infestation during Rabi 2017-18 : Altogether 22 entries were evaluated against climbing cut worm under artificial infestation condition on 1-5 scale. Out of which 10 entries were grouped under least susceptible

Evaluation of maize Genotypes against climbing cutworm under artificial infestation during Rabi 2017-18 : Altogether 20 entries were evaluated against climbing cut worm under artificial infestation condition on 1-5 scale. Out of which 10 entries were grouped under least susceptible

Survey of insect pests of maize at Muzaffarpur and its adjoining districts : Altogether 20 entries were evaluated against climbing cut worm under artificial infestation condition on 1-5 scale. Out of which 10 entries were grouped under least susceptible

3. PIGEONPEA

IVT Late: Out of fifteen entries three entries namely Pusa 163 (3210 kg/ha), Pusa 162 (3095 kg/ha) and DA 16-2 (2909 kg/ha) were found at par with the check Bahar (3054 kg/ha).

AVT-1: Out of six entries only one entry namely DA 15-1 (2637 kg/ha) was found at par to the check Bahar (2457 kg/ha) while at National Level it got 1st rank having the mean yield over the eight locations (1924 kg/ha) and got promoted AVT-2.

Station Trial: Out of sixteen entries only two entries namely DA 17-1 (1964 kg/ha) and DA 17-2 (2054 kg/ha) were found at par to the check Bahar (1612 kg/ha)

Nutrient management in pigeon pea based intercropping system: Intercropping of urdbean in paired row planting of pigeonpea (2:2) row ratio was found more beneficial than normal planting pattern in pigeonpea. In pigeon pea + urdbean only 75% RDF of urdbean should be applied along with RDF of pigeon pea. However, in pigeon pea + sesame and pigeon pea + sorghum, RDF and

125% RDF of intercrops, respectively, should be applied together with RDF of pigeon pea for obtaining higher pigeon pea equivalent yield.

Standardization of crop geometry and nutrient management for Rabi pigeon pea: Closer plant spacing of 30 x 15 cm produced higher grain yield (931.6 kg/ha) which was at par with spacing of 45 x 15 cm (743.6 kg/ha) and significantly higher over wider plant spacing of 60 x 15 cm (598.1 kg/ha). Similarly, foliar application of 0.2% micro-nutrient at 50% flowering together with RDF and 5.0 t. FYM/ha. recorded significantly higher number of pods/plant and grain yield (889.1 kg/ha) than application of RDF + 5.0 FYM/ha (606.4 kg/ha).

Nutrient and pest management in pigeon pea: Foliar application of multi micronutrient at 50% flowering @ 2 ml/litre of water together with RDF and two spray of insecticides i.e. indoxacarb at flowering followed by profenofos 15 days after first spray produced maximum grain yield (2733.4 kg/ha) but was found at par with two spray of these insecticides together with RDF (2666.7 kg/ha) and 1% urea + 0.25% Znso4 + 0.25% Borex at 50% flowering along with RDF (2755.6 kg/ha) and significantly higher over rest of the treatments. Spray of indoxacarb at 50% flowering followed by profenofos 15 days after first spray significantly reduced the incidence of pod borer.

Evaluation of sequential application of insecticides against pod borer (*Helicoverpa armigera*) in Pigeonpea: Pod fly damage was significantly varied from 9.2 % in sequential spray of (Chlorantraniliprole -18.5SC@30g.a.i./ha — Flubendiamide -480SC @30g.a.i./ha —Dimethoate-30 EC@600g. a. i./ha) to 41.5 % in untreated control. Minimum 2.6% pod damaged by pod borer was observed in T₆ to 26.5 % in untreated control. Per cent pod damage was reduced significantly by all the treatments over control (41.5% and 26.5%) due to pod fly and pod borer, respectively. Yield varied significantly from untreated control. Maximum grain yield of 1438.1 kg/ha was in T₆ followed by T₅ (Chlorantraniliprole-18.5SC @ 30g.a.i./ha —Indoxacarb-15.8 EC @73g. a. i./ha —Acetamid-20 SP @ 20g. a. i./ha) i.e. 1287.5Kg/ha to minimum 927.5 Kg/ha in untreated control.

Monitoring of *Helicoverpa armigera* in Pigeonpea. : The pest activity started during 2nd week of February, 2017 and continued till the last week of March, 2017. The moth population, number of

eggs and larval population in the beginning were low which gradually increased and reached its peak (6.2/trap, 17.0 eggs/plant and 9.0 larval plant during 1st week of March, 2017 where corresponding maximum, minimum temperature relative humidity at 7:00AM and 2:00PM were 28.4⁰C, 9.4.⁰C, 98.00%, 85.00%, respectively. The lowest moth population (2.6/ trap) was recorded in the 3rd week of March, 2017.

Validation of location specific integrated pest management in pigeon pea: Low pod damage in IPM treatment may be due to intercrop and three sprays of insecticides, which may have influenced the level of pest damage. The grain yield in farmer's practices was 1093.20 kg/ha whereas it was 1525.00Kg/ha in IPM practices.

Evaluation of IVT, AVT, Genetic stock, National released entries & ICRISAT entries

against wilt caused by *Fusarium udum*: Out of one hundred thirty (130) entries of pigeon pea evaluated, 25 entries were exhibited resistant reaction (up to 10 % wilt) against the disease. 63 entries recorded mod. resistant reaction and remaining entries showed susceptibility to the disease. The wilt incidence in different entries ranged from 2.9 to 100 percent. In susceptible check ICP 2376, more than 50% disease incidence was observed.

Evaluation of IVT, AVT, Genetic stock, National released entries & ICRISAT entries

against sterility mosaic disease: Out of 133 entries evaluated, only four entries viz., IVTM-14, IVTL-1, PHY-6 & ICPWS1617 showed resistant reaction against sterility mosaic disease under epiphytotic conditions. Twenty four entries recorded moderate. Resistant reaction against sterility mosaic disease and remaining entries showed susceptibility to the disease. The disease incidence in susceptible check ICP 8863 was more than 80%.

Monitoring of races of *Fusarium udum* through host plant differentials: In nine (9) Pigeonpea entries wilt differentials were evaluated, ICP8858 & BDN1 recorded resistant reaction; ICP8863, ICP8859 & ICP 9174 entries recorded resistant to moderately resistant reaction against wilt consistently for last ten years. Based on reaction of wilt on standard differentials at multilocation testing, variant 1 of *F. udum* was identified at Dholi. The disease reaction of Dholi, Gulbarga, Khargone, IIPR Kanpur and Bangalore on the said differentials was alike and matched with variant 1.

4. CHICKPEA

IVT Late Sown: Out of thirty one test entries none of the entry have shown the significant superiority over the best check KPG 59 (1.3 t/ha), however DC 16-116 (1.15 t/ha) was found on par to the check.

AVT 1 Desi: Out of twelve test entries two entries viz; GL 13001 (1.76 t/ha) and DC 16-2 (1.70 t/ha) have shown the significant superiority over the best check KPG 59 (1.5 t/ha). Entry from Dholi centre i.e. DC 16-2 has been retained in AVT-1 which had shown 9.5 % yield superiority over the best check and ranked second in the AVT-1 Rabi 2017-18 at national level.

IVT Desi: Out of forty five test entries four entries viz; BG 3088 (2.81 t/ha), KGD 2017-1 (2.80 t/ha), GNG 2372 (2.79 t/ha), and H 14-11 (2.66 t/ha) were found at par to the best check GNG 21-71 (2.68 t/ha).

MLT 2017-18: Among the eight chickpea (desi) entries three entries viz; GNG 2264 (2.21 t/ha), Rajendra Chana 1 (2.1 t/ha) and DC 16-114 (2.07 t/ha) have shown the significant superiority over Pusa 256 (1.82 t/ha) as well as DK 16-313 (Kabuli) also showed the significant superiority over the Kabuli check HK 4 (1.34 t/ha). Five desi genotypes viz; DC 17-1111, DC 17-1115, DC 18-1, DC 18-2, and DC 16-2 (R) and two Kabuli genotypes DK 16-313, DK 17-1306 were submitted for testing under National Evaluation System for rabi 2018-19.

Evaluation of chickpea entries against wilt diseases : Out of thirty eight entries, thirty two entries were found to be moderately resistant.

Evaluation of chickpea entries against wilt diseases: Out of five entries, four entries viz., ICCV 07111, ICL P2, ICL P3, and ICC 12467 were found to be moderately resistant.

Evaluation of chickpea wilt & root rot nursery (ICAR-ICRISAT Collaborative trial): Out of 32 entries evaluated, nineteen entries showed resistance against wilt. Wilt incidence in susceptible check ICC 4951 was 52.00 %.

Field evaluation Rabi 2017-18 coordinated trials, IVT, AVT 1, AVT 2 material against keyinsect pests of the locality : AVT 1 (Desi)-Only 5 entries out of 21 were found least susceptible as compared to check variety, KPG-59. The least susceptible entries (with pod damage varied from 3.0 to 6.7%) were H 12-63, Phule G 3075, Phule G 0818, GNG 2325 and BG 3076. Rests of the entries were found susceptible to *H. armigera* when compared with check variety KPG-59 (with Pod damage varied from 8.0 to 18.4%). IVT (Desi) Only 9 entries out of 27 were

found least susceptible as compared to check variety, KPG-59. The least susceptible entries (with pod damage varied from 2.22 to 6.73%) were RLBG-1, BRC 5, AKG 1401, CSJ 867, GJG 1511, RG 2015-07, KGD 2017-1, BDNG 2010-1 and Phule G 0914-08-14. Rests of the entries were found susceptible to *H. armigera* when compared with check variety KPG-59 (with Pod damage varied from 6.95 to 17.39%). AVT2 + AVT 1(Late sown) only 3 entries out of 6 were found least susceptible as compared to check variety, KPG-59. The least susceptible entries (with pod damage varied from 3.12 to 6.73%) were GNG 2299 (AVT-2), GNG 2299 (AVT-1) and H 12-29 (AVT-1). IVT (late sown) only 10 entries out of 24 were found least susceptible as compared to check variety, KPG-59. The least susceptible entries (with pod damage varied from 1.33 to 7.00%) were PG 187, CSJ 887, BRC 305, CSJ 956, RG 2015-05, NBeG 773, GL 13042, JG 2017-50, Phule G 1012-10-9 and GL 14015. Rests of the entries were found susceptible to *H. armigera* when compared with check variety KPG-59 (with Pod damage varied from 8.09 to 15.57%). AVT 1 (Rain fed) only 1 entry out of 3 was found least susceptible as compared to check variety, KPG-59 (5.00%). The least susceptible entry (with pod damage 5.33%) was CSJ 824. IVT (Rain fed) only 7 entries out of 23 were found least susceptible as compared to check variety, KPG-59. The least susceptible entries (with pod damage varied from 0.66 to 3.33%) were Phule G 0913-2-11, GL 14002, PBC 516, GNG 2392, CSJ 740, DBGV 214 and NBeG 753. Rests of the entries were found susceptible to *H. armigera* when compared with check variety KPG-59 (with pod damage varied from 3.33 to 19.66%). AVT 1 (Kabuli) only one entry (NBeG 440) was found susceptible with pod damage (19.28%) as compared to check variety, KPG-59 (5.58%) IVT (Kabuli + ELS Kabuli) only one entry (GLK 15304) was found least susceptible with pod damage (3.12%) as compared to check variety, KPG-59 (4.47%). Rests of the entries were found susceptible to *H. armigera* when compared with check variety KPG-59 (with Pod damage varied from 8.69 to 24.47%). AVT 1 (ELS Kabuli) only one entry (GLK 14311) was found least susceptible with pod damage (14.22%) as compared to check variety, KPG-59 (16.33%). AVT 1 (Mechanical Harvesting) only 4 entries out of 5 were found least susceptible as compared to check variety, KPG-59. The least susceptible entries (with pod damage varied from 11.89 to 14.33%) were JG 2016-24, Phule G 08108, CSJ 515 and H-13-09. IVT (Mechanical Harvesting) only 7 entries out of 13 were found least susceptible as compared to check variety, KPG-59. The least susceptible entries (with pod damage varied from 11.95 to 14.78%) were PG 144, NBeG 868, DBGV 212, Phule G 1012-15, RG 2010-10-5, Phule G 1005-5-4 and JG 2017-48. Rests of the entries were

found susceptible to *H. armigera* when compared with check variety KPG-59 (with Pod damage varied from 15.03 to 19.17%).

Screening of tolerant entries for confirmation of source of resistance to *Helicoverpa armigera*

: Only 6 entries out of 13 were found least susceptible as compared to check variety, KPG-59. The least susceptible entries (with pod damage varied from 9.00 to 13.67%) were BG 3043, GL 12021, Pule G 13107, NBeG 807, NBeG 49 and CSJ 855. Rests of the entries were found susceptible to *H. armigera* when compared with check variety KPG-59 (with pod damage varied from 14.67 to 33.33%).

Incidence of insect pests of chickpea and their natural enemies throughout cropping period. :

Pod damage due to borers in early date sown was 31.90 per cent during 11th Std. week and normal date sown was 43.64 per cent during 12th Std. week whereas in late date sown it was 49.00 per cent during 12th Std. week. Yield of the crop was higher in normal date sown crop than early and late sown crop. Yield (kg/ha) in normal date sown was 1250.00kg/ha whereas in late date sown it was 935.00kg/ha. On the basis of per cent pod damage it was clear that *H. armigera* caused more pod damage to the late sown crop than early sown and normal sown crop resulting in lower production of the grain yield in late sown crop over early and normal sown crop. No parasitized larvae by *C. chloridae* were recorded.

Monitoring of pod borer, *H. armigera* moth using pheromone traps : Monitoring was done from 5th standard weeks to 15th standard weeks. The activity was recorded from 4th standard week to 15th standard weeks. Maximum number of adults 3 traps/week) (24.66) were recorded during 12th standard weeks.

Estimation of crop losses in chickpea due to pod borer, *Helicoverpa armigera*: Less pod damage was observed in protected plot (6.73%) as compared to unprotected plot (14.66%) with 53.06% reduction in pod damage over unprotected plot. Similarly average yield in protected plot was recorded higher (1093.29 kg/ha) as compared to unprotected plot as against 847.74kg/ha. The only 22.93 % avoidable loss recorded due to low incidence of insect pests.

5. MULLaRP

AVT - 1: Out of 8 (eight) urdbean entries tested, one entry U17-7 (1013 kg/ha) recorded significant superiority over the check Uttara (915 kg/ha), where as KU17-5 (925 kg/ha) was found at par to the check.

Lentil Extra Early₂: Out of fifteen test entries two entries namely L 4751 (3.36 t/ha) and RL 8 (3.43 t/ha) have shown the significant superiority over the best check HUL 57 (2.5 t/ha).

IVT Small Seeded: Out of nineteen test entries only one entry namely PL 260 (2.05 t/ha) was found on par to the best check HUL 57 (2.03 t/ha).

IVT Field Pea (Tall): Out of nineteen test entries only two entries namely IPF 17-18 (1.68 t/ha) and NDPT 2017-04 were found significantly superior to the best check VL 42 (1.19 t/ha).

IVT Field Pea (Dwarf): Out of nineteen test entries four entries namely KPF 14-36 (1.81 t/ha) HUDP 1715 (1.82 t/ha), HUDP 17-11 (1.84 t/ha) and Pant P 365 (1.77 t/ha) were found significantly superior to the best check SKNP 04-09 (1.67 t/ha).

IVT Field Pea (Rice Fallow): Out of twelve test entries only one entry namely IPFD 2014-2 (2.14 t/ha) has shown significant superiority over the best check VL 42 (1.95 t/ha) however IPFD 16-4 (1.91 t/ha) was found at par to the check.

Breeder Seed Production: Lentil HUL 57 (2.15 t), Field Pea HUDP 15 (1.16 t), GDFP 1 (0.93 t) & Rajmash Utkarsh (0.78 t)

Front Line Demonstration (FLD): FLD on Lentil (HUL 57) with full package was conducted in ten hectare and overall 37% of yield superiority was recorded over the farmers practices having the mean yield 1.71 t/ha. FLD on Field pea (HUDP 15) with full package was conducted in five hectare and overall 31% of yield superiority was recorded over the farmers practices having the mean yield 2.3 t/ha.

Herbicide weed management in urdbean.: Lower weed dry weight (4.10 g/m²), higher weed control efficiency (89%) and higher seed yield of urdbean (1018 kg/ha) was recorded in the treatment having hand weeding twice at 20 and 35 DAS. Among the different herbicides applied Clodinafop propargyl 8% + Aciflourfen sodium 16.5 % @ 187.5 g/ha at 15-20 DAS (995 kg/ha), Pendimethalin 30 EC+ Imazethapyr 2 EC @ 1.0 kg/ha–PE (949 kg/ha) and Imazamox 35 wg + Imazethapyr 35 WG @ 60 g/ha at 15-20 (926 kg/ha) proved quite promising alternative to hand weeding for controlling weeds in urdbean.

Foliar nutrition on urdbean productivity. : Application of different foliar nutrition at flower initiation stage resulted in higher grain yield as compare to water spray. Foliar application of NPK

(18:18:18) 2% at flower initiation recorded significantly higher grain yield (995 kg/ha) which remained at par with neem coated urea 2% + salicylic acid @ 75 ppm (949 kg/ha), salicylic acid 75 ppm spray at flower initiation and 7 days after first spray(926 kg/ha) and neem coated urea 2 % at flower initiation stage over rest of the treatment. It registered 43.4, 36.7, 33.4 and 26.8 % higher yield respectively over water spray.

Conservation agriculture practices for enhancing productivity (rice–lentil) cropping system:

Conventional tillage practice recorded the highest grain yield of lentil (1757 kg/ha) which remained on par with reduced tillage (1687 kg/ha) and both proved significantly superior over zero-tillage (1431 kg/ha). Crop residue management did not influenced the grain yield but higher grain yield (1648 kg/ha) was recorded under residue as compare to without residue (1602 kg/ha).

Effect of nutrient management practices and foliar nutrition for sustainable production of

Field pea : Application of 125% RDF recorded higher grain yield (1900 kg/ha) being at par with 100% RDF (1858 kg/ha) over 75% RDF (1533 kg/ha). Among the foliar nutrition, application of NPK (19:19:19) 0.5% at pre-flowering and pod initiation stage recorded higher grain yield (1994 kg/ha) closely followed by NPK (17:44:0) also and neem coated urea (NCU) 2% spray at pre-flowering and pod initiation stage over NPK (0:0:50) 0.5% (1884 kg/ha) and water spray (1847 kg/ha). The percent increase was to the tune of 34.18, 26.78 and 24.90 % respectively over water spray.

Multilocation evaluation of mungbean yield trial entries (IVT, AVT1 and AVT 2 entries)

against yellow mosaic disease (MYMV): Entries were screened by infector row technique, Entries: 48+1 (Susceptible Check LGG 450) , Out of 48 entries evaluated, only 9 (nine) entries were found resistant against MYMV and 9 (nine) entries were found resistant against CLS. None of the entries showed resistance against both disease MYMV and CLS.

Multilocation evaluation of urdbean yield trial entries (IVT & AVT1 entries) against yellow

mosaic disease : Entries were screened by infector row technique. Entries: 33+1(Susceptible Check LBG 623) , Out of 33 entries,13 (thirteen) entries recorded resistance against MYMV and 16 (sixteen) entries recorded resistance against CLS. 11(Eleven) entries showed resistance against both disease MYMV and CLS.

National nursery for evaluation of AVT and IVT germplasm entries against important

diseases of mungbean (MYMV) : Entries were screened by infector row technique. Among the

57 (fifty seven) entries, 28 (twenty eight) entries were found resistant against MYMV and 4 (four) entries were found resistant against CLS. Only one entry KMP 17-14 was found to be resistance against both the diseases MYMV, & CLS.

National genetic stock nursery (NGSN-1) against important diseases of mungbean (MYMV) : Entries were screened by infector row technique. Entries: 42+1 (Susceptible Check LGG 450) . Among the forty two entries, thirty seven entries were found resistant against MYMV . None of the entries were found to be resistant against CLS..

National nursery for evaluation of AVT and IVT germplasm entries against important diseases of urdbean (MYMV) : Entries were screened by infector row technique. Entries: 40+1(Check) . In National nursery, 40 (forty) entries were evaluated, in which fourteen entries were recorded resistant against MYMV disease and twenty six entries were showing the resistance against CLS. Whereas only eleven were resistant to both the disease MYMV & CLS.

National genetic stock (urdbean) against important diseases of urdbean: Entries were screened by infector row technique. Entries: 15+1(Check) In National nursery, fifteen entries were evaluated, in which all the entries were found resistant against both the diseases MYMV as well as CLS except NGU-9 and NGU-15 which was showing moderately resistant reaction against MYMV.

Station Trial - Exploitation of urdbean germplasm for multiple disease resistance (MYMV, Cercospora leaf spot, web blight & powdery mildew : Eighteen entries (PU 31, Uttara, NDU12-1, VBG 7, KUG 503, OBG 35, KPU 7, Vijay, PU08-5, IPU 10-23, T9, KU 363, KUG 540, VBG 10-0024, IGKU 02-1, KPU 34, NDU 12-2, UH 07-06) can be used as a donor for developing resistant varieties.

Improvement of mungbean (*Vigna radiata* (L.) Wilczek) in resistance to Mungbean Yellow Mosaic Virus (MYMV) through induced mutations : Seeds of mungbean varieties of SML 668 and Pusa Vishal treated by GR at different doses ranging from 300-800 Gy. The LD₅₀ was analyzed by germinating irradiated seeds (M₀) on moist filter paper in the laboratory. The LD₅₀ of varieties of SML 668 and Pusa Vishal were 600 Gy and 550 Gy, respectively. The M₀ seeds were drilled in rows, after which the mutants were periodically observed right after germination. At maturity, each mutant plant (M₁) was individually harvested. The non-irradiated population sown at the same time in the same plot will be used as the control.

Screening of Trombay (BRNS) mungbean genotypes for MYMV : Entries were screened by infector row technique. Entries: 6 +1(susceptible Check) three entries were found resistant to

MYMV and three entries were showing moderately resistance reaction. Only one entry TMB-146 was found to be resistant against both the disease MYMV & CLS.

Screening Nursery for AVT entries of Rajmash against *Sclerotinia* blight : None of the entries were found to be resistant or moderately resistant. Disease incidence ranged from 15.96 to 52.13 % in RP 17-2 and RP 17-8 entries, respectively, in 8 entries. Disease incidence recorded on S-Check (HUR 137) = 39.71 %.

Screening nursery for AVT and IVT entries against lentil wilt : Out of 79 entries, 33 entries showed resistant against lentil wilt.

Screening of Urdbean genotypes for resistance against root-knot nematodes (*Meloidogyne incognita* and *M. javanica*): Out of 32 (thirty two) entries 2 (two) entries shown the moderately resistance reaction against root-knot nematodes (*M. incognita* and *M. javanica*).

Screening of Mungbean genotypes for resistance against root-knot nematodes (*Meloidogyne incognita* and *M. javanica*): Out of 29 (twenty nine) entries 5 (five) entries shown moderately resistance reaction against root-knot nematodes (*M. incognita* and *M. javanica*).

6. WHEAT

Evaluation of Seven Promising Genotypes with Two Checks for Late Sown condition : Two entries namely, RAUW- 4 (4.65 t/ha) & RAUW- 6 (4.5 t/ha) were significantly superior over check DBW 14 (4.08 t/ha) whereas RAUW7 (4.20 t/ha) was at par to checks.

Evaluation of Seven Promising Genotypes with One Check for Timely Sown condition : One genotype namely, RAUW-104 (5.82 t/ha) was significantly superior over best check HD 2967 (5.36 t/ha) and one genotype RAUW-105 (5.57 t/ha) was at par to best check.

Evaluation of 62 germplasm under North Eastern Plain Zone Trial (NEPZT) for Timely Sown : 9 genotypes were selected on the basis of their yield and yield attributing traits for inclusion in breeding programme.

Evaluation of 62 germplasm under North Eastern Plain Zone Trial (NEPZT) for Late Sown : Six genotypes were selected for wheat breeding programme. All these materials are suitable for late sown condition.

One Wheat variety namely, Rajendra Genhu-1 has been recommended by 3rd Research Council Meeting of RPCAU, Pusa and proposal has been approved by SVRC for release in Bihar. One

variety namely, WB02 has been recommended by Pre-Variety Release Committee for presentation in Research Council Meeting of the University.

One project entitled “Biofortification of wheat” of 20000 \$ per year has been sanctioned by Harvest Plus. Two trials at five locations have been conducted successfully under Biofortification of wheat project with 50 germplasm and seeds have been sent to project coordinating unit, Hyderabad for Zinc and Iron analysis.

Performance of wheat varieties at different dates of sowing (IR-TAS-DOS) : There was a significant decline in yield from 4.81 t/ha to 4.01 t/ha when sowing was delayed from timely to very late because of significant reduction in number of grains/ear head and 1000 grain weight. The yield declined due to late sowing and very late sowing by 6.98 and 16.62%, respectively. The test genotype DBW 187 produced the maximum grain yield (4.78 t/ha) followed by the check varieties DBW (4.70) and DBW 39 (4.65 t/ha). These three varieties/genotypes were statistically at par. The second test entry PBW 757 obtained 4th rank with yield of 4.51 t/ha which was significantly less than the best check variety.

Plan of work for the ensuing season: Will be continued with another set of genotypes

Performance of wheat varieties at different dates of sowing (SPL-9) : 5th November sown wheat produced the maximum yield (4.68 t/ha) which was significantly superior to other dates of sowing. The delay in wheat sowing from 5th November to 5th January decreased the grain yield by 17.2 % whereas the reduction in yield was 10.28% in 5th December sowing. Across sowing time HD 2967 produced the maximum and significantly higher grain yield (4.68 t/ha) followed by WR 544 (4.56 t/ha) and HD 3086 (4.54 t/ha).

Advance Varietal Trial of Barley for Irrigated condition : The trial was conducted with eight genotypes, three entries with five checks and none of the entry was superior over any check.

7. SOYBEAN

PLANT BREEDING AND GENETICS:

Initial Varietal Trial (Soybean): EZ: Out of 45 entries evaluated (Entry Code 34) NRCSL 1 (2205.76kg/ha) was best followed by DS 3108 (1917.66kg/ha) and PS 1611(1769.55kg/ha) which all significantly out yielded best check JS-335 (1366.26 kg/ha).

Advanced Varietal Trial I + II (Soybean): EZ: Best Check JS 97-52 (1296.30 kg/ha) was the highest yielder.

Advanced Varietal Trial II (Soybean): NPZ: PS 1572 (1406.25 kg/ha) was the highest yielder and at par to the best Check PS 1092 (1238.42 kg/ha)

PLANT PATHOLOGY

Evaluation of IVT entries for different diseases: During evaluation of IVT entries against different diseases, only incidence of soybean yellow mosaic virus (YMV) was recorded. Among 41 (IVT entries) + 2 (check) entries evaluated, 4 (MACS 725, AUKS 174, JS 20-17 & NRC 131) entries of soybean were found Moderately Resistant whereas the checks, JS-335 and JS-93-05 were found under Highly Susceptible and Susceptible category respectively against incidence of soybean yellow mosaic virus (YMV).

Evaluation of breeding materials (AVT-I entries) for existent donors(s): During evaluation of soybean AVT-I entries against different diseases, only incidence of soybean yellow mosaic virus (YMV) was recorded. Among 16 (AVT-I entries) + 2 check entries (JS-335 & JS-93-05) evaluated, 2 entries (KDS 921 & RSC 10-52) were recorded under Moderately Resistant category whereas both the checks (JS-335 & JS-93-05) were found under Susceptible category against incidence of soybean yellow mosaic virus (YMV).

Evaluation of breeding materials (AVT-II entries) for resistant donor (s): During evaluation of soybean AVT-II entries against different diseases, only incidence of soybean yellow mosaic virus (YMV) was recorded. Among 12 (AVT-II entries) + 2 check entries (JS-335 & JS-93-05) evaluated, 2 (PS 1572 & RSC 10-46) and 1 (SL 1074) entries were recorded as Highly Resistant and Resistant respectively whereas both the check varieties *viz.*, JS-335 and JS-93-05 were found Susceptible against incidence of soybean yellow mosaic virus (YMV).

8. RAPESEED-MUSTARD & LINSEED

RAPESEED-MUSTARD

GRM (R&M) activity I. Maintenance & evaluation:

(A) Own Germplasm: RAUDT-62, RAUDT-15, RAUDT-7, RAUDT-67, RAUDT-36, RAUDT-16, RAUDT-74, RAUDT-79, RAUDT-7, DC9401, Dwarf Toria, Satha local of Toria; RAUDYS-89-111, RAUDYS-9701; RAUDYS-9702; RS-1; Pendent Local of YS; MDOC-8; MDOC-

53;MDOC-27; RAURDA 09-3, RAURDA 09-34, RAURDA 09-78, RAURDA 09-153, RAURDA 09-170, RAURDA 09-172, RAURDA 09-212, RAURDA 09-214 of mustard for Yield , Earliness , Yield components ,Resistance/ Tolerance to Diseases -Pests and Quality traits identified as good source materials.

(B)Received Germplasm : IGT-2, IGT-64 , IGT-91, TH-9802, of Toria;BSH-1of B.S.; TPM-1, RK-8401, NDRE -4 IC -401574; IC-399788; TM-12, BIO94, Domo, Jatai Local, , EC 339000, EC 338997 , EC-399301, PAB 9511, PAB 9534 , IC401574, IC 399788 of mustard; TOWER, HNS 0004 & HYOLA 401 of *napus* and KIRAN, PBN-2001, PBN-2002, PBN9501, PBC9221 of *carinata* for Yield , Earliness , Yield components ,Resistance/ Tolerance to Diseases -Pests and Quality traits identified as good source materials.

IVT (Toria) Irrigated : AICRP-RM Trial : At Dholi,out of 14 Toria entries TH1602 (16.23q/ha), Tapeshwari(LR) (15.93q/ha) RAUDT 14-09 (13.86 q/ha) and TH 1603 (15.68q/ha) were at par to each other. RAUDT 14-9: Promoted in AVT I in Zone V (Rain-fed) AICRP-RTs- Zone V(*Rabi* :2018-19).

IVT (YS) Irrigated (AICRP-RM): At Dholi and Morena our Entry RAUDYS14-09 (1574 and 2698 kg/ha, respectively significantly out-yielded YSH 0401(NC-1247 kg/ha) and were at par to Pitambari(LR-1735 kg/ha) . In AICRP (RM) Trials during Rabi 2017-18, at Dholi and Morena, our Entry RAUDYS 14-09 (1574 and 2698 kg/ha, respectively significantly out-yielded YSH 0401(NC-1247 kg/ha).However none of the entries promoted at national multi-location basis. RAUDYS 14-09 proposed for MVST (GOB-DRPCAUBAU) for 2018-19.

IVT (Early Mustard) Irrigated (AICRP-RM) : At Dholi SVJ 104 (1750 kg/ha) significantly out-yielded best check (LR) pusa Mustard 27 (1405 kg/ha) and at par to check was NDRE-08-14-1 (1405 kg/ha). However, none entry significantly out yielded best check PM-27(23.68q/ha) . SVJ 104(109 DPM) and NDRE-08-14-1(115 DPM) were promising.

IVT (Mustard –Late sown-Irrigated) AICRP (RM) Trial: At Dholi two entries HUJM 16-8 (2661 kg/ha) exhibited 11.15% yield superiority and was at par to the best check NRCHB 101 (2394 kg/ha). HUJM 16-8 was promising for Bihar MVST 2018-19 (GOB-DRPCAUBAU) Trial

IHT (mustard –Timely sown -Irrigated) AICRP (RM) Trial: At Dholi DMH-1(Hybrid Check) gave yield level of 2870 kg/ha which was at par to RGN 73(ZC) 2842 kg/ha. At national multilocation level none of the hybrid was promoted.

AVT I : QUALITY MUSTARD AICRP (RM) TRIAL: At Dholi one entries LES 54 (OO) (2022 kg/ha) significantly out yielded HEM mustard checks Pusa mustard 30(LR-QC) 1381 kg/ha and Kranti (NC) (1833 kg/ha) .

LINSEED

AVT I : QUALITY MUSTARD AICRP (RM) TRIAL: At Dholi one entry LES 54 (OO) (2022 kg/ha) significantly out yielded HEM mustard checks Pusa mustard 30(LR-QC) 1381 kg/ha and Kranti (NC) (1833 kg/ha) .

Large number of Individual plants from each treatment selected & evaluated for traits. These single plant selections were also under evaluation under laboratory conditions. The mutants reflected earliness in flowering and maturity, bold-very bold pods, bold-very bold seeds, long siliqua, and mutagenic variation in other traits.

In IVT(RF) and AVT I+II (RF) no promotion was made .

In IVT (Linseed-Irrigated) TL 145 (LINOLA), RLC-167, NDL 2015-3& SL 117 were at par to Shekhar. In AVT I+II, TL 99(LINOLA) was repeated as AVT I Entry for evaluation in Zone II including Bihar. TL 99 and TL 145 (Both LINOLA) edible quality linseed are promising for Bihar MVST 2018-19 (GOB-DRPCA-BAU) Trial.

Utilization of Genetic Variability through Hybridization and selection of superior types.

Number of Crosses, Their Generation and Number of Selections Practiced: To develop high temperature tolerant mustard strains for early sown condition with high yield and early / medium maturity 174 SPS (F_{3s}) grown in plant to row progenies out of which 122 single plant selections made in F_5 generation. To develop early sown mustard strains with high yield and early maturity , from the 27 single plant progeny rows grown 19 selections attempted for earliness in flowering-maturity, yield components in segregating F_6 generation. To develop Timely sown mustard strains with high yield and early maturity, from the 39 single plant progeny rows grown 29 Single Plant Selections attempted for earliness in flowering-maturity, yield components in segregating F_6 generation. To develop Late sown mustard strains with high yield and early maturity, from the 59 single plant progeny rows grown 63 selections attempted for earliness in flowering-maturity, yield components in segregating F_6 generation. To develop Alternaria Resistant/ Tolerant strains with high yield in Mustard suitable for Early/Timely/Late sown conditions , from the 139 single plant progeny rows grown 139 selections attempted for earliness in flowering-maturity, yield components in segregating F_5 generation.

STATION MATERIALS UNDER ADVANCED STAGES OF EVALUATION

1. **TORIA: RAUDT 10-33 (2014-15):** Already evaluated for two years (2013-14 & 2014-15) in Advanced Varietal Station Trial and proven significantly superiority(pooled) over best checks. Promoted from IVT(2015-16) to AVT I (Ist & IInd time) Trials during 2016-17 & 2017-18 completed in Zone III(AICRP-R&M). Proposed for Bihar State Level Farmers Field Multi-location Evaluation during Rabi 2018-19 for presenting its Release proposal for Bihar State during Rabi 2019-20.
2. **TORIA: RAUDT 14-09 & RAUDT 14-04:** Already evaluated for two years (2015-16 & 2016-17) in Advanced Varietal Station Trial and proven significantly superiority (pooled) over best checks. Contributed for evaluation in IVT Toria (Irrigated & Rainfed) in national multi-location AICRP trials (Rabi 2017-18). RAUDT 14-9 promoted in AVT I in Zone V (Rain-fed) ML Trial-(2018-19). Both Entries proposed for Multi-location State Varietal Trial (GOB-DRPCAUBAU) for Rabi 2018-19 in Bihar.
3. **YELLOW SARSON: RAUDYS 14-05 & RAUDYS 14-09:** Already evaluated for two years (2015-16 & 2016-17) in Advanced Varietal Station Trial and proven significantly superiority (pooled) over best checks. In AICRP (RM) Trials during Rabi 2017-18, at Dholi and Morena, our Entry RAUDYS 14-09 (1574 and 2698 kg/ha, respectively significantly out-yielded YSH 0401(NC-1247 kg/ha). Entries, RAUDYS 14-05 & RAUDYS 14-09 proposed for Multi-location State Varietal Trial for Rabi 2018-19 (GOB-DRPCAUBAU) in Bihar.
4. **INDIAN MUSTARD:** Three medium maturity entries RAURD-14-18, RAURD-14-8 and RAURD 14-08 contributed to MVST (GOB-DRPCAUBAU) for *Rabi* - 2018-19: at State MLTs level.
5. **CANOLA (OO):** Quality Indian mustard; LES 54 was promising for Bihar. Proposed for MVST (GOB-DRPCAUBAU) for 2018-19.
LINOLA (Edible Quality Linseed): TL99 and TL 145 were promising for Bihar. Proposed for MVST (GOB- DRPCAUBAU) for 2018-19.

Long term fertility trial on mustard-based system : Significant highest mustard yield (1765 kg/ha) was obtained where 150% NPK (T4) was applied than all other treatments but was found at par with the treatment where FYM @ 2.5 t/ha (T8) was applied in addition to 100 % NPK

fertilizers (1615 kg/ha). Similar trend was recorded in case of rice, moong and mustard yields. Treatments which received sulphur, zinc or boron in addition to 100% NPK were found at par.

Agronomic evaluation of promising rapeseed-mustard entries : NRC HB101 was found best yielder under rainfed condition.

Enhancing water use efficiency in rainfed rapeseed-mustard : Significantly higher mustard yield (1554.3 kg/ha) was obtained under treatment (T₉) where hydrogel was applied @ 5.0 kg/ha and followed by spraying of salicylic acid @ 200 ppm at flowering and siliqua formation. Hydrogel had more pronounced effect on yield than salicylic acid. Effect of different rates of salicylic acid was found non-significant.

Survey and surveillance of dominant weed flora in rapeseed-mustard crops under changing climatic scenario : Dominant weeds found in Samastipur district in mustard field were-*Cynodon dactylon*, was the main grassy weeds; *Cannabis sativa*, *Chenopodium sp*, *Anagallis arvensis*, *Parthenium hysterophorus*, *Vicia spp.* and *Convolvulus arvensis* were among the broad leaved ones while *Cyperus spp.* was the only sedges observed in mustard field. Dominant weed flora observed in Muzaffarpur district were- *Cynodon dactylon* and *Sorghum alepense* were mainly observed among grassy weeds; *Chenopodium Sp.* , *Cannabis sativa* *Parthenium hysterophorus*, *Anagallis arvensis*, and *Convolvulus arvensis* were among the broad leaved weeds while *Cyperus sp.* was noticed as sedges.

Screening of Brassica AVT-1 & AVT-2 strains against Alternaria blight diseases under natural condition : Out of 43 entries, no entry were found free during Rabi 2017-18 from Alternaria blight (AB) disease under natural condition. Moderate to severe Per cent disease severity were recorded during season. The Severity of the disease in the test entries were ranged in between 39.0 to 61.5 %. However the entries CS 2009-335, CS 13000-3-1-1-4-2, RGN 400, CS 2009-154 and Giriraj are superior because the severity of the disease were lower or at par with the resistant checks GSL 1 (40.8%) EC 399299 (42.2%) and DLSC 1 (43.2%).

Screening of Brassica AVT-1 & AVT-2 strains against Alternaria blight diseases using artificially inoculated infector-row under field condition : Out of these 43 entries no entry were found free from Alternaria blight (AB) disease in artificially inoculated infector-row under field condition during Rabi 2017-18. All the entries falls under the score Susceptible to Highly Susceptible in respect of per cent disease severity. Disease severity recorded in the entries were ranged in between 41.9 to 64. %.

Uniform Disease Nursery (UDN) trial for Alternaria blight disease of rapeseed- mustard (under natural condition) : None of the 40 entries were found free from Alternaria blight severity when screened these entries in Uniform Disease Nursery (UDN) trial. Disease severity in the entries recorded ranged from 17.5 to 29.8 %. However the entries JMM-991, DRMRSJ-14-1-2, DRMRSJ-31-2-2, PRD-14-1 and PRD-14-16 are superior because the severity of the disease was lower or at par with the resistant checks EC 399299 (23.8%) and DLSC 1 (22.4%).

National Disease Nursery (NDN) for Alternaria blight under artificial inoculated condition : None of 25 entries were found free from Alternaria blight severity. All entries recorded disease severity which ranged from 28.3 to 42.3%. However the entries NDRS-2008-1, NPJ-219, RMWR-09-1 and DRMR-2019 are superior because the severity of the disease were lower or at par with the resistant checks EC-399301 (29.1%) and PHR-2 (29.6%).

National Disease Nursery (NDN) trial for Sclerotinia Stem Rot under artificial condition: 11 entries were screened under artificial inoculated conditions against Sclerotinia rot disease. Only five entries were found moderately resistant (MR) against Sclerotinia rot disease and may be used in further resistant breeding programme. All entries recorded disease severity which ranged from 5.0 to 65.0%.

Screening of IVT entries of Brassica against Alternaria blight disease under natural condition : None of the 133 entries evaluated were found free from Alternaria blight disease under natural condition. However one entry NPJ 214 was recorded as MR. The severity was recorded in all entries which ranged from 24.3 to 54.4%.

Epidemiology of Alternaria blight disease : Experiment was laid out with cv. Varuna and Rajendra Suflam. The seeds were sown with 8 dates of sowing started from October 03 to November 20 at weekly intervals. The disease first appeared on 60DAS & 86 DAS in Varuna & Rajendra Suflam respectively continued to progress upto 120 DAS on leaves on Varuna where as it 130 DAS on Rajendra Suflam cultivars. The AB severity was more on cv. Varuna at 120 DAS in Oct. 23 sown (70.3%) while on cv. Rajendra Suflam it was 45.6% at 130 DAS .

Integrated Management of Sclerotinia rot in Indian mustard : ST with Carbendazim 50WP @ 2g/kg seed + No irrigation during 25th Dec. to 15th Jan+ Foliar spray (FS) of Carbendazim 50WP @2g/l at 40-45 DAS followed by 65-70 DAS) gave highest and wider spacing (45 cm x 15 cm) is the best treatment in respect of reducing the disease severity and ultimately giving highest yield.

Yield loss due to Sclerotinia rots disease : Yield loss due to sclerotinia rot was observed in all test entries. Maximum yield loss (91.5%) was reported in 66-197-3 (YS) on rating 4 scale followed by Rajendra Suflam (86.9%) on same rating.

Disease monitoring on Farmers' field : The Alternaria blight disease severity were ranged from 37 to 56 %, white rust severity ranged from 14 to 21 % and Sclerotinia Stem rot severity were ranged from 24 to 46 % at different locations of Samastipur & Muzaffarpur districts.

Screening of IVT entries of Brassica for resistance against mustard aphid : Altogether 177 entries + 1 susceptible check i.e. YS 66-197-3 (Yellow sarson) were screened against mustard aphid, *Lipaphis erysimi*. Entries were categorized as: MR – 86 and S - 92 . Among them ,promising 30 R&M entries ,witnessing AII above 2.5 to 3.0 were KMR(E) 17-1, TM 277, DRMR 2017-11, NPJ 212,KMR 17-3, GDM 4, CS2800-1-2-3-5-1,LES 57, PDZ 9 (all *B. juncea*), TH 1603, Bhawani, TL 15 (*B. rapa* var. toria), DRMR 2017-5, RH 1518, DRMR 150-35, NPJ 213 (*B. juncea*), RH 1599-41, KMR (L) 17-5,TM 117, RH 1569 (*B. juncea*), RHH 1687, DMH 1,PHR 1500, RHH 1665, SVJH 100, 7 IJ0003 , Kranti (*B. juncea*), AKMS 8138, (*B. napus*), T-27 and RTM 314(*B. carinata*).

Screening of AVT-I and AVT-II entries of Brassica for resistance against mustard aphid : Altogether 75 entries + 1 susceptible check i.e. YS 66-197-3 (Yellow sarson) were screened against mustard aphid, *Lipaphis erysimi* .Entries were categorized as: MR- 34 and S - 42. Among them ,promising 16 R&M entries ,witnessing AII above 2.5 to 3.0 were , PRE 2013-10, RGN 73, GM 2, CS 2009-335, Kranti, CS 900-1-2-2-1-3,RGN 400, RH 0406, RH 0406, DRMR 2035, JD 6, Raj Vijay Mustard 2, PRO 5222 , NRCHB 101, Kranti, RGN 73 (all *B. juncea*)witnessed AII above 2.5 to 3.0.

Assessment of promising lines for resistance against mustard aphid : Altogether 62 promising lines of rapeseed- mustard and 1 susceptible check i.e. YS 66-197-3 (Yellow sarson) were assessed for resistance against mustard aphid, *Lipaphis erysimi*. Among them ,promising 13 R&M entries ,witnessing AII above 2.5 to 3.0 were , CS 13000-3-1-1-4-2, NPJ 208, KMR 15-4, KMR(E) 16-1, LES 55, CS 56, RGN 330, RH 1369 , Rohini, DRMRIJ16-3, PM 30, CS 508-1 P2 and RGN 368 witnessed AII above 2.5 to 3.0.

Assessment of yield losses due to aphid in *Brassica* crops : Avoidable yield loss due to mustard aphid was 28.33% in Rajendra Sufalam, 28.09 % in NRCDR-2 and 26.51 % in BSH-1.

Population dynamics of mustard aphid on *Brassica* crops (late sown) : Maximum temperature, minimum temperature and relative humidity at 07 hrs. were positively correlated with mustard aphid population; whereas relative humidity at 14 hrs. was negatively correlated with mustard aphid population.

Screening of genotypes for high temperature tolerance at seedling stage : Twenty four genotypes of Indian mustard (*B. juncea*) were tested for high temperature tolerance at seedling stage under field conditions. 100 count seeds of each genotype were sown in 2 m row length on 21st October 2017 (as seed was received late) in RCBD with three replications. The field experiment was continued for 30 days. Maximum temperature during the experimental period ranged from 27.0 °C to 33.0 °C with an average 30.3 °C while the minimum temperature varied from 13.7 °C to 23.5 °C with an average 18.5 °C . Seedling mortality ranged from 26% (PM 28) to 70% (CAURM 1) while dry weight/ 10 seedlings were 9.7 g (CAURM 1) to 28.4 g (PM 28) The lowest RWC was in CAURM 1 (56.8%) while maximum in PM 28 (91.7%) Similarly, the lowest SPAD value was in the genotype CAURM 1 (22.5) while maximum in PM 28 (52.5).

Screening of genotypes for drought tolerance : A total of 19 genotypes of *B. juncea* were evaluated for drought tolerance under field conditions at TCA, Dholi. Sowing was done on 26th October 2017 and harvesting was done on 28.03.2018. Main treatment consisted of i) two post sowing irrigations at 35 and 65 DAS and ii) no post sowing irrigation. The percent reduction was computed under drought condition over normal sown. Percent reduction in MSI, Chlorophyll content, Siliqua on main shoot, seeds/siliqua and seed yield ranged from 5.7(LES 56) to 14.3 (NPJ 216), 5.0 (LES 56) to 13.1 (PUSA MH 8) , 4.4 (LES 56)to 13.6 (NPJ 215), 7.6 (LES 56) to 34.9 (NPJ 212) and 8.8 (LES 56) to 15.4 (RH 0725)% respectively Stress decreased the SPAD value, RWC and test weight in the range of 4.6 (NPJ 213) to 12.1(PUSA MH 8), 3.4 (LES 57) to 11.5 (RH 0725), 2.0 (GDM 5) to 14.5% (NPJ 211) DSI was least in NPJ 210 (0.69) followed by LES 56 (0.74) and NPJ 211 (0.83) Less than 5% reduction in CT was observed in two genotypes viz., LES 56 and LES 57. Thus, based on overall percent reduction in all parameters genotype LES 56 had comparable performance both under stress and irrigated module.

Screening of genotypes for high temperature tolerance at terminal stage : Sixteen mustard genotypes were sown in the field at two dates i.e. optimum/normal sowing (NS) in the first week of November (1st November 2017) and late sown in the second week of December (LS) (on 10th December 2017). Late sown (LS) crop faces high temperature (30 °C) at seed filling stage. The percent reduction was computed under late sown over normal sown. Membrane stability was hampered with late planting to the tune of 6.8 (LES 56) to 24.6% (NPJ 212) over normal sowing. Values of HSI among genotypes varied from 0.63 (LES 56) to 1.51 (NPJ 215). Minimal decline in seeds/siliqua was 4.2 % in NPJ 216 and maximum was in the genotype NPJ 210 (31.7%). Terminal heat stress reduced seed weight ranging from 5.6 to 25.3% while the decline was comparable in LES 56 (5.6%) and PDZ 9 (6.4%). Seed yield declined by 27.2% (NPJ 215) and only two genotypes (NPJ 208 and LES 56) registered less than 15% yield reduction. Thus the genotype LES 56 seems to possess tolerance to high temperature at terminal stage.

9. SMALL MILLETS

Evaluation of thirty genotypes of finger millet in Initial Varietal Trial: Among 30 genotypes, none of the genotype was significantly superior over check. However, six genotypes (FM-IVT -5, 6, 8, 9, 26 and 29) were at par to local control (40.74q/ha).

Evaluation of sixteen genotypes of foxtail millet in Advance Varietal Trial: Among sixteen genotypes, none of the genotype was superior over Rajendra Kauni-1 (24.50q/ha).

Evaluation of eight genotypes of proso millet in Advance Varietal Trial: Among eight genotypes, none of the genotype was superior over BR 7 (22.0q/ha).

Evaluation of eleven genotypes of finger millet in Advance Varietal Trial: Out of sixteen genotypes, only one genotype FM-AVT I&II-2 (51.26q/ha) was significantly superior over local control (40.74q/ha).

Evaluation of eight genotypes of finger millet in station Trial: Among eight genotypes, three genotypes namely, RAUF-21(46.80q/ha), RAUF-23 (47.70q/ha) and RAUF-25 (48.00q/ha) were significantly superior than RAU-8 (40.50q/ha).

Evaluation of ten genotypes of foxtail millet in station Trial: Out of eight genotypes, only one genotype RAUFO-5 (32.50 q/ha) was significantly superior than Rajendra Kauni-1 (26.00q/ha).

- Two entries of Finger millet have been incorporated in coordinated trials.
- 5.5 Q Breeder seed of Finger millet (RAU8) has been produced.

10. TUBER CROPS (OTHER THAN POTATO)

Collection, Conservation, Cataloguing and Evaluation of Genetic Resources of Tuber Crops:

Altogether 1335 accessions of 12 (twelve) tuber crops are being maintained at Dholi centre. Dholi centre is maintaining highest number of accessions of sweet potato (1052) followed by yam bean (140) and Taro (65) during the period under report. Six new germplasm of tuber crops viz. Taro (01) Banda (01) and Elephant foot yam (04) along with four polycrossed entries of Elephant foot yam have been added. Polycrossed seedlings of EFY have been raised to produce Clonal generation- I (CG-1), selected seedling progenies will be raised to CG-2 during 2018-19.

Survey and surveillance of pests for root and tuber crops .: Sweet potato infestation by sweet potato weevil (*Cylas formicarius*) varied from 18.8-38.5 % and 10.8-18.3 % during April and December, respectively. The tuber infestation due to termite varied from 9.8-17.5 percent in April and 4.5-11.5 percent in the month of December. Flower and pod infestation in yam bean by spotted pod borer varied from 16.2-28.6 percent and 10.3 – 24.3 percent, respectively. However, mosaic infestation varied from 4.0-7.3 % during the month of December. Infestation of aphid (*Aphis gossypii*) and tobacco caterpillar (*Spodoptera litura*) on taro (Arvi) varied from 10.4 - 28.6 aphid/leaf and 6.2-11.4/leaf caterpillars, respectively. The incidence of Phytophthora leaf blight ranged from 16.0-36.4 percent in different parts of Vaishali and Muzaffarpur districts. Elephant foot yam was found to be infected by mosaic (6.0-8.0 %) and collar rot (6.5-12.8 %) during the month of August.

Management of sweet potato weevil: On the basis of three years data (2014-15 to 2016-17), for management of sweet potato weevil in Bihar, the treatment comprising of vine treatment with Chlorpyrifos 20 EC @ 0.02 %, earthing up along with fertilizer application, two spraying of Chlorpyrifos @ 0.02 % at 30 & 60 DAP has been found effective in minimizing vine infestation, tuber infestation with highest marketable tuber yield (17.8 t/ha) along with net profit (Rs 47,300.00 /ha) with B:C ratio of 17.51.

IET on orange flesh sweet potato (1st Year): Among 7 (seven) tested entries, TSp 16-2 gave highest marketable tuber yield of 15.8 t/ha, which was found at par to both the checks i.e. Kamla Sundari and ST-14 with marketable tuber yield of 14.6 t/ha and 14.4 t/ha, respectively. Weevil incidence (%) ranged between 17.8 to 28.9 at collar region and 8.0 to 16.0 on tubers. These entries varied 23.46 to 29.16 for dry matter percentage, 9.4 to 20.1 for starch and 6.01 to 8.0 for sugar percentage with good cooking qualities.

MLT on sweet potato for weevil resistance (1st Year): Five sweet potato entries including 2 (two) checks viz; Kishan and Cross-4 as national and local checks, respectively were evaluated

against sweet potato weevil and tuber yield along with quality attributes in Multilocation trial. The data revealed that highest marketable tuber yield (16.8 t/ha) was recorded with the entry TSp 12-6 which was found superior to TSp 12-4 (10.1 t/ha) and TSp 12-14 (13.6 t/ha) as against 13.4 t/ha and 12.2 t/ha in Kishan and Cross-4, respectively. Lowest vine infestation 3.9%, 9.8% and 16.4% recorded in the entry TSp 12-6 at 30, 60 and 120 days after planting (DAP), respectively as pooled mean of 04 locations.

IET on *Colocasia* (Ist Year): Among 16 tested entries, TTr17-3 recorded highest cormel yield (15.9 t/ha), which was statistically at par with TTr17-2 (13.8 t/ha) and significantly superior to SreeReshmi (13.2 t/ha) and RA-1 (13.4 t/ha) used as national and local checks, respectively.

IET on *Colocasia* (Bunda) (Ist Year): Among 09 tested entries, Tbd 17-4 recorded highest corm yield (34.6 t/ha), which was statistically at par with Tbd 17-3(29.2 t/ha) and significantly superior to other entries and IGB-5 (17.5 t/ha) used as check.

MLT on *Colocasia* (Ist Year): Among 06 tested entries, TTr12-8 recorded highest tuber yield (16.0t/ha), which was statistically at par with TTr12-4 and TTr 12-7 (15.2t/ha) including Muktakeshi (15.6t/ha) and RA-1 (15.9t/ha) used as national and local checks, respectively. TTr 12-8 also recorded the highest number of side tubers (11.8/plant) and cormel weight (261.0 g/plant) as compared to other entries.

MLT on *Colocasia* entries for *Phytophthora* leaf blight resistance/ tolerance (Ist Year): Among 6 (six) entries under test, TCbl 12-4 recorded highest average cormel yield (16.5t/ha) which was statistically superior to TCbl 12-3 (15.0 t/ha), TCbl 12-5 (14.0 t/ha) and against checks. TCbl 12-4 also recorded better cormel weight/plant (290.6 g). TCbl 12-4 also recorded lowest PDI (12.8) with score 2.1, which was at par to the TCbl 12-3 (13.6) and resistant check Muktakeshi (11.6).

IET on Elephant foot yam (Ist Year): Among 7 (seven) test entries, TEy 17-1 recorded highest corm yield (34.23 t/ha), which was statistically at par with Gajendra (35.32 t/ha) used as national check.

Validation of organic farming technologies in Elephant Foot Yam. - Organic farming practice (T3) recorded significantly superior value of plant height (43.4 & 63.7 cm), pseudo stem girth (16.2 cm), canopy spread (77.5 x 75.7 cm & 109.3 x 105.9 cm N-S x E-W), tuber yield (53.3 t/ha) and net return (Rs.507716/ha) than the traditional farming practice but was found statistically at par to conventional practice.

URT on Yam bean (2nd year): Among 08 test entries, significantly higher tuber weight (315.6 g/plant) and tuber yield (37.6 t/ha) was recorded in entry TYb 14-9 followed by TYb 14-10 with 311.3 g/plant tuber weight and 35.4 t/ha tuber yield as against 252.3 g/plant and 31.6 t/ha for tuber weight and tuber yield, respectively in RM-1 as check. Pooled data of two years, entry TYb-14-9 gave highest tuber yield with pooled yield of 39.5 t/ha., which was followed by entry TYb-14-10 with pooled mean yield of 36.9 t/ha.

Weed management in Sweet potato and Elephant Foot Yam. - Combination of herbicides (Pendimethalin @ 1.0 kg /ha as pre-emergence + Quizalofop-p-ethyl @ 75 g /ha as post-emergence) may be suggested to farmers for effective weed management in sweet potato and Elephant Foot Yam particularly where, grassy weeds (*Sorghum halepense*) are predominant to get good yield and net return .

Micro-nutrient studies in Sweet Potato- Among different treatments at 3 MAP and at harvest, significantly higher value of vine length (116.7 & 129.5 cm), number of branches (8.2 & 9.1), number of leaves (73.3 & 91.4) and leaf area (4852.5 & 5854.7 cm²) were recorded in T5 (FYM @ 10 t/ha and NPK (60:40:60 kg/ha) along with application of Mg, B and Zn). T5 also recorded significantly superior value of tuber length (16.7 cm), tuber girth (13.2 cm), number of tubers/plant (6.3), tuber yield/plant (239.7 g), tuber yield (24.72 t/ha, marketable tuber yield (23.8 t/ha), net return (Rs. 162825/ha) and B:C ratio (2.14) over rest of the treatments.

Screening of sweet potato entries against sweet potato weevil in MLT(Ist Year): Among 5 (five) tested entries, lowest vine infestation 3.9%, 9.8% and 16.4% were recorded in the entry TSp 12-6 at 30, 60 and 120 days after planting (DAP), respectively as pooled mean of 04 locations. Among the remaining entries, TSp 12-4 was found statistically at par to TSp 12-6 in respect to vine infestation at 60 DAP (9.2 %) and 120 DAP (16.8 %). However, evaluated entries were found superior in terms of low vine infestation as compared to Kishan and Cross-4 used as checks at 30, 60 and 120 DAP, respectively. Among the test entries the lowest tuber infestation (8.2 %) was recorded with TSp12-6 and had 1.0 score as against 13.3% (1.3 score) and 21.3% (2.3 score) tuber infestation in checks i.e. Kishan and Cross-4, respectively.

Evaluation of Sex pheromone traps on the infestation pattern of weevil and tuber yield. No grubs of sweet potato weevil were found at 30 days after planting (DAP) in any of the treatments in vine at collar region. The lowest grub population (1.2 and 2.6/plant) were recorded at 60 and 90 DAP, respectively at collar region in treatment T₁ i.e. vine treatment with chlorpyrifos (0.02%) before planting and installation of sex pheromone trap which was at par i.e. dipping the planting

material in 0.02% chlorpyrifos (20EC) (1.4 and 3.2/plant) to T₄. Vine treatment with chlorpyrifos (0.02%) along with installation of sex pheromone trap continued to show its supremacy in recording lowest number of grubs (1.6 /tuber) which was at par with T₄ (2.0/tuber) as against 5.2 grubs/tuber in untreated control (T₅) at 90 DAP. However, mean marketable tuber yield was more in T₄ (18.2 t/ha) which was found at par to T₁ (17.1 t/ha).

11. POTATO

Advanced varietal trial (AVT) with medium maturing potato hybrids: Hybrid AICRP-P-9 (Total tuber bulb yield 28.82 & 34.27t/ha) was recorded significantly superior in both the crop duration (75 & 90 days crop) as compared to best check AICRP-C-14 (Total bulb yield 24.83 & 26.45t/ha).

Initial varietal trial (IVT) with medium maturing white skinned potato hybrids: In both the crop duration hybrid AICRP-P-9 (Total tuber bulb yield 25.87 & 28.65t/ha) was recorded significantly superior as compared to best check AICRP-C-14 (Total tuber bulb yield 23.34 & 25.18t/ha).

Initial varietal trial (IVT) with early maturing potato hybrids (60 days crop) : Two hybrids were evaluated with three check varieties. None of the hybrids performed better (Best hybrid AICRP-P-36 total tuber yield were 18.34 & 17.29 t/ha) as compared to best check var. AICRP-C-14 (Total tuber bulb yield 20.45 & 19.55t/ha).

Initial varietal trial (IVT) with red skinned potato hybrids: Three hybrids were evaluated with two check varieties for two crop duration (60 & 75 Days). Best check var. K. Lalit (Total tuber bulb yield 15.28 & 18.45 t/ha) was recorded significantly higher as compared to best hybrid AICRP-P-34 (Total tuber yield 12.63 & 15.60t/ha) for both the crop duration.

Initial varietal trial (IVT) with processing (chips) potato hybrid: Two hybrids were evaluated with three check varieties for two crop duration (75 & 90 days). The check varieties performance was different in both the crops duration. Check variety AICRP-C-10 (Total tuber bulb yield 17.57t/ha was in 75 days crop & in 90 days crop check var. K. Surya with 18.51t/ha total tuber yield was better performer). Overall the check varieties performance was better.

CROP PRODUCTION

Nitrogen requirement of newly released Potato cultivars: The nitrogen levels have significant effect on tuber yield of variety *K. Surya*. Nitrogen @225kg/ha may be recommended for commercial production of variety *K. Surya*.

Effect of NPK levels on growth and yield of potato: Application of 150% RDF (225:135:150kg NPK/ha) may be recommended for commercial cultivation of potato.

Plan of work for the ensuing season: To be continued.

Optimizing phosphorus requirement of potato: Application of 90 kg P₂O₅/ha may be recommended for commercial production of potato in North Bihar.

Development of potato based organic farming system: Application of crop residues + Bio-fertilizers + 25 t FYM/ha (21.45 t/ha) may be recommended for organic farming of potato in North Bihar.

Testing of Dhanzyme gold on potato: Two spray of Dhanzyme gold (liquid) @1000ml/ha (1st at 45 DAS and 2nd at 65 DAS) and may be recommended for commercial production of potato. A pilot trial was conducted to see the comparative effect of Mushroom spent, vermicompost and FYM on potato yield. The plot size for each organic source was 25sq^m. Yield in case of Mushroom spent, FYM and vermicompost was 25t/ha, 23.60t/ha & 21.60t/ha), respectively.

12. ONION & GARLIC

Advance Varietal Trial-I (AVT-I) Kharif Onion.: Eighteen entries were evaluated including check variety ADR. Nine entries *viz*; ON16-01, ON16-03, ON16-05, ON16-08, ON16-13, ON16-27, ON16-29, ON16-30 and ON16-32 were found significantly higher yielder as compare to check var. ADR. Entry ON16-08 with 427.22q/ha total bulb yield was superior one.

Advance Varietal Trial (AVT-II) Kharif Onion.: Thirteen entries were evaluated including check variety ADR. Eight entries *viz*; ON15-16, ON15-27, ON15-32, ON15-11, ON15-29, ON15-21, ON15-13 and ON15-45 were recorded significantly higher yielder as compared to check var. ADR. Entry ON15-16 with 471.94 q/ha total bulb yield was superior one.

Initial Evaluation Trial (IET) Kharif Onion.: Eight entries were evaluated including check variety ADR. Five entries *viz*; ON17-56, ON17-54, ON17-58, ON17-62 and ON17-69 were found significantly higher yielder as compared to check var. ADR. Entry ON17-56 with 491.39 q/ha total bulb yield was superior one.

Initial Evaluation Trial (IET) Late Kharif Onion.: Fifteen entries were evaluated including check variety ADR. Five entries *viz*; ONLK-17-31, ONLK-17-11, ONLK-17-28, ONLK-17-34 and ONLK-17-16 were recorded significantly higher yielder as compared to check var. ADR. Entry ONLK-17-31 with 241.67 q/ha total bulb yield was superior one.

Advance Varietal Trial (AVT-II-II) Late Kharif Onion. : Eleven entries were evaluated including check variety ADR. Four entries *viz*; ONR17-31, ONR17-15, ONR17-19 and ONR17-35 were found significantly higher yielder as compared to check var. ADR. Entry ONR17-31 with 231.11 q/ha total bulb yield was superior one.

Initial Evaluation Trial (IET) Rabi Onion: Twelve entries were evaluated with check var. ALR. Entry ON17-58, ON17-67, ON17-69, ON17-71 and ON17-73 are significantly superior as compared to check variety. Entry ON17-69 with 18.67 t/ha total bulb yield was highest yielder.

Advance Varietal Trial-I (AVT-I) Rabi Onion: Twenty one entries were evaluated including check var. ALR. Entry ON16-11, ON16-13, ON16-20, ON16-25, ON16-27, ON16-35, ON16-37 and ON16-54 are significantly better as compare to check. Entry ON16-27 with 21.53 t/ha total bulb yield was higher yielder.

Advance Varietal Trial-II (AVT-II) Rabi Onion: Fourteen entries were evaluated including check var. ALR. Entry ON15-06, ON15-11, ON15-27, ON15-45 and ON15-48 are significantly superior as compare to check variety. Entries ON15-45 with 201.00q/ha bulb yield was higher yielder.

Advance Varietal Trial-I (AVT-I) Garlic: Nine entries were evaluated including check var. G - 323. Entry GN15-62, GN15-65, GN15-68 and GN15-83 are significantly superior as compare to check variety. Entry GN15-83 with 8.13 t/ha total bulb yield was highest yielder.

Initial Evaluation Trial (IET) Garlic: Nine entries were evaluated including two check var. G - 323 and G-50. Entry GN17-05, GN17-14, GN17-16 and GN17-19 were found significantly superior as compared to best check. Entry GN17-16 with 8.77 t/ha total bulb yield was higher yielder.

Garlic Germplasm: Twenty six entries were evaluated with including check var. G-323 (4.96 t/ha). Eight entries *viz*: RAU G-01, RAU G-07, RAU G-09, RAU G-10, RAU G-12, RAU G-14, RAU G-15 and RAU G-25, were recorded significantly higher yielder as compared to check variety. Entry RAU G-12 with 8.23 t/ha total bulb yield was higher yielder.

Screening of Kharif onion AVT-I entries against Onion thrips (*Thrips tabaci*): Eighteen onion entries including check variety ADR were evaluated during Kharif 2017. Thrips population ranged from 5.65 to 16.80. The lowest number of thrips/plant (5.65) was recorded in entry ON16-08 which was statistically superior to all the other entries.

Screening of Kharif onion AVT- II entries against onion thrips (*Thrips tabaci*): Thirteen onion entries including check variety ADR were evaluated during Kharif 2017. Thrips population ranged from 6.33 to 17.38. Lowest number of thrips/plant (6.33) was recorded in entry ON15-16 which was statistically superior to all the other entries.

Screening of Kharif onion (IET) entries against onion thrips (*Thrips tabaci*). : On the basis of thrips infestation, entry ON 17-56 (8.99) was statistically superior to all the other entries but was at par with ON 17-54 (9.10).

Screening of late Kharif onion AVT- II-II entries against onion thrips (*Thrips tabaci*): Eleven onion germplasms including check variety ADR were evaluated during late Kharif season. Thrips population ranged from 13.66 to 27.12. Lowest number of thrips/plant (13.66) was recorded in entry ONR17-15 which was statistically superior over all the other entries.

Screening of late Kharif onion (IET) entries against onion thrips (*Thrips tabaci*): Fifteen onion germplasms including check variety ADR were evaluated during late Kharif season. Thrips population ranged from 16.11 to 27.55 per plant. Lowest number of thrips/plant (16.11) was recorded in entry ONLK-17-31 which was statistically superior over all the other entries.

Initial Evaluation Trial (IET) Rabi Onion (Ento.): Twelve onion germplasm including one check var. (ALR) were evaluated against thrips. Significantly low no. of thrips/ plant (17.85) was recorded in entry ON17-73.

Advance Varietal Trial-I (AVT-I) Rabi Onion (Ento.): Twenty one onion germplasm including one check var. (ALR) were evaluated against thrips. Significantly low no. of thrips/ plant (18.15) was recorded in entry ON16-27.

Advance Varietal Trial-II (AVT-II) Rabi Onion (Ento.): Fourteen onion germplasm including one check var. (ALR) were evaluated against thrips. Significantly low no. of thrips/ plant (20.57) was recorded in entry ON15-27.

Advance Varietal Trial-I (AVT-I) Garlic (Ento.): Nine garlic germplasm including one check var. (G-323) were evaluated against thrips. Significantly low no. of thrips/ plant (19.24) was recorded in entry GN15-68.

Initial Evaluation Trial (IET) Garlic (Ento.): Nine garlic germplasm including two check var. (G-323 & G-50) were evaluated against thrips. Significantly low no. of thrips/ plant (19.29) was recorded in entry GN17-16.

Initial evaluation trial (IET) of *Kharif* onion entries against *Stemphylium* Blight & Purple Blotch disease: Among 8 entries screened, only 1 entry (ON17-56) was found Resistant against *Stemphylium* Blight. 3 (ON17-54, ON17-58 & ON17-62) entries were found Moderately Resistant against *Stemphylium* Blight as well as Purple Blotch disease.

Screening of late *Kharif* onion (IET) entries against *temphylium* Blight & Purple Blotch disease: Among 15 entries screened, 2 (ONLK-17-31 & ONLK- 17-11) and 3 (ONLK-17-31, ONLK-17-11 & ONLK-17-28) entries were found Moderately Resistant against *Stemphylium* Blight and Purple Blotch disease, respectively.

Screening of *Kharif* onion (AVT-I) entries against *Stemphylium* Blight & Purple Blotch disease: Among 18 entries screened, 5 (ON16-29, ON16-01, ON16-03, ON16-13 & ON16-24) and 4 (ON16-29, ON16-01, ON16-03 & ON16-13) entries were found Moderately Resistant against *Stemphylium* Blight and Purple Blotch disease, respectively.

Screening of *Kharif* onion (AVT-II) entries against *Stemphylium* Blight & Purple Blotch disease : Among 13 entries screened, 4 (ON15-32, ON15-16, ON15-27 & ON15-11) and 3 (ON15-32, ON15-16 & ON15-27) entries were found Moderately Resistant against *Stemphylium* Blight and Purple Blotch disease, respectively.

Screening of late *Kharif* onion (AVT-II-II) entries against *Stemphylium* Blight & Purple Blotch disease. : Among 11 entries screened, 3 (ONR17-31, ONR17-15 & ONR17-19) and 2 (ONR17-31 & ONR17-15) entries were found moderately resistant against *Stemphylium* Blight and Purple Blotch disease, respectively.

Initial Evaluation Trial (IET) of *Rabi* onion entries against *Stemphylium* Blight (SB) & Purple Blotch (PB) disease: Among 12 entries screened, 1 entry *viz.*, ON17-69 was found Resistant against *Stemphylium* Blight disease of onion whereas, 5 entries *viz.*, ON17-58, ON17-67, ON17-71, ON17-73 & ON17-85 and 4 entries *viz.*, ON17-58, ON17-67, ON17-69 & ON17-73 were found Moderately Resistant against against both diseases.

Screening of *Rabi* onion AVT-I entries against *Stemphylium* Blight (SB) & Purple Blotch (PB) disease: Among 21 entries screened, 1 entry *viz.*, ON16-27 and 2 entries *viz.*, ON16-27 &

ON16-54 were found Resistant against Stemphylium Blight & Purple Blotch disease on onion respectively. 9 entries viz., ON16-11, ON16-13, ON16-20, ON16-22, ON16-25, ON16-30, ON16-35, ON16-37 & ON16-54 and 5 entries viz., ON16-11, ON16-20, ON16-30, ON16-35 & ON16-37 were found Moderately Resistant against both diseases on onion respectively.

Screening of Rabi onion AVT-II entries against Stemphylium Blight (SB) & Purple Blotch (PB) disease : Among 14 entries screened, 1 entry viz., ON15-45 was found Resistant against Purple Blotch disease of onion whereas, 5 entries viz., ON15-06, ON15-11, ON15-27, ON15-45 & ON15-48 and ON15-01, ON15-06, ON15-11, ON15-27 & ON15-48 were found Moderately Resistant against both diseases.

Screening of Initial Evaluation Trial (IET) of Garlic against Stemphylium Blight (SB) & Purple Blotch (PB) disease: Among 9 entries screened, 2 entries viz., GN17-14 & GN17-16 were found Resistant against Stemphylium Blight disease of garlic whereas, 3 entries viz., GN17-03, GN17-05 & GN17-19 and 4 entries viz., GN17-05, GN17-14, GN17-16 & GN17-19 were found Moderately Resistant against both diseases.

Screening of Advanced Varietal Trial-II (AVT-I) of Garlic against Stemphylium Blight (SB) & Purple Blotch (PB) disease: Among 9 entries screened, 1 entry viz., GN15-83 was found Resistant against Stemphylium Blight disease of garlic whereas, 3 entries viz., GN15-62, GN15-65 & GN15-68 and 4 entries viz., GN15-62, GN15-65, GN15-68 & GN15-83 were found Moderately Resistant against both diseases.

Initial Evaluation Trial (IET) of Rabi onion entries against Stemphylium Blight (SB) & Purple Blotch (PB) disease: Among 12 entries screened, 1 entry viz., ON17-69 was found Resistant against Stemphylium Blight disease of onion whereas, 5 entries viz., ON17-58, ON17-67, ON17-71, ON17-73 & ON17-85 and 4 entries viz., ON17-58, ON17-67, ON17-69 & ON17-73 were found Moderately Resistant against both diseases.

Screening of Rabi onion AVT-I entries against Stemphylium Blight (SB) & Purple Blotch (PB) disease: Among 21 entries screened, 1 entry viz., ON16-27 and 2 entries viz., ON16-27 & ON16-54 were found Resistant against Stemphylium Blight & Purple Blotch disease on onion respectively. 9 entries viz., ON16-11, ON16-13, ON16-20, ON16-22, ON16-25, ON16-30, ON16-35, ON16-37 & ON16-54 and 5 entries viz., ON16-11, ON16-20, ON16-30, ON16-35 & ON16-37 were found Moderately Resistant against both diseases.

Screening of Rabi onion AVT-II entries against Stemphylium Blight (SB) & Purple Blotch (PB) disease : Among 14 entries screened, 1 entry viz., ON15-45 was found Resistant against

Purple Blotch disease of onion whereas, 5 entries *viz.*, ON15-06, ON15-11, ON15-27, ON15-45 & ON15-48 and ON15-01, ON15-06, ON15-11, ON15-27 & ON15-48 were found Moderately Resistant against both diseases..

Screening of Initial Evaluation Trial (IET) of Garlic against Stemphylium Blight (SB) & Purple Blotch (PB) disease: Among 9 entries screened, 2 entries *viz.*, GN17-14 & GN17-16 were found Resistant against Stemphylium Blight disease of garlic whereas, 3 entries *viz.*, GN17-03, GN17-05 & GN17-19 and 4 entries *viz.*, GN17-05, GN17-14, GN17-16 & GN17-19 were found Moderately Resistant against both diseases.

Screening of Advanced Varietal Trial-II (AVT-I) of Garlic against Stemphylium Blight (SB) & Purple Blotch (PB) disease: Among 9 entries screened, 1 entry *viz.*, GN15-83 was found Resistant against Stemphylium Blight disease of garlic whereas, 3 entries *viz.*, GN15-62, GN15-65 & GN15-68 and 4 entries *viz.*, GN15-62, GN15-65, GN15-68 & GN15-83 were found Moderately Resistant against both diseases.

13. FRUITS

BANANA

Collection, Characterization, Conservation and Evaluation of germplasm: In field gene bank of 69 banana accessions are being maintained. Twenty four accessions produced more than 20.0 kg bunch weight in plant crop cycle under agro-ecological conditions of Bihar. Seven varieties produced more than 25 Kg fruits/ plant i.e. Gandevi Selection (27.5kg /Bunch), Grand Naine (26.8kg/Bunch), Kanthali (29.0kg /Bunch), FHIA-3(25.6kg/Bunch), FHIA-23 (25.5kg /Bunch), (Robusta (25.0kg /Bunch) and Kothia (26.0 kg/Bunch).

Clonal selection of Banana: Three promising clones have been selected from farmer's field.

Enhancing input use efficiency in banana: The effect of various inputs like drip irrigation, fertigation, micronutrients, spray of SOP and polythene mulching on different growth parameters and yield parameters of banana were studied against RDF + flooding and found that there was no significant difference among the treatments.

Assessment of phenology, productivity and incidence of insect pests and diseases in banana grown under varying climatic conditions: On 13.1.2017 and 14.1.2017 minimum temperature declined to 1.5⁰C and 2.5⁰C respectively, which badly damaged the banana crops and resulted in severe burning of banana leaves due to extreme cold situation. No visible difference were recorded with respect to phenology of banana i.e. days to flower from transplanting; days to fruit maturity

from fruit set; length of fruiting period (days) etc. The trend of disease development in case of leaf spot, rhizome rot, and BBTV was increasing while in case of Panama wilt it was decreasing in comparison to previous year i.e. 2015-16.

New and emerging disease(s) of banana: During survey of the state, Panama wilt was observed as a major problem of tall bananas i.e. Malbhog (AAB), Alpan (AAB), Champa (AAB), Chini Champa (AB), Kanthali (AAB), Kothia (ABB) in Zone – I comprising of Samastipur, Muzaffarpur, Vaishali, Hazipur districts. Fortunately the incidence of the disease (45%) was less as compared to previous year in this zone. This disease did not appear in Zone-II (Saharsa, Katihar, Purnea and Bhagalpur districts). Eumusae leaf spot (24 PDI) and BBTV(16%) were observed as a major problem in both the zone. In both the cases trend of disease development was increasing when compared with their incidence in the previous year 2014-15. It needs to mention that BBTV is a problem of the entire state irrespective of varieties (both tall and dwarf varieties). Dwarf Cavendish varieties were found to be more susceptible than tall ones. Rhizome rot with 18% incidence was observed only in zone II on Cavendish group of banana at initial stage of crop growth but the overall scenario showed a slowly increasing trend as compared to previous year (2015-16). All the diseases of banana appeared to be more severe during rainy season (i.e. July to October) as compared to other parts of the year. Nearly 20-30% plantations in Koshi region of Bihar have now been established with tissue-cultured plants which were found free from Panama wilt. However, Eumusae leaf spot (12 PDI), Rhizome rot (0-6%) and CMV (0-6%) were observed in those tissue cultured plantations.

Integrated management of *Fusarium* wilt disease of banana: On the basis of eight years of experimentation it was concluded that for managing Panama wilt disease of banana use of disease free suckers after dipping in 0.2% Carbendazim for 45 minutes followed by soil drenching (0.2%) carbendazim @2-3 litres /plant at 0, 2 and 4 MAP and Carbendazim injection @ 3ml of 2% solution at 3rd, 5th and 7th, months after planting may be recommended. However, bio-control agents i.e. *Trichoderma viride* (@ 10g/sucker three times) used as soil application also found highly effective and causes marked suppression of Panama wilt so may be included in integrated crop management (ICM)/ integrated diseases management (IDM) schedule in strict organic system.

Diagnosis of banana viruses in germplasm and planting material used in experiments: Sixty nine germplasms were critically observed to record the presence of viral disease(s) in germplasm

and planting material used in experiments. BBTV was found in CV Robusta, Grand naine, Basrai, Kothia and Alpan and the incidence percentage was ranged between 2 and 16%. CMV was observed in Grand naine tissue cultured plants only with 6% incidence.

Screening of germplasm against Rhizome rot: Sixty nine germplasm were screened in natural conditions against Rhizome rot . No banana germplasm was found affected by the disease.

PAPAYA

Assessment of phenology, productivity and incidence of insect pests and diseases in papaya grown under varying climatic conditions: Decline of minimum temperature to 1.5⁰C - 2.5⁰C On 13- 14 January 2017, badly damaged the crop and resulted in severe burning of papaya leaves due to extreme cold situation. In agro-ecological conditions of Pusa, October planted papaya crop took 140-150 days to flower, 90-100 days to fruit maturity from fruit set and length of fruiting period was 280-318 days. No apparent change in phenology of papaya plant was observed during the year 2016-17 as compared with the year 2015-16. During 2016-17 trend of disease development was decreasing in case of leaf curl and PRSV, and increasing in case of fruit rot while in case of damping off and root rot no-change situation was observed in comparison with that in the previous year.

Enhancing input use efficiency in papaya: Of the treatments maximum number of fruits/plant (27.70) and average fruit weight /plant (15.90kg) were recorded in the treatment of (raised- bed cultivation + drip irrigation (80% ER at all stages) + fertigation (75% RDF) + mulching with 100 - micron UV stabilized black polyethylene as compared to the control (Soil application of RDF with basin irrigation and no mulching).

Emerging disease(s) of papaya: Survey in major papaya growing districts of Bihar, viz, Samastipur, Muzaffarpur, Vaishali, Siwan ,Saran, Katihar, Saharsa ,Bhagalpur and Aurangabad during 2016-17, the incidence of various fungal diseases –collar rot ,fruit rot and root rot was observed at various locations. The highest incidence was observed in case of root rot (60-80%) while fruit rot and collar rot showed less than 16% incidence in the area under survey. The incidence of PRSV was found between 80 and 100%; while leaf curl showed only less than 3% incidence. Leaf curl and PRSV showed decreasing trend, collar rot no change, whereas fruit rot and papaya root rot showed increasing trend as comparison to those in the previous year, i.e., 2015-16.

Epidemiology and Integrated management of papaya ring spot virus:

A. Epidemiological studies: PRSV emerged as a serious threat to papaya plantation leading to rapid shrinkage of area under this crop in Bihar. In Bihar papaya is planted during two seasons (June-July and September-October). In the year 2015-16 the planting time was found to exert appreciable effect on incidence of PRSV. Data on the effect of planting season in relation to incidence of PRSV and aphid population at different stages of plant growth was recorded. Comparative study clearly revealed that the October- planted crop delayed the onset of PRSV up to 130 days with 18% incidence and further development rate was also slower and reached 100% incidence at the age of 280 days fruit setting stage, whereas in case of July -planted crop the initial symptoms of PRSV disease appeared only at the age of 45 days with higher 35% disease incidence and disease developed at faster rate reaching 100% at the age of 165 days at fruiting setting stage. October -planted papaya plants were exposed to PRSV disease for shorter duration as compared to July planted crops which was exposed to PRSV disease for much longer duration, so resulting in much less marketable fruit yield (18 kg/plant) as compared to October -planted crop with higher marketable fruit yield (24 kg/plant). October planting of papaya appeared to be more suitable for managing PRSV. Aphids populations were prevalent throughout year, but the rate of disease development was delayed in case of October planted crop as compared to July planted crop. Thus weather parameters and aphids populations being common, the plant age appeared to play a vital role in development of PRSV disease in papaya in agro-ecological conditions of Bihar.

b. Management: Most effective treatment was spraying of urea @ 10g/litre + zinc sulphate @1.5g + boron @ 1.0g per litre applied at monthly intervals up to 8 months which registered the lowest rate of PRSV disease development(12% at 150days, 25% at 180days and 48% at 210 days),delayed appearance of the disease(up to 120 days) and recorded maximum marketable fruit yield (48 Kg/plant) in comparison to untreated control. With the help of the above management technology the crop may produce a satisfactory yield (up to 48 Kg/plant) in the first year even under heavy disease pressure, due to delayed disease appearance under managed condition.

Integrated management of papaya diseases: Comparative study of Module-I (proposed recommendation) and Module-II (Standard recommendation of the university) on development of papaya diseases showed that the module-I recorded PRSV in the month of February 2016 at 6% which enhanced to the level of 62% in the month of August 2016 where as in case of module-II PRSV disease appeared earlier in the month of January 2016 at the level of 8% which increased to

15% in February 2016 and further enhanced to 71% in the month of August 2016. Thus module-I slowed down the development of PRSV. Regarding root rot disease of papaya (*Fusarium solani*) module-I showed 60% incidence of root rot in the month of August, 2016 whereas module-II also registered 68% incidence. Thus both the modules were effective in controlling the root rot of papaya in agro-ecological conditions of Bihar.

14. SPICES

Germplasm Collection, Characterization, Evaluation and Conservation of ginger. : Of 75 accessions, only fifteen accessions gave higher yield ranging from 93.75 to 184.62q ha⁻¹ as compared to the check variety, Nadia. Of promising accessions, RG-9 gave the highest yield of 184.62q ha⁻¹ followed by RG-60 (180.00q ha⁻¹) under shaded condition.

Germplasm Collection, Characterization, Evaluation and Conservation of turmeric. : Of 100 accessions, only sixteen accessions gave higher yield ranging from 392.25 to 456.63q ha⁻¹ as compared to check variety, Rajendra Sonali & Rajendra Sonia (396 & 343q ha⁻¹ respectively). Of sixteen promising accessions, RH-14 gave highest yield (456.63q ha⁻¹) followed by RH-421 (443.75q ha⁻¹).

Organic package on production of ginger. : Effect of varieties: Of the three varieties of ginger, Nadia, Surabhi & Suprabha, none showed significantly higher yield. **Effect of organic package:** Effect of both the organic packages (organic package of IISR-Calicut and organic package of DRPCAUI) was found to be non-significant on yield. **Interaction effect (Variety x organic package):** Interaction effect was non-significant on yield.

Effect of micro-nutrient for growth and yield of ginger. : Effect of varieties: Of the three varieties, viz., Nadia, Varada & Surabhi, Nadia produced significantly higher yield (123.75q ha⁻¹) as compared to Surabhi and Varda (103.54 & 91.46q ha⁻¹, respectively). **Effect of micro-nutrients:** Of the two packages of micro-nutrients (IISR-Calicut & DRPCAUI), micro-nutrient package of DRPCAUI gave significantly higher yield (111.45q ha⁻¹) than that of IISR-Calicut (101.05q ha⁻¹). Interaction effect (varieties x micro-nutrients) on yield was found non-significant.

Initial evaluation trial on turmeric. : Of nine entries and one local check, Rajendra Sonali, evaluated under Initial evaluation trial, RH-441 was found significantly superior for yield (542.59q ha^{-1}) to the local check variety (yield 462.22q ha^{-1}).

Effect of micro-nutrients on growth and yield of turmeric. : Effect of varieties: Of the three varieties of turmeric Rajendra Sonia, R. Sonali and Pratibha, R. Sonali gave significantly higher yield (556.09q ha^{-1}) than R. Sonia and Pratibha (500.48 & 325.93q ha^{-1} , respectively). Of the two packages of micro-nutrients (IISR-Calicut & DRPCA), micro-nutrients package of DRPCA gave significantly higher yield (481.95q ha^{-1}) than that of IISR- Calicut (439.21q ha^{-1}). Interaction effect (varieties x micro-nutrients) on yield was found non-significant.

Effect of organic package on production of turmeric. : Of the three varieties turmeric, Rajendra Sonia & R. Sonali gave significantly higher yield (617.48 & 613.88q ha^{-1} , respectively) than Pratibha (401.44q ha^{-1}). Of two organic packages, (IISR-Calicut & DRPCA) organic package of DRPCA gave significantly higher yield (563.05q ha^{-1}) than that organic package of IISR-Calicut (525.48q ha^{-1}). Interaction effect (Varieties x organic package) was found non-significant.

Effect of organic manures and bio-fertilizers on ginger. : Among sixteen treatments and a control, all the treatments were found to give significantly higher yield as compared to control (55.23q ha^{-1}), except the RDF ($80:50:80\text{kg ha}^{-1}$ N.P.K). However, among the treatments, T₁₁-RDF (N.P.K: $80:50:80\text{kg ha}^{-1}$) + FYM (30t ha^{-1}) + *Trichoderma* gave the highest yield (155.27q ha^{-1}) followed by T₁₂- RDF (N: P: K: $80:50:80\text{kg ha}^{-1}$) + FYM- 30t ha^{-1} + PSB (143q ha^{-1}).

Coordinated varietal trial on turmeric. : Among ten entries and two checks evaluated under coordinated varietal trial, RH-9/90 and RH-80 gave significantly higher yield (547.33 and 539.78q ha^{-1} respectively) than the best check variety, Rajendra Sonali (433.71q ha^{-1}) and other entries.

Germplasm collection, characterization, evaluation and conservation of coriander: Out of one hundred sixty accessions, only seventeen accessions gave higher yield ranging from 21.94 to 20.0q ha^{-1} as compared to best check variety, Rajendra Swati (19.44q ha^{-1}). Among promising accessions, RD-434 gave the highest yield of 21.94q ha^{-1} followed by RD-422 giving the yield of 21.53q ha^{-1} .

Germplasm collection, characterization, evaluation and conservation of fenugreek. : Out of one hundred sixty six accessions, only thirteen accessions gave the highest yield ranging from 21.62 to 20.56q ha^{-1} as compared to best check variety, Rajendra Kanti giving yield of 19.72q ha^{-1} . Among promising accessions, RM-15 followed by RM-190 gave the highest yield of 21.62 & 21.39q ha^{-1} respectively.

Initial evaluation trial on coriander (IET): Coriander entries RD-437 & RD-383 have been contributed in coordinated varietal trial.

Initial evaluation trial on fenugreek (IET): Fenugreek entries, RM-196 & RM-201 has been contributed in coordinated varietal trial.

Response of coriander genotypes to leaves cutting management for leaf & seed yield (Station trial) : Among five promising genotype and three levels of cutting, DH-228-1 produced significant higher leaf yield (104.20 qha⁻¹) with two cutting of coriander leaves (45 & 65DAS) as compared to other entries & levels of cuttings. However, Rajendra Dhanian-1 gave significantly higher seed yield (20.00 qha⁻¹) with no cutting as compared to other entries and other levels of leaf cutting.

Coordinated varietal trial on coriander (CVT): Coriander entry, RD-417 has been recommended for released as variety at national level in XXIX AICRP on Spices workshop.

New area of research identified and new research projects formulated; if any with details: New CVT started in Rabi, 2018.

Effect of different level of fertilizers with bio-fertilizers on coriander: Application of either PSB or *Azospirillum* @15kg ha⁻¹ along with NPK@60:40:30 kgha⁻¹ was recommended for getting higher yield of coriander in XXIX AICRP on Spices workshop.

Initial evaluation trial on fennel (IET): Fennel entries, RF-31 & RF-5 have been contributed in coordinated varietal trial.

Germplasm collection, characterization, evaluation and conservation of fennel : Out of sixty accessions, only twelve accessions gave the highest yield ranging from 24.13 to 17.50 qha⁻¹ as compared to best check varieties, GF-11 & Rajendra Saurabh giving yield of 16.25 qha⁻¹. Among the promising accessions, RF-67 followed by RF-2 gave the highest yield of 24.13 & 22.50 qha⁻¹ respectively.

Germplasm collection, characterization, evaluation and conservation of coriander: Out of one hundred sixty accessions, only seventeen accessions gave higher yield ranging from 21.94 to 20.0 qha⁻¹ as compared to best check variety, Rajendra Swati (19.44 qha⁻¹). Among promising accessions, RD-434 gave the highest yield of 21.94 qha⁻¹ followed by RD-422 giving the yield of 21.53q ha⁻¹.

Germplasm collection, characterization, evaluation and conservation of fenugreek. : Out of one hundred sixty six accessions, only thirteen accessions gave the highest yield ranging from 21.62 to 20.56 qha⁻¹ as compared to best check variety, Rajendra Kanti giving yield of 19.72 qha⁻¹.

Among promising accessions, RM-15 followed by RM-190 gave the highest yield of 21.62 & 21.39 qha⁻¹ respectively.

Initial evaluation trial on coriander (IET): Coriander entries RD-437 & RD-383 have been contributed in coordinated varietal trial.

Initial evaluation trial on fenugreek (IET): Fenugreek entries, RM-196 & RM-201 has been contributed in coordinated varietal trial.

Response of coriander genotypes to leaves cutting management for leaf & seed yield (Station trial) : Among five promising genotype and three levels of cutting, DH-228-1 produced significant higher leaf yield (104.20 qha⁻¹) with two cutting of coriander leaves (45 & 65DAS) as compared to other entries & levels of cuttings. However, Rajendra Dhania-1 gave significantly higher seed yield (20.00 qha⁻¹) with no cutting as compared to other entries and other levels of leaf cutting.

Germplasm collection, characterization, evaluation and conservation of fennel : Out of sixty accessions, only twelve accessions gave the highest yield ranging from 24.13 to 17.50 qha⁻¹ as compared to best check varieties, GF-11 & Rajendra Saurabh giving yield of 16.25 qha⁻¹. Among the promising accessions, RF-67 followed by RF-2 gave the highest yield of 24.13 & 22.50 qha⁻¹ respectively.

Management of Phyllosticta leaf spot of ginger. : To manage the phyllosticta leaf spot of ginger, foliar spray with Carbendazim (0.1%) + Mancozeb (0.2%) first at disease appearance & subsequently 2 times at 20 days interval may be recommended.

Screening of turmeric germplasm against foliar disease.: Among 65 germplasm of turmeric screened against foliar disease, 13 (RH-445, RH-419, RH-425, RH-416, RH-6, RH-438, RH-80, RH-14, RH-417, RH-415, RH-423, RGH-428 & RH-13/90) and 39 germplasms were found to be resistant and moderately resistant respectively against leaf blotch disease caused by *Taphrina maculans*. Susceptible check (var. Morangia) showed susceptible reaction against leaf blotch disease.

Evaluation of turmeric germplasms/ varieties of different AICRP centre for resistance to foliar diseases. : Among 16+1 (susceptible check, var. Morangia) germplasms/varieties of turmeric screened against leaf spot (*Colletotrichum capsici*) & leaf blotch (*Taphrina maculans*) diseases., turmeric germplasms/ varieties, except CL-34, CL-52, NDH-40 & NDH-74, were found to fall under of the resistant category (HR/R/MR). Highest yield of 36.95 t/ha was recorded in RH-

406 which showed highly resistant (HR) and moderately resistant (MR) disease reaction against leaf spot and leaf blotch disease respectively.

Screening of coriander germplasm against stem gall disease: Out of 71 germplasm screened against stem gall, eight (8) nos. of germplasm (RD-377, RD-385, RD-392, RD-405, RD-412, RD-414, RD-424 & RD-439) were found Highly Resistant against stem gall disease of coriander. Susceptible check, Rajendra Swati showed Highly Susceptible reaction against stem gall disease.

Integrated management of stem gall disease of coriander : Significant lowest PDI (5.83) and highest yield (20.25 qha⁻¹) followed by PDI=5.89 and yield=20.04 qha⁻¹ over control (PDI= 16.63 & yield= 16.90 qha⁻¹) were recorded in treatment comprising soil application with *Trichoderma* @10kg/ha + seed treatment with Carboxin + Thiram @0.40% and foliar spray with Azoxystrobin + Tebuconazole @0.1% at 45, 60 & 75 DAS followed by treatment comprising soil application of *Trichoderma* @10kg/ha and foliar spray with Azoxystrobin +Tebuconazole @0.1% at 45, 60 & 75 DAS.

15. VEGETABLE CROPS

Collection, Evaluation and Conservation of Early cauliflower germplasm: Survey for collection of early cauliflower was made during last year and collected 02 new germplasms from different parts of North Bihar. Nine early cauliflower germplasm were evaluated against check Sabour Agrim. RECF-4 recoded highest average fruit weight (666.66 g).

Collection, Evaluation and Conservation of Mid season cauliflower germplasm : Survey for collection of mid cauliflower was made during last year and collected 01 new germplasm from different parts of North Bihar. Five genotypes of mid cauliflower were evaluated against check Pant Subhra. Out of which RMCF 5 gave highest average fruit weight 570 g, which is at par with check in curd length and have highest value in curd length.

AVT -II on Round Brinjal : Seven entries were evaluated against one local check Swarm Mani. Entry no 2015 BRRVAR – 2 recoded highest yield 450.05 q/ha followed by BRRVAR -1, BRRVAR -4 & BRRVAR -3 which all are at par to each other.

Collection, Evaluation and Conservation of Cowpea germplasm : 27 new germplasms of Cowpea were collected from different parts of India. 27 diverse genotypes were evaluated against one check Kashi Unnati. Germplasm line PL-1 recorded highest yield (200.46 q/ha) followed by EC390237 (193.92 q/ha) and GP-3 (176.14 q/ha).

Collection, Evaluation and Conservation of Brinjal germplasm: 22 Brinjal germplasms were collected last year from different parts of Bihar and India.

Collection, Evaluation and Conservation of Tomato germplasm: 71 germplasms were collected last year from different parts of Bihar and India

Collection, Screening and Conservation of Pointed gourd germplasm: Sixteen germplasm of pointed gourd were screened during 2016-17 and germplasm PGS-3 recorded maximum yield among all germplasm.

IET on Mid season Cauliflower : Seven entries were evaluated against one local check. Out of which CAUMVAR-7 284.28 q/ha recorded maximum yield (284.28 q/ha) which is at par with local check (259.86 q/ha).

Organic production of spinach beet : Maximum leaf yield was recorded with the treatment T₅ (VC@ 5t/ha+ PSB& AZOS@ 5kg/ha) which was at par with T₇ (PM@ 15 t/ha + PSB& AZO@ 5kg/ha) i.e. 234.21 q/ha and T₆ (FYM@ 20 t/ha + PSB& AZO@ 5kg/ha) i.e.230.61 q/ha. Minimum was recorded with the treatment T₁ (Recommended 100:50:50 NPK Kg/ha).

INM studies in French Bean : Maximum Pod yield was recorded with the treatment T₃ (75% NPK through inorganic source + 25% N VC) i.e. 140.12 q/ha and minimum was recorded with the treatment T₈ (Control) i.e. 64.39 q/ha

Protected cultivation of Tomato under naturally ventilated polyhouse: Five hybrids entries (Pant PTH-1, Pant PTH-2, Palam Tomato Hybrid-1, GS 600 and Novara) along with one local check (Indam 535) were evaluated under naturally ventilated polyhouse. None of the entries were found significantly superior over check

16. FLORICULTURE

Testing of new genotypes of gladiolus: On the basis of three year pooled data and economics, Gladiolus genotype “Arka Naveen” produced best results for all the three year of experimentation. This may recommended for commercial cultivation in state of Bihar along with package and practices of N:P:K – 100:60:60 at spacing of 30 cm x 20 cm and planting in the month of October to November.

Testing of new genotypes of tuberose: On the basis of three year pooled data and economics, genotype “Bidhan Rajani H-1” produced best results for all the three year of experimentation. This may recommended for commercial cultivation in state of Bihar along with package and practices of N:P:K – 120 : 60 : 60 kg / ha at spacing of 30 cm x 30 cm and planting in the month of March.

Testing of new genotypes of marigold for loose flower: Ten genotypes including two check were tested for their performance with regard to floral character and yield. None of the genotypes perform better than check genotype Pusa Narangi Genda (African Marigold) and Jafri local (French Marigold).

Collection of genotype for crop improvement of tuberose: All together 10 genotypes were collected during 2017-18 and 18-19, out of its 7 are single types and 3 is double type florets. Genotype BR H-1 single type and BR H 24 double type florets registered its superiority through spike length, rachis length, number of florets / spike.

Evaluating performance of gerbera varieties for cut flower production under poly house conditions: Performance of five gerbera varieties including one check were evaluated. The genotype “ Liberty ” differed significantly with respect to length of flower stalk (58.48 cm), Diameter of flowers (10.52 cm), number of flower / plant/year (33.08) and Vase life (7.70 days) was better than other genotypes. Dyana Alen was the next superior genotype with respect to flower stalk and flower character .

Evaluating performance of chrysanthemum varieties for cut flowers production under poly house condition: Performance of five chrysanthemum varieties including one check was evaluated. The genotype “ Salvadore ” differed significantly with respect to plant height (82.60 cm), No. of primary branches (7.53), Plant spared (33.15 cm), Diameter of flowers (8.48 cm) and number of flowers / plants (64.65) was better than other genotypes. Aris was the next superior genotype with respect to plant height and flower character.

17. OIL PALM

Nutrient requirement studies in oil palm under Bihar and North East region: Recently this experiment has been started in July. This experiment has treatment 4; Replications: Five; Design: RBD, No. of palms/plot-6. No. of plot: 20; Spacing: 9m hexagonal; Total number of palms maintained under this experiment is 120. Soil sample has been taken in July 2018, leaf sample of oil palm has been send to Pusa for their analysis, based on the existing soil /leaf analysis report targeting 20 t/ha and the dose of different fertilizers may be modified based on the annual analysis report. Layout plan of the experiment has been prepared and fertilizer doses as per treatments has been applied except 4th treatment. Fertilizers have to be applied in four equal splits in a year. In case of T1, T2 and T3, one third of the dose during first year of planting, two-third of the dose during second year of planting and full dose from third year onwards have to be applied.

Magnesium and Boron dose has been applied in T1, T2 and T3 treatments as MgSO₄; 500 g/p/y and Boron 100 g/p/y as recommended by ICAR-IIOPR, Pedavegi. Quarterly data related to the concerned parameters will be recorded from September onward.

Demonstration on oil palm production potential in Bihar and North East Region: Presently 66 oil palm tree (varieties: *Costarica*) has been maintained under this experiments, which were planted in 2009 in the maximization plot design at spacing of 9 m X 9 m X 9m (triangular) where maintained plant population are 6 palms/plot. All the recommended crop management practices have been adopted to attained maximum yield potential of this crop. The average palm height, collar girth and number of leaves per plant during June 2018 as per suggestion received from ICAR-IIOPR, Pedavegi, were, 8.69 m, 4.76 m, & 15 leaves per palm respectively. Pollinating weevil brought in July 2018, from ICAR-IIOPR, Pedavegi and was released in the plantation. After releasing the pollinating weevil in the plantation fruit set has been improved. The number of FFB produced per palm was 9 with an average fresh fruit bunch weight of 14.7 kg, FFB weight (kg/palm/year) was 132.3 and FFB Yield (t/ha) recorded up-to 18.91 t/ha. The results obtained from the above experiment shows that the oil palm crop grows well under the climatic condition of Bihar.

Evaluation of new cross combination in oil palm: Ten new oil palm hybrids developed from ICAR-IIOPR, were planted during the year 2011, by adopting RBD with 3 replications and Plant population per plot was 6 palms, at Spacing of 9 m X 9 m X 9m (hexagonal) for evaluation of new cross combination in oil palm crop. The results obtained from progeny evaluation trials which varies from NRCOP1 to NRCOP10 has been shown in table. Among ten hybrids evaluated for growth and yield parameters the highest palm height (8.98 m) and the maximum number of functional leaves produced (13.27) was recorded under NRCOP7 while the maximum palm girth (3.84 m) measured under NRCOP2. Data on yield attributes of oil palm revealed that the highest number of fruit bunches per palm (9.36), bunch weight (12.49 kg), FFB weight (116.91 kg/palm/year) and FFB yield (16.72 t/ha) were recorded under NRCOP8 for the period of April' 17 to March'2018. While the minimum number of functional leaves produced per year (10.89), lowest palm girth (2.78 m), lowest fruit bunches weight of (9.12), minimum FFB weight (69.40 kg/palm/year), and FFB Yield (9.93 t/ha) were recorded under NRCOP10, whereas the lowest number of bunches (7.26) recorded in NRCOP4.

Evaluation of new (experimental) cross combinations in oil palm: Layout and planting of this trial were done in the experimental field during June, 2013, by adopting RBD with 3 replications and Plant population per plot was 6 palms, at Spacing of 9 m X 9 m X 9 m (hexagonal) for evaluation of new (**experimental**) cross combination in oil palm crop, which varies from NRCOP31 to NRCOP40. Growth parameters of the palms recorded in March 2018. The evaluation of different genotypes of oil palm has been carried out considering the all concerned vegetative parameters reproductive parameters. The growth of the plants with respect to plant height and collar girth over a period of one year was found to be statistically at par in all the cross combinations. The maximum palm height (5.82 m) was recorded in NRCOP33 while the lowest palm height (4.56 m) was recorded in NRCOP38. The highest palm girth (3.40 m) was recorded under NRCOP39 and lowest palm girth (2.68 m) under NRCOP38. The number of leaves produced was recorded the maximum (26.62) in NRCOP33 followed by NRCOP39 (25.21), while lowest number of leaves produced by NRCOP38 (17.49). All the palms are in the initial stage of bearing. Data related to reproductive parameters of palms recorded in 1st Quarter (April-June'2018), shows that the maximum number of fruit bunch (6.2) is produced by genotype NRCOP35, while the lowest number of fruit bunch (3.9) was produced by genotype NRCOP33. The maximum fruit bunches weight were recorded in genotype NRCOP34 (1.9 Kg), while the lowest fruit bunch weight (0.8 Kg) was produced by genotype NRCOP40. The fruit bunch weight is a key factor for determining the yield potential of palm, as it is clear from the table that even the less number of fruit bunch (4.9) is produced by NRCOP34, but due to higher fruit bunch weight it produces maximum FFB Yield (9.31 kg/palm) in first quarter.

Intercropping of Turmeric, Rai and lentil in Juvenile Oil Palm Garden: the experiment on feasibility of growing different crops as an intercrop in young oil palm garden was conducted in experimental plot of oil palm with four treatments in four replications having plot size 4m x 25m= 100 m². The intercrops like Turmeric variety *R. Sonia*; Turmeric variety *R. Sonali*; Rai variety *R. Suflam* and Lentil variety *Arun* were sown in oil palm cropping system. During 2017-2018, the number of annual leaves production, number of fresh fruit bunches and FFB yield were similar in all the treatments. The maximum net return (Rs./ha 1,37,568/-) was obtained from intercropping of Turmeric variety *R. Sonali* in T2; followed by intercrop of Turmeric variety *R. Sonia* (Rs./ha 1,02,372/-), while the lowest net return recorded in T3: Rai variety *R. Suflam* (Rs./ha 9704/-). The productivity of the oil palm cropping system is higher than the monocrop of oil palm due to

additional yield from the intercrops. B:C ratio was highest in T2 (4.44) followed by T1 (3.30) and T4 (1.69).

18. SUGARCANE

Collection, maintenance and screening of sugarcane germplasm for their flowering behaviour: The germplasm were screen out to study the flowering behaviour. Flowering was observed only in 53 varieties during 2017-18 in the whole gene pool. Out of these, 19 belong to profuse flowering, 16 to normal flowering and 08 to shy flowering groups. Except BO 154(62%), CoP031 (50%) pollen fertility of others were observed less than 50%.

Hybridization programme at Pusa with the prime objective to evolve varieties suitable for biotic and abiotic stresses: Altogether, 37 in which 12 self were attempted and 25 Field Crosses were collected during 2017-18. Total 5225 seedlings were raised from Pusa Crosses.

Plan of work for ensuing season: Elite clones of North central and Eastern zone and newly named BO and CoP clones will be included in the germplasm pool for hybridization work.

Hybridization programme at S.B.I., Coimbatore with the prime objective to evolve varieties having high cane yield and high sucrose: Altogether, 82 Crosses (Biparental-40, Poly cross-5 and GCs-37) were attempted and 18587 seedlings were generated.

Selection in Seedling Generation: Altogether, 448 clones were screened out on the basis of their height, girth, number of millable canes, high juice brix (HR), single cane wt., green foliage and field resistance to major diseases and pests from 25852 seedlings which were planted during 2016 in second ground nursery.

Evaluation of Early varieties in Initial Varietal Trial: Out of 8, 4 entries viz, CoP 14437, CoLk 14206, CoSe 14451 & CoSe 14454 were promoted to AVT trial based on overall performance with respect to cane yield, quality traits and disease reactions in NC& North Eastern Zone.

Evaluation of Early varieties in Advanced Varietal Trial-I Plant: In Advance varietal trial - Ist Plant Early among the three test entries CoP 13437 (87.74 t/ha) had maximum cane yield followed by CoSe13451 (83.47 t/ha) than the best standard CoSe 95422 (75.43 t/ha). In respect of sucrose % juice among the entries CoSe 13452 had maximum value of 17.54 % followed by CoSe13451(17.20). None of the entry was found superior with respect to the best standard CoLk 94184 (18.37%). In case of CCS t/ha the entry CoP13437 (10.23 t/ha) showed higher value followed by CoSe 13451 (9.93 t/ha) than the best standard CoLk 94184 (8.54 t/ha).

Evaluation of Early varieties in Advanced Varietal Trial-IInd Plant : In advance varietal trial IInd plant early among the three test entries CoLk12207 (106.71 t/ha) had maximum cane yield followed by CoP12436 (97.03t/ha) and CoSe12451 (80.69t/ha) while BO130 was judged as the best standard with cane yield of 79.98 t/ha. In respect of sucrose % juice CoLk12207 registered highest sucrose % of 17.78 followed by CoSe 12451(17.20) while among standard BO130 had highest value of 17.94%. In case of CCS t/ha the variety CoLk12207 (13.21t/ha) registered significantly highest value than better standard BO130 (9.47t/ha.)

Evaluation of Early varieties in Advanced Varietal Trial-Ratoon: In advance varietal trial early ratoon, among the three test entries CoP 12436 (85.43 t/ha) had maximum cane yield followed by CoLk12207 (84.08 t/ha) and CoSe12451(78.45 t/ha) while BO130 was judged as the best standard with cane yield of 64.22 t/ha. In respect of sucrose % juice CoSe12451 registered highest sucrose % of 17.04% followed by CoLk12207(16.89%) and CoP12436 (16.78%) while among standard BO130 had highest value of 17.94%. In case of CCS t/ha the variety CoP12436(9.93t/ha) registered significantly highest value than better standard BO130 (8.0t/ha.)

Plan of work for ensuing season: Three promoted entries viz., CoP 13437, CoSe 13451 and CoSe 13452 will be managed as AVT Early -Ratoon.

Evaluation of Midlate varieties in Initial Varietal Trial: 5 Varieties CoLk 14208, CoLk 14209, CoP 14438, CoP14439 and CoSe 14455 were promoted to AVT - I Plant Midlate

Evaluation of varieties in Advanced Varietal Trial -II Plant Midlate :In Advance Varietal Trial on midlate IInd plant, among the test entries maximum cane yield of 98.28 t/ha was recorded for the entry CoP 12438 followed by CoLk 12209(94.27 t/ha) and CoSe 12453 (90.39 t/ha) while the the best check was BO 91(85.79t/ha.). In case of sucrose % juice the entry CoLk09204 recorded highest value of 18.32% followed by CoLk12209 (18.18%) while the best checks was CoP 9301 (17.59 %).The entry CoP 12438 (12.07t/ha) had maximum CCS t/ha while best check was BO 91(10.12t/ha.).

Evaluation of Midlate varieties in Advanced Varietal Trial-Ratoon: In Advance Varietal Trial on midlate ratoon, among the test entries maximum cane yield of 88.92t/ha was recorded for the entry CoLk 09204 followed by CoP 12438 (78.20 t/ha) while the best check was BO 91(64.36 t/ha.) In respect of CCS %, among the test entries CoLk 09204 (12.74 t/ha) had maximum vale followed by CoLk 12209(12.72t/ha) and CoSe 11453(12.60 t/ha) while the best checks was CoP 9301(12.72 t/ha.). In case of sucrose % juice, the test entry CoLk12209 recorded highest value of 18.55 % followed by CoLk 09204 (18.46%) while the best checks was BO 91(18.27 %).

Maximum CCSt/ha was recorded by CoLk 09204(11.31t/ha) among the entry while best check was BO 91(8.14t/ha).

Evaluation and identification of climate resilient ISH and IGH genetic stocks for waterlogging tolerance -II Plant under normal condition : SA04-409, AS 04-635, AS 04-1687), AS 04-2097 and AS 04-245 were found suitable varieties for waterlogging tolerance.

Evaluation and identification of climate resilient ISH and IGH genetic stocks for Waterlogging tolerance -II Plant under waterlogging condition: AS04-1687, AS04-1689, AS04-2097 and SA 04-454 were found suitable varieties for waterlogging tolerance.

Evaluation and identification of climate resilient ISH and IGH genetic stocks for water logging tolerance-ratoon under normal condition : AS04-1687, AS04-1689 and SA 04-454 were found suitable varieties for waterlogging tolerance.

Seed Multiplication for ZVT : Under ZVT Seed Multiplication following -31 entries are under multiplication at SRI, Pusa and will be supplied to the other centres viz, eorahi,(U.P), Gorakhpur(U.P), Motipur (Bihar), Buralikson (Assam) and Bethaudeharib (W.B) for conducting AICRP trials.

Genetic diversity in early maturing clones : Among the thirteen entries the genotype CoP 16437(106.23t/ha) had maximum cane yield followed by CoP 15437(102.50 t/ha), CoSe 12451(99.86t/ha) and CoP 16438(98.61t/ha) with respect to check CoP 11437(94.06t/ha). In respect to sucrose % in juice at 10th month none of the genotype found superior than check CoP 11437(18.88%), The maximum value for CCS t/ha obtained by the genotype CoP 16437(13.41t/ha) followed by CoSe 12451(12.65t/ha), CoP 15437(12.31 t/ha) and CoP 16438(12.31 t/ha) with respect to the check CoP 11437 (11.92t/ha).

Evaluation of sugarcane midlate clones under waterlogged condition: BO155 was the most suitable variety among the clones studied for severe waterlogged conditions. Clones CoP2061, CoP15440 and BO154 were also high yielders under waterlogged conditions. These clones may be used directly as waterlogging tolerant clones and also as a parent for breeding clones for waterlogging tolerance.

Micro-propagation of newly developed/ released variety: Rajendra Ganna-1 is being multiplied under in-vitro condition at MS Media under controlled environment for faster multiplication and disease and insect free plantlets. Tissue culture plants are available in the all four stages such as establishment, multiplication, rooting and hardening as per protocol developed earlier. Nucleus seed is to be generated from tissue culture plantlets for further multiplication and its distribution.

Use of plant growth regulators (PGRs) for enhanced yield and quality of sugarcane: Planting of setts after overnight soaking in 50 ppm etrel solution enhanced the rate and extent of sugarcane germination resulting in higher yield contributing characters, cane yield and economics over conventional planting could be recommended for realizing higher productivity and monitoring returns.

Scheduling irrigation with mulch under different sugarcane planting methods : The growth, yield attributes and cane yield varied significantly with planting method. Paired row trench planting (30: 120 cm row spacing) with trash mulching @ 6 t/ha being at par with paired row trench planting (30: 120 cm row spacing) without trash mulching produced significantly higher millable canes (1,43,300/ha) and cane yield (99.5 t/ha) over other planting methods. The number of irrigation was 3, 2 and 2 at IW: CPE ratios 1.00, 0.80 and 0.60, respectively. The total water applied on the basis of depth (7.5 cm) and number of irrigations was 22.5, 15.0 and 15.0 cm at IW: CPE ratios of 1.00, 0.80 and 0.60, respectively. Among the levels of irrigation, irrigation scheduled at IW: CPE ratio 1.00 recorded the significantly higher plant population (2, 24,500/ha), cane diameter (2.37 cm) and millable canes (1, 25000/ha). However cane yield recorded at IW: CPE ratio 1.00 was statistically comparable to IW: CPE ratio 0.80.

Carbon sequestration assessment in sugarcane based ratoon cropping system : Sugarcane-ratoon-wheat (trash incorporation through rotavator and *Trichoderma* incorporation before sowing of wheat was better with respect to production of comparatively more number of millable canes and cane yield with better organic carbon build-up in post-harvest soil. The higher grain and straw yield of rice and wheat was obtained with rice-wheat-rice-wheat (residue retention with *Trichoderma*) cropping system.

Agronomic performance of early elite sugarcane genotypes: The 90 cm row spacing recorded significantly higher plant population (1, 83,600 /ha) millable canes (1, 26,200 /ha) and cane yield (96.2 t/ha). Though, sucrose content juice did not varied significantly. Genotypes had significant impact on growth, yield and quality of sugarcane. Genotype CoSe 95422 noticed maximum cane yield (104.4 t/ha) which was followed by CoSe 12451 (94.04 t/ha) and CoLk 12207 (91.8 t/ha). Though higher sucrose content juice was obtained with the genotype CoLk 12207 (18.13 %) which was statistically similar to BO 130 (std.).

Agronomic performance of mid-late elite sugarcane genotypes: Planting of sugarcane at 90 row spacing recorded significantly higher plant population (1, 74,100 /ha) NMC (1, 13,500 /ha)

and cane yield (94.1 t/ha). However, sucrose content juice was found to be non-significant. The maximum cane yield of 106.7 t/ha was obtained with the genotypes CoLk 09204 which was followed by BO 91 (Std.) and CoSe 12453. Though, maximum sucrose content juice (18.04 %) was noticed with the genotype CoP 9301 which was followed by CoLk 09204 (17.39%) and BO 91 (17.29%).

3rd year early varietal trial: On the basis of cane yield and sucrose percent in juice the following genotypes has been selected:

Genotypes	Maturity group	Named after selection
CoX 11192	Early	CoX 18436
CoX 11407	Early	CoX 18437
CoX 11506	Early	CoX 18438

3rd year mid-late varietal trial: Variety had significant influence on growth, yield attributes and yield of sugarcane. The maximum cane yield (94.3 t/ha) was noted with the variety CoX 11547 which was significantly higher over CoX 11123 and significantly comparable to rest of the varieties. The maximum sucrose content juice during the months of November (16.95%) and December (17.98%) was obtained with the variety CoX 11407 which was closely followed by CoX 11547 with a respective values of 16.89 and 17.89%. Though, this variety showed maximum sucrose content (18.89 %) during the month of January.

To find out suitable planting geometry of sugarcane planted with bud chips raised settlings under plant crop : Maximum cane yield (141.4 t/ha) was obtained with the treatment 150 % RDF + Vermicompost (VC) + Biofertilizer (BF) + Zn which was statistically comparable to 150 % RDF +VC + BF + Zn (132.6 t/ha) and significantly superior to the rest of the treatments. Though, higher sucrose content juice 17.48 % was noted with the treatment RDF + VC + Zn which was followed by 125 % RDF (17.21 %).

To find out suitable planting geometry of sugarcane planted with bud chips raised settlings under ratoon crop: Application of 150% recommended dose of NPK to sugarcane plant –ratoon system are required to achieve optimum benefit: cost ratio of sugarcane planted with bud chip raised settlings. Farmers can earn Rs. 1, 86800 and 1,79200/ha with a benefit: cost ratio of 1.80 and 2.22 from sugarcane plant and ratoon crop.

Effect of planting methods and varieties on yield and quality of sugarcane under waterlogged condition: Planting did not cause significant impact on yield and sucrose content of sugarcane. Though comparatively higher cane yield was obtained with three budded setts. Genotype BO 156 recorded higher cane yield (70.3 t/ha) which was significantly superior to BO

91 (58.0 t/ha) and significantly superior over rest of the genotypes. Genotypes had non-significance impact on sucrose content juice. Though comparatively higher value was noted due to the CoP 14438 (17.17%).

Impact of integrated application of organics and inorganics in improving soil health and sugarcane productivity : The number of tillers and millable cane, single cane weight and cane yield were significantly affected due to different treatments but effect on germination and plant height and girth was non- significant. The highest number of tillers at 120 & 150 DAP (127670 & 149930 /ha) and NMC (108530 /ha) were recorded in treatment receiving fertilizer on soil test basis i.e. 200 kg N- 100 kg P₂O₅- 100 kg K₂O/ha along with organics @ 20 tonnes/ha and lowest tillers at 120 & 150 DAP (78330 & 90670/ha) and NMC (68530/ha) in 50% RDF plot. The cane yield was significantly higher in treatments receiving RDF (67.65 t/ha) and application of fertilizer on soil test basis (80.73 t/ha) over 50% RDF (49.65t/ha). Application of fertilizers on soil test basis alongwith FYM @ 20 tonnes/ha recorded significantly highest cane yield (85.06 t/ha) over 100 % RDF. The cane juice quality viz. brix, sucrose and purity percent was not affected due to different treatments. The maximum uptake of N, P and K (308.25, 25.27 and 246.63 kg/ ha) by plant crop was recorded in treatment receiving fertilizer on soil test basis alongwith FYM @ 20 tonnes/ha and minimum in control (150.25, 11.70 and 126.30 kg/ha)). The post-harvest soil showed significant improvement in available soil nutrients viz. N, P, K, treated plots over control which ranged from 217.2 -285.6, 11.2 – 22.7, and 60.6 – 78.4.33 kg/ha. Thus, integrated application of nutrients was found effective in improving soil fertility and cane yield. The application of fertilizers on soil test i.e. 200 kg N, 100 kg P₂O₅ and 100 kg K₂O alongwith organics @ 20 t/ha was found suitable for boosting cane yield and maintaining soil fertility in calcareous soil of Bihar.

Effect of vermicompost and fertilizer levels on soil fertility, yield and quality of sugarcane in calcareous soil of Bihar: The application of vermicompost @ 5.0 t/ha alongwith 100% RDF was beneficial for improving the soil fertility, cane and sugar yield in calcareous soil of Bihar.

Effect of integrated organic nutrition modules on production efficiency of sugarcane : The germination, plant height, tillers, millable cane, single cane weight and cane yield were significantly affected due to integrated use of nutrients through inorganic and organic sources. The

application of oil cakes at planting leads to significant reduction in germination of sugarcane. Cane yield under various integrated organic nutrition modules was at par with RDF. The highest cane yield (73.21t/ha) were recorded in treatment receiving 50% N through inorganics + 75 % N through various source of organics (vermicompost + castor cake + neem cake) along with bio-fertilizer (*Azotobacter* and PSB) @ 4.0 kg /ha and being lowest in treatment receiving 50% RDF+25% N as VC +bio-fertilizer (48.58 t/ha). The mean value for organic carbon (4.6-5.1 g/kg), water-soluble carbon (0.18-0.81mg/kg), CO₂ evolution (10.26-16.79 mg/100gm soil/ day) and carbon storage (95.85-106.0 kg/ha) varied significantly among treatments and being lowest in plots receiving RDF. The integrated nutrient management module was also found effective in improving soil fertility in terms of available NPK content of post harvest soil over control. However, the effect of treatments on pH and EC of the soil was found non-significant. The cane juice extraction (65.39-73.56 %) and sugar yield (5.39-8.30 t/ha) varied significantly due to various treatments. However, cane juice quality viz. brix, sucrose, and purity percent was not affected due to different treatments.

Residual effect of organics on productivity and soil fertility of sugarcane in calcareous soil :The application of RDF alongwith organic sources of nutrient (PM + Neem cake (9:1) @10 q/ha was beneficial for improving the soil fertility, cane and sugar yield in calcareous soil of Bihar.

Identification of pathotypes of red rot pathogen : Out of 12 test isolates and 10 differentials used , differentials Co1148 and Khakai produced susceptible reaction whereas, differential BO 91 and SES 594 showed resistant reaction while, differentials Co 419, CoS 8436, Co 62399, Co 975, CoV 92102 and CoSe 95422 showed differential reaction against all the test isolates. Pathotypes CF 07 and isolates RR1, RR2, RR3, RR5 and RR6 produced resistant reaction on Co 419 and Co 975 and intermediate reaction on CoS 8436, Co 62399, CoV 92102 and CoSe 95422. Pathotype CF07 and isolates RR1, RR2, RR3, RR5 and RR6 exhibited the similar pathological reaction on differentials. Likewise, pathotype CF 08 and isolates RR4, RR7, RR8, RR9 and RR10 produced intermediate reaction on Co 419 and Co 975 and susceptible reaction on CoS 8436, Co 62399, CoV 92102 and CoSe 95422. Hence, CF 08 and isolates RR4, RR7, RR8, RR9 and RR10 exhibited the similar pathological reaction on differentials. Thus, only two pathotypes of red rot pathogen were identified. Score and Rating-0.0-2.0 R, 2.1-4.0 MR, 4.1-6.0 MS, 6.1-8.0 S, above 8.1 HS.

Evaluation of zonal Varieties/genotypes against red-rot disease: 23 genotypes alongwith one check were tested artificially against red rot disease by adopting plug and nodal cotton swab methods of inoculation. The reaction of varieties against CF 07 and CF 08 are 03 were resistant, 16 were moderately resistant, 03 were moderately susceptible and one variety is found susceptible to red rot disease. Score and Rating-0.0-2.0 R, 2.1-4.0 MR, 4.1-6.0 MS, 6.1-8.0 S, above 8.1 HS.

Evaluation of Zonal Varieties /genotypes against smut disease : **Resistant (16):** CoLk 14206, CoLk 14207, CoP 14436, CoP 14437, CoSe 14451, CoSe 14453, CoLk 94184, CoLk 14208, CoLk 14209, CoLk 14210, CoP 14438, CoP 14439, CoSe 14452, CoSe 14455, CoP 9301 and CoP 06436 **Moderately Resistant (07):** CoSe 14454, CoBln14501, CoSe 01421, CoSe 95422, CoSe 14456, CoBln 14502 and BO 91

Evaluation of Zonal Varieties /genotypes against wilt disease : **Resistant (08):** CoLk 14206, CoLkCoP 14437, CoSe 14453, CoSe 01421, CoLk 14209, CoSe 14455, CoP 9301 and CoP 06436; **Moderately Resistant (11):** CoLk 14207, CoP 14436, CoSe 14451, CoBln 14501, CoLk 94184, CoLk 14210, CoP 14438, CoP 14439, CoSe 14452, CoSe 14456 and BO 91; Moderately susceptible (02) CoLk 14208 and CoBln 14502 and Susceptible (02) CoSe 14454 and CoSe 95422. Mean wilt severity index = Sum of wilt indices of individual stalks/number of stalks samples

Survey of Sugarcane diseases naturally occurring on Sugarcane Varieties : The disease survey was conducted in different cane growing areas of Bihar. Eleven sugarcane varieties were found affected with Wilt, Red rot, Smut, Grassy shoot, Pokkah boeng, Ratoon stunting and Yellow leaf diseases.

Screening of Pokkah boeng disease in sugarcane : Twenty varieties were screened under natural condition, out of which, eighteen varieties showed mild infection whereas, two varieties (CoP 11437 and CoBln 14502) showed moderately susceptible against Pokkah boeng disease. The disease appeared in the last week of May and remains till 1st week of September. The maximum incidence was observed during 2nd week of June to last week of July and gradually decreased. The minimum and maximum temperature ranged between 23.9 to 34.70C, relative humidity 64.7 to 90.5% and rainfall 43.8 to 432.6 mm, respectively were recorded from May to September. Humidity and rainfall play an important role in Pokkah boeng disease incidence.

Evaluation of zonal varieties/genotypes for their reaction against major insect pests of sugarcane : Forty varieties genotypes comprising different maturity groups were evaluated against root, shoot, top and stalk borer at SRI, Pusa. The cumulative incidence of early shoot borer was recorded as lowest (6.60%) in variety CoSe 01421 AVT E I P and highest (16.50%) in variety CoLk 12209 AVT ML P. The genotypes tested under different maturity groups are graded under less to moderately susceptible reaction against early shoot borer. While, incidence of root borer was found minimum (6.80%) in variety CoSe 14451 IVT E and maximum (9.75%) in variety CoLk 94184 AVT E IP graded as less susceptible reaction. The incidence of top borer was recorded as less to moderate being 7.00% in variety CoP 06436 IVT M and 12.00% in variety CoP 14436 IVT E against 4th brood of top borer. All the genotypes exhibited less to moderately susceptible reaction against top borer based on 4th brood incidence. The stalk borer infestation index varied from untraceable to 1.00 per cent and showed less susceptible reaction for all tested genotypes.

Survey and surveillance of sugarcane insect pests: A survey was conducted on the insect pests of sugarcane under different village of reserved area of Majhulia and Hasanpur sugar factory during cropping season of 2017-18. The per cent incidence of early shoot borer (5.0 to 11.0%), root borer (2.5 to 4.5%), top borer (10.5 to 15.0 %), stalk borer below 5%, army worm (5.0 to 6.0 %) and Pyrilla (8.0 to 12.0) per leaf were observed as the key pests of sugar factory reserved area of sugarcane. The incidence of other pests like Mealy bug, Termite, Grass hopper, Scale insect, White fly, etc. were also recorded in traces. Beside, sugar mills reserved areas, a roving survey was also conducted at sugarcane field in and around Pusa and SRI Museum at monthly interval. The per cent incidence of early shoot borer, root borer, top borer plassey borer and stalk borer were varied from 2.0 to 9.0%, 2.0 to 8.0 % and 5.0 to 16.0 % 9.0 to 19.0% and 1.0 to 7.0%, respectively. While, Pyrilla was observed 5-12 per leaf at Pusa Farm.

Monitoring of insect pests and bio-agents in sugarcane agro-ecosystem: The mean per cent incidence of Root, Shoot, Top and Stalk borer varied from 1.5 to 9.5 %, 2.2 to 14.8%, 0.80 to 17.0% and 1.8 to 4.2% respectively. Whereas, the incidence of sugarcane Pyrilla varied from 0.25 to 11.30 leaf. The bio-agents of Root and Early shoot borer were not observed during cropping season of 2017-18. While, parasitization of bio-agents such as, *Apantelis flavipes*, *Rhanconotus scirpophagae* and *Stenobracon deesae* were recorded against top borer. The population of *Stenobracon deesae* varied from 2.0 to 10.20 during May to November. Where its peaks (10.20%)

noticed in September. Population of *Apanteles flavipes* ranged between 2.5 to 13.5 during May to November with its highest population (13.5%) was recorded in month of September. The activity of *Rhaconotus scirpophagae* was recorded from July to November with its peak (8.2%) in month of September. The parasitization of *Tetrastichus pyrillae* and *Epiricania melanoleuca* were recorded from July to November and May to November, respectively and their peaks were noticed in the month of November (30.15%) and September (20.20%), respectively. In case of Stalk borer, the parasitization of *Apanteles flavipes* was recorded from 6.20 to 14.2% during August to November.

Formulation and validation of IPM module of sugarcane insect pests : The germination (%), no. of millable cane/ha, cane yield (kg/ha) increased by 21.30%, 20.96% and 18.38%, respectively. The percentage incidence of borer pests over farmer practices varied from 13.63 to 17.97 and maximum (17.97%) reduction was noticed with plassey borer. In case of sucking pests, maximum (16.80) reduction in incidence of mealy bug and minimum (13.11%) reduction was recorded with scale insect over farmer practices. The quality parameters, an increase of 1.90, 1.8, 0.5 and 2.1% of brix, sucrose, purity and CCS%, respectively, were noticed over farmer practices. Hence, IPM module has potential to increase yield, growth and quality parameters and reduction in insect pests incidence in sugarcane crop.

Seasonal history of top borer in ratoon, spring & autumn crops : The 1st generation of top borer in 2nd week of March, 2nd generation in 3rd week of April, 3rd generation in 2nd week of June, 4th generation was observed in 3rd week of July and 5th generation in 1st fortnight of September during the crop season of 2017-18 at Pusa Farm, Sugarcane Research Institute, Pusa.

ALLIED RESEARCH

1. HONEY BEES & POLLINATORS

(A) **Nesting behaviour and domiciliation of *Xylocopa fenestrata* :** In case of carpenter bee (*Xylocopa fenestrata*), the acceptance percent for nesting in bamboo tops varied from an extent of 70 to 80 per cent having a mean value of 72.50%. The nest of carpenter bees was located at a height of 164.3 cm (male) and 177.7 cm (female) on bamboo from ground. The diameter of entrance hole was found in case of male was 1.79 cm and 1.97 cm in female. The girth of bamboo having nest of carpenter bee varied from 2.53 to 2.61 cm.

(B) Relative abundance of different insect pollinators on ridge gourd : On the ridge gourd bloom, the abundance of different insect visitors species revealed that the mean population of *Apis mellifera* (20.20) was highest followed by *Apis dorsata* (16.02) *Xylocopa fenestrata* (16.94) and the least population of *Apis florea* being 11.16 was recorded. The correlation between mean population of insect pollinators and temperature was found positive while negative correlation was found with relative humidity.

(C) Foraging behaviour of *Xylocopa fenestrata* : On the ridge gourd bloom, the foraging rate of *Xylocopa fenestrata* was minimum in the morning hours (0700-0900 h) being 3.8-4.4 flowers/min. and evening hours (1500-1700 h) being 2.8- 3.6 flowers/min. The maximum foraging rate was recorded during mid day being 7.44 flowers/min. at 1300 h followed by 1100 h being 6.12 flower/min on ridge gourd. The average time spent/flower by *Xylocopa* was highest during 1700-h (23.54 s) followed by 1500-h (17.90 s), 0700-h (17.38 s), 0900-h (16.14 s), 1100-h (13.64 s) and lowest at 1300-h (10.80 s).

(D) Quantification of Role of *Xylocopa fenestrata* in enhancing productivity of ridge gourd: The fruit yield parameter in ridge gourd indicated that there was significant increase in fruit length, fruit girth, fruit weight and yield in open pollinated (OP) crop followed by *Xylocopa* pollinated (XP1, XP2 and XP3) over pollination exclusion (PE). There was 39.00%, 37.00%, 26.30% and 20.00% increase in OP, XP3, XP2 and XP1, respectively, over PE.

(E) Stock improvement through selection of *Apis mellifera*: For stock improvement in *Apis mellifera*, the performance parameters viz., bee strength varied between 7.10 frames to 7.80 frame, brood area varied between 6050.2 to 8560.5 cm² and pollen area varied between 170.6 to 320.6 cm². The bee takes about 21.00 to 34.00 hour in removing dead bees and amount of debris collected from bee hives varied from 0.81 g to 1.62 g.

(F) Survey of bee diseases and enemies: The survey bee diseases in *Apis mellifera* apiaries indicated that about 9.49% colonies were infested with nosema, wax moth and mite. In a day, about 22.55 wasps were attacking *Apis mellifera* apiaries. The intensity of predatory bird, green bee eater in the apiaries were recorded in the tune of 8.38 birds per day. No new disease incidence was recorded in the apiaries.

(G) Bee pollination studies in fennel (*Foeniculum vulgare*): On fennel, the abundance of different insect visitors species revealed that the mean population of *Apis mellifera* (12.38) was highest followed by *Apis dorsata* (9.68), *Xylocopa fenestrata* (8.78) and the least population of *Apis florea* being 6.84. The correlation coefficient of insect pollinators abundance with

temperature was found positive and highly significant in case of *Apis mellifera* (0.856**), *Apis dorsata* (0.821**), *Apis florea* (0.810**) and *Xylocopa fenestrata* (0.822*). The population of pollinator species showed negative correlation with relative humidity. *Apis mellifera*, *Apis dorsata*, *Apis florea* and *Xylocopa fenestrata* showed negative and significant correlation with relative humidity being -0.710*, -0.751*, -0.691* and -0.701*, respectively. In fennel, the average seed yield was recorded maximum in open pollination treatment (11.50 q/ha), followed by BP and XP (10.80 q/ha and 9.70 q/ha, respectively) while minimum seed yield was recorded in the pollinator exclusion treatment (8.20 q/ha). The per cent increase in seed yield over PE was 40.0%, 31.00%, and 18.00% in OP, BP and X_p, respectively, over PE.

2. FORAGE CROPS AND ITS UTILIZATION

Varietal trials: During *Kharif* 2017, four coordinated varietal trial on Pearl millet and Rice bean were successfully conducted at Pusa centre. **IVT Pearl Millet:** Of the eight entries, IVTPM-1 recorded maximum green fodder (374q/ha) and dry matter (85.2q/ha) yield. It was significantly superior to other test entries, except IVTPM-6(371q/ha) and IVTPM-7(347q/ha). **AVT Pearl Millet:** Entry AVTPM-6, Of seven entries tested at Pusa, outyielded all the other test entries with green fodder yield of 457q/ha and dry matter yield of 103.2q/ha, except AVTPM-3(439q/ha). **IVT Rice bean:** Entry IVTR-7 produced maximum green fodder yield (264q/ha) and dry matter yield (55q/ha) and it was significantly superior to the rest of the entries, except IVTR-3(259q/ha). **AVT Rice bean:** Of the five entries tested, AVTR1-4 recorded maximum green fodder yield (274q/ha) and dry matter yield (56q/ha). It was significantly superior to other test entries, except AVTR1-3(261q/ha). Trial will continue with the change of culture

Sorghum Varietal Trial: Eight varieties of forage sorghum were procured from Indian institute of Millet Research, Hyderabad, to evaluate their performance at Pusa. Based on two year-trial, it was found that variety CSV30F recorded maximum green forage yield of 373q/ha and dry matter yield of 80q/ha, closely followed by CSH20MF(367q/ha), UPMC 503(364q/ha), Co(FS)29(362q/ha) and CSH 24MF(362q/ha). These varieties were significantly superior to the rest of the varieties tested.

Nitrogen Varietal trial in Pearl Millet: The performance and yield of the entries improved consistently with increase with level of nitrogen application up to 120kg/ha (409q/ha) which was

37.4 and 11.7% higher than with 40 and 80kgN/ha, respectively, in terms of green fodder yield. Entry PHBF-4(417q/ha) and NDFB-1502(396q/ha) were superior to other entries. Entry PHBF-4 recorded 8.1 and 12.3% higher green fodder yield than raj bajra chari-2 and TSFB15-8, respectively.

Varietal trial on IVT Oat (SC) : Among fourteen entries, entry HFO-529 recorded maximum green fodder yield (397q/ha) and dry matter yield (79.24q/ha).It was significantly superior over National check Kent (326q/ha).

Varietal trial on AVT -1 oat (SC): Among eleven entries, entry JC-05-7 recorded maximum green fodder yield (388q/ha) and dry matter yield (77.45q/ha). It was significantly superior over Kent (299q/ha).

Varietal trial on IVTO (MC): Among nine entries, entry OL-1874 recorded maximum green fodder yield (377q/ha) and dry matter yield (74.80q/ha). It was significantly superior over National check UPO-212 (329q/ha).

Varietal trial on IVT Berseem: Among eight entries, entry **HFB-14-7** recorded maximum green fodder yield (308q/ha) and dry matter yield (55.40q/ha). It was significantly superior over WARDAN (NC) (230q/ha).

Varietal trial on AVT Berseem : Among six entries, entry **JHB-16-01** recorded maximum green fodder yield (322q/ha) and dry matter yield (57.9q/ha). It was significantly superior over Wardan (NC) (283q/ha).

3. MEDICINAL, AROMATIC PLANTS AND BETEL VINE

CROP IMPROVEMENT

Collection and Maintenance of germplasm of Brahmi (*Bacopa monnieri* L): 14 genotypes are being maintained at Herbal garden. There were variations among them with respect to vegetative growth and herbage yield. The accession number IC-0622291 registered the highest herbage yield (222.53 q/ha) and IC number 0622293 recorded the lowest (99.51 q/ha).

MLT evaluation of promising lines of Kalmegh for high yield and quality: 13 entries and one local check were evaluated in three replications. Among them three entries (AK-5, AK- 6 and AK-3) recorded significantly higher fresh herbage yield than the local check. Maximum fresh herbage (124.77 q/ha) was recorded in the entry AK-12 and the minimum in the check AL-1 (75.76 q/ha)

MLT evaluation of promising lines of Basil for high yield and quality: Four entries (AB-1 to AB-4) and one local check were evaluated in five replication. All the four entries recorded significantly higher fresh herbage yield than the local check. Maximum fresh herbage (220.12 q/ha) was recorded in the entry AB-2 and minimum was recorded in the check GAB-1 (97.31 q/ha)

MLT evaluation of promising lines of Basil (seed purpose) for high yield and quality: Six entries 4 (OB1 to OB6) and one local check were evaluated in four replications. All the six entries recorded significantly higher fresh herbage yield than local check. Maximum fresh herbage (231.38 q/ha) was recorded in the entry OB-5 and minimum in the check Rahuri-1 (80.12 q/ha)

Effect of organic manures and biofertilizers on Satawari (*Asparagus racemosus*): Application of vermicompost (2 t/ha) + mustard cake (1 t/ha) inoculated with mixture of PSB-5 kg and Azospirillum- 2 kg/ ha (M4 S3) produced significantly higher root yield (149.04 q/ha) whereas minimum root yield (112.31 q/ha) was recorded with vermi-compost (2.0 ton/ha) inoculated with *Azospirillum* (2.0kg/ha)

Standardization of organic Production Technology of kalmegh: Plant biomass yield recorded maximum (134.98 q/ha) with vermicompost application(M2), a significantly higher yield than that of the rest treatment . This was followed by S2 biofertilizer (Azotobacter + PSB) with biomass yield (129.14 q/ha) which was significantly higher than that with the rest of the treatments.

Collection, cataloguing and seasonal activity of different insect pests associated with the medicinal plants: There were two categories of insects found on tulsi plants, i.e., major and minor groups of insects. Major group of insects were lace bug, leaf folder on *Ocimum basilicum* while spittle bug on *Ocimum sanctum*. The other associated insects (minor) were Epilichna beetle, snail and Scutellarid bug. The adult and nymph of lace bugs feed gregariously on upper portion of the plants' leaves on dorsal surface of leaves . Adults feed occasionally on tender shoots of the plant. Injured leaf showed tiny black excrement on feeding-dorsal surface of the leaves. . Intensity of lace bug was found to decrease in comparison to previous year. The spittle bugs have been found inside spittle on plant's branch/branches, generally upper portion, and sucked portion became distorted leading to drying and weakening of plants. The effect of drying was reduced growth of the

plant. The Intensity of spittle bug was found to increase in comparison with the last year. Lace bug counting on Tulsi were done at weekly intervals from 37 standard weeks to first standard week. Lace bug's peak number was found during 44 standard week at 29.80°C and 19.50°C temperature at 86 and 60 per cent maximum and minimum relative humidity. Population started to increase during 39th standard week up to 50th standard week. Spittle bug counting on Tulsi was done at weekly interval from 37 standard weeks to first standard week. Spittle bug peak number was found during 39th standard week when average temperature was 35.05°C and average relative humidity. was 78 %. Thereafter population started to decrease and disappeared after 45 standard week.

Biology of Lace bug in laboratory under ambient condition: The *Cochlochila bullita* had 4-7 days, 10-14 days, 14-21 days, 32-38 days and 46-59 days incubation for nymphal, total developmental period, adult longevity and total life cycle, respectively,

Biology of leaf folder of Tulsi in laboratory under ambient condition: The leaf folder had 3-6 days, 9- 12 days, 4-6, 16-24 days, 9-11 days and 25- 35days incubation for larval ,pupal , total development period, adult longevity and total life cycle, respectively,

Evaluation of bio-efficacy of botanical products against lace bug (*Cochlochila bullita*) in Tulsi (*Ocimum basilicum*). : All the treatments were found to exert significant ($p < 0.05$) effect on bug population at different days of spraying. After 1st, 2nd, 7th and 14th day of spraying, treatments of tobacco decoction 5 %, NSKE 5% and Neem oil 5% were found significant being control and found at par among each other. But the treatment of karange oil 2% was found significantly different fromwith the others after 14th day of spraying.

Management of lace bug through intercrop with chilli and onion in Tulsi : Intercrops were found to exert significant ($p < 0.05$) effect in each month of assessment. During the months of September, October and November, all the ratios of intercrops were found to show significant effect on lace bug population and also at par with each other. This type of effectiveness could be due to lesser numbers of insects' presence

Study on diseases of medicinal plants: The medicinal plants garden at Pusa was closely monitored for the presence of various diseases on various medicinal plants. The crop-Mandookparni (*Centella asiatica*) showed serious incidence of stolon rot, caused by *Fusarium* clade VII(IMI 502631 during july-september,2017(up to35%)).The crop Pipali(*Piper logum*) was

found to be affected by leaf spot(5-10 % intensity) caused by *Botryodiplodia theobromae* (ITCC-8867.12) during August-September,2017

The crop- Sarpagandha (*Rauwolfia serpentina*) showed the incidence of leaf spot (up to 15% intensity) caused by *Khuskia oryzae*(IMI 503563). in the month of July – October ,2017.).The crop- Ghrit kumari(*Aloe vera*) showed the incidence of black rot(< 10 % intensity) caused by *Colletotrichum gloesporioides*((IMI 503564). The crop tulsi (*Ocimum sanctum*) was found to be affected by leaf spot(<10%)caused by *Alternaria alternata* during July to September, 2017 and Powdery mildew (trace) caused by *Erysiphe* sp. during April,2017.

Integrated management of Leaf spot of Sarpagandha(*Rauwolfia sirpentina*) caused by *Khuskia oryzae*.: The soil incorporation of FYM 100 q/ha inoculated with *Trichoderma harzianum* formulation(10g/kg FYM) combined with seedling treatment with *Trichoderma harzianum*@ 10g/L of water for 10 minutes and foliar spray with neem oil @ 5ml/L of water as preventive measure accompanied with one spray of propiconazole or carbendazim 1ml/L of water just after appearance of symptom was found highly effective in controlling the disease development(10%PDI) over control (30% PDI).

Integrated management of Leaf spot of Tulsi caused by *Alternaria alternata*: The soil incorporation of FYM 100 q/ha inoculated with *Trichoderma harzianum* formulation(10g/kg FYM) combined with seedling treatment with *Trichoderma harzianum*@ 10g/L of water for 10 minutes and foliar spray with Copper oxychloride @ 3.0g/l of water of as preventive measure accompanied with one spray of Copper oxychloride @ 3.0g/l water just after appearance of symptom was found highly effective in controlling the disease development(10%PDI) over control (30% PDI) and highest herbage yield(130.5q/ha).

Integrated management of stolon rot of Mandookparni(*Centella asiatica* caused by *Fusarium* clade VII: The soil incorporation of FYM inoculated with *Trichoderma harzianum* combined with sapling treatment with the same bio-agent was the most effective and caused maximum disease suppression (65.16 %) over control and the highest yield (10.06q/ha on dry weight basis). Likewise the soil incorporation of FYM inoculated with *Trichoderma viride* combined with sapling treatment of the same bio-agent was also markedly effective in suppression of stolon rot by 60.06 % to with dry herbage yield of 8.72q/ha The similar trend has been found during the year 2014-15,15-16 and 16-17

Based on concluded trial it may be recommended that the stolon rot of *Centella asiatica* may be effectively controlled by soil incorporation of FYM (200kh /ha) inoculated with *Trichoderma*

harzianum(2.0g/kg FYM) combined with sapling treatment *Trichoderma harzianum* (10g/L) for 10 minutes.

Management of Leaf spot of Piper longum caused by *Botrydiplodia theobromae*:The incorporation of 10g of *Trichoderma viride* formulation with 100g of FYM per pit at the time planting along with preventive spray of Blitox 50(0.3%) and one spray of Propiconazole(0.1% or Carbendazim (0.1%) just after appearance of initial symptom showed might be effective for disease control causing 64.28 % reduction over control

Roving survey of diseases of betel vine under ago-ecological condition of Bihar: In course of survey during the year 2017-18, between July to September was found to favour the development of *Phytophthora* rot at all the locations with maximum disease severity of *Phytophthora* rot(15 % PDI) in Vaishali. Thereafter disease development declined. The development of anthracnose was favoured during August –September at various locations with maximum PDI (15 %) in the month of September .

Nematological survey of medicinal and aromatic plants under agro-ecological condition of Bihar: Pre- and post-monsoon surveys of medicinal plant- Babchi, (*Psoralea corylifolia*) indicated predominant population of plant parasitic nematode viz. Stunt nematode, *Tylenchorhynchus* spp., Spiral nematode, *Helicotylenchus* spp. and Lesion nematode, *Pratylenchus* spp. Frequency of dominating nematodes varied from 80% and 70% in pre and post monsoon surveys, respectively. Other nematodes observed were Lance nematode, *Hoplolaimus* spp., Reniform nematode, *Rotylenchulus reniformis* and *Tylenchus* spp. Pre- and post- monsoon surveys of aromatic plants, namely lemon grass (*Cymbopogon flexuosus*) and palmarosa (*Cymbopogon martini*) indicated predominant population of phytonematode, viz. Spiral nematode, *Helicotylenchus* spp., Lesion nematode, *Pratylenchus* spp. and Stunt nematode, *Tylenchorhynchus* spp. Frequency of dominating nematodes varied from 80% and 70% in pre- and post-monsoon survey respectively. Other nematode observed were Lance nematode, *Hoplolaimus* spp., Reniform nematode, *Rotylenchulus reniformis* and *Tylenchus* spp. Pre and Post monsoon surveys of Medicinal plant- Ashwagandha (*Withania somnifera*) indicated predominant population of plant parasitic nematode viz. Stunt nematode, *Tylenchorhynchus* spp., Lesion nematode, *Pratylenchus* spp. and Reniform nematode, *Rotylenchulus reniformis* . Frequency of dominating nematodes varied from 70% and 60% in pre- and post- monsoon surveys respectively Other nematode observed were Spiral nematode, *Helicotylenchus* spp Root knot nematode, *Meloidogyne* spp., Lance nematode,

Hoplolaimus spp. And *Tylenchus* spp. Pre- and post-monsoon surveys of aromatic plant -mint (*Mentha arvensis*) indicated predominant population of phytonematodes viz. Spiral nematode, *Helicotylenchus* spp., Lesion nematode, *Pratylenchus* spp. and Stunt nematode, *Tylenchorhynchus* spp. and Reniform nematode, *Rotylenchulus reniformis* . Frequency of dominating nematodes varied from 70% and 60% in pre and post monsoon survey, respectively Other nematode observed were Root knot nematode, *Meloidogyne* spp. , Lance nematode, *Hoplolaimus* spp. and *Tylenchus* spp.

4. AGROFORESTRY

Selection of new superior genotypes of Shisham (*Dalbergia sissoo*) for Agroforestry system:

The plant height of one-year-old plantations of *Dalbergia sissoo* was recorded maximum for genotype P-38 (2.16 m) which was statistically at par with PS-20 (1.89 m) and P-52 (1.73 m). The lowest height was recorded with Hisar L-5 (0.73 m). On the other hand, collar diameter ranged from 2.46 cm (PS-54) to 3.60 cm (P-38) and all these values were statistically at par. Maximum survival percentage was recorded with P-38 (80.6 %) followed by PS-90 (69.4 %) and PS-20 (66.7 %).

Evaluation of different clones of poplar (*Populus deltoides*) for their growth and productivity:

Different morphological growth parameters for one-year-old 18 poplar clones were recorded in terms of height and diameter at breast height (DBH). Height and DBH varied from 2.63 (S-2) to 4.06 m (PP 9-J1, PP 9-OPR-1) and 1.94 (S-2) to 4.71 m (PP 9-J1), respectively. By and large, taking both the parameters in consideration, S-1, PH-6, PP 9-25, PP 9-J1 and PP 9-OPR-J were found superior.

Evaluation of Aonla (*Emblica officinalis*) based Agrihorticultural System with turmeric varieties:

The intercrops grown were three varieties of turmeric viz, Rajendra Sonia, NDH-92 and Rajendra Sonali in the interspaces of Aonla orchard at the age of 12 to 16 years. At the age of 16-year-old orchard, reduction in yield of turmeric was maximum with Rajendra Sonali (53.7 %) and minimum with NDH-92 (30.5 %) when compared to the yield in open area. The average turmeric

yield data of five years (2013-2017) indicated that NDH-92 gave the maximum yield (18.51 Mg ha⁻¹). Turmeric yield and light intensity under canopies of Aonla orchard showed highly significant and positive relationship ($r^2 = 0.802^{**}$ to 0.864^{**}). The average yield data of four years indicated that the production of fruits (16.01-16.17 Mg ha⁻¹) increased by 24 to 26 % due to intercrops. By and large, Aonla+NDH-92 system is the most profitable on the basis of Land Equivalent Ratio (2.06), Aonla Equivalent Weight (27.17 Mg ha⁻¹) and B: C ratio (4.15).

Growth, biomass and carbon stocks in an age series of Kadamb (*Anthocephalus cadamba*) plantation under Agrisilvicultural System: The annual increment of *A. cadamba* trees reached its maximum point or the intersection between MAI (Mean annual increment) and PAI (Periodic annual increment) at the age of 10 years. Volume of the tree increased with the age and varied from 66.0 (8-year-old) to 116.5 m³ ha⁻¹ (12-year-old). Carbon stock in timber biomass varied between 16.83 and 29.71 Mg ha⁻¹ from 8 to 12-year plantation age and thus, these plantations of different ages may remove CO₂ 61.8 – 109.0 Mg ha⁻¹ from the atmosphere. This study recommends *A. cadamba* planting as a viable option for sustainable production and carbon mitigation.

Performance of agricultural crops under different density Semal (*Bombax ceiba*) plantations. : The results indicated that the yield of crops under three-year-old Semal plantations adversely affected under higher density plantations (666 – 1000 trees ha⁻¹). Sesame yield varied from 4.75 (5x2m tree spacing) to 5.40 q ha⁻¹ (5x5m tree spacing). Height, girth at breast height (GBH) and Crown diameter of tree varied from 2.53 to 3.34 m, 14.28 to 24.89 cm, and 1.56 to 2.60 m, respectively. Semal plantations of different spacing intercropped with sesame were found to have average light intensity varying from 375×100 lux (58.8 %) to 462×100 lux (73.4 %).

5. AGRO-METEOROLOGY

Agroclimatic characterization and climatic risk analysis for enhanced crop productivity under rainfed condition in Bihar: : Accumulated assured rainfall (AAR) to the tune of 250-300 mm was observed in a vast tract of the state implying that only short to medium duration crop varieties will be able to produce at potential level. Moisture availability index (MAI) for the districts of Bihar have also been evaluated and presented in thematic maps at different probability levels. In terms of longer length of water availability and higher values of MAI, Zone II appeared to be the most potential agro climatic zone followed by Zone I and Zone IIIA. The Zone IIIB was adjudged as the least potential Zone in terms of shorter water availability period for rainfed crop

production. PET values during Kharif season and over different months of summer seasons have been worked out and spatial variability over the state have been presented through thematic maps. Onset, cessation and duration in weeks of potential moisture based on soil moisture index (SMI) \geq 0.70 considering different soil textural classes have been worked for potential productivity evaluation and the results have been presented in GIS maps.

Studies on crop-weather relationship in rabi maize : Studies on crop weather relationship in *rabi* maize were carried out during *rabi* season of 2017-18 with three varieties *viz.* Shaktiman 4, Shaktiman 5 and X3522 grown under four sowing dates *viz.* 1 November, 10 November, 20 November, and 30 November. The crop performance was found to be better when the crop was sown on 20 November due to favourable temperature regime during different phenological stages. The variations in maximum temperature, minimum temperature and mean temperatures during different phenophases of the crop across various dates of sowing revealed that during knee high to tasseling stage, the lowest temperature was experienced by the early sown crop. The maize crop sown on 1 November (1st date of sowing) encountered the lowest temperature during critical growth phases. The lower maximum and minimum temperatures experienced by early sown crop during knee high to tasseling, tasseling to silking and silking to milking specially during knee high to tasseling and tasseling to silking stages as compared to later sown crops might have contributed to poor growth and lesser grain yield for early sown crops. Phasic models were also developed to account for the effect of weather on crop yield. As far as the impact of temperature on grain yield is concerned, it was observed that maximum temperature during tasseling to silking ($r=-0.65^*$) and silking to maturity ($r=-0.58^*$) played an important role in deciding the grain yield. On the other hand, minimum temperature during germination to knee high ($r=-0.60^*$) and milking to dough ($r=0.72^{**}$) had significant impact on grain yield. Minimum temperature produced greater impact on pheno-phase duration. The effect of temperature was found to be more pronounced during germination to knee stage than during knee high to tasseling stage. Phase duration decreased by almost 9 days with one degree rise in minimum temperature during germination to knee stage. Similarly, it decreased by almost 6 days in response to increase in minimum temperature by 1 degree during knee high to tasseling stage. The crop sown on 30 November recorded the highest heat use efficiency (HUE: 4.68 Kg ha⁻¹⁰Cday⁻¹) followed by 10 November sown crop. The lowest HUE of 3.25 Kg ha⁻¹⁰Cday⁻¹ was associated with 1 November sown crop. Among the varieties, X3522 recorded the highest HUE (4.72 Kg ha⁻¹⁰Cday⁻¹) and the lowest HUE was associated with the variety Shaktiman 4.

Agroclimatic resource characterization and climate change studies : Water balance parameters have been estimated by employing Thornthwaite and Mather Climatic water balance model for coarse, medium and fine textured soils in Muzaffarpur district to assess crop production potential under rainfed condition. Dry spell analysis showed that the probability of consecutive two-week dry spell increases significantly after 36 standard meteorological week in Muzaffarpur district. Variability in PET during *rabi* season, and during December and January has been assessed and thematic map has been generated for different districts of Bihar. Variability in rainfall and rainy days has also been depicted through GIS map.

6. NEMATODES IN AGRICULTURE

Diversity and distribution mapping of economically important nematodes (Plant parasitic nematodes) in the country : The soil samples of the crops, pointed gourd, banana, paddy, moongbean, turmeric and sugarcane have been collected randomly from five farmers of five villages of blocks, pusa, tajpur and kalyanpur in Samastipur and the blocks, muraul and mushahari of Muzaffarpur districts. The population of plant parasitic and saprophagous nematodes was estimated through Cobb's decanting and sieving method. It was observed that pointed gourd, banana and paddy were heavily infested with root knot nematodes, *Meloidogyne* spp. The other plant parasitic nematodes found, were, *Aphelenchoides* spp., *Aphelenchus* spp., *Hirschmaniella* spp., *Helicotylenchus* spp., *Hoplolaimus* spp. and *Tylenchorhynchus* spp.

Documentation of nematode infested horticultural nurseries in the state : The five randomly selected saplings of the four private nurseries of Samastipur and Muzaffarpur districts were analysed through root staining method for observation of plant parasitic nematodes infected roots. It was found that three out of four nurseries, the citrus saplings were heavily infested with citrus nematodes, *Tylenchulus semipenetrans*. This citrus nematode is associated with slow decline of citrus. The roots of jackfruit, banana and guava were infested with root knot nematodes, *Meloidogyne* spp.

7. MUSHROOM

Germplasm collection: A survey was by conducted during the year 2017-18 in West Champaran district in Bihar. A total of 2 germplasms were collected and identified as *Calocybe indica* and *Agaricus* sp.

Evaluation of *Calocybe indica* strains: 9 strains, i.e. CI-01-01 to CI-01-09, were evaluated for their yield potential. CI-07-02 gave maximum yield (74.12 kg/ 100 kg straw). Strains CI-17-04 & CI-17-06 failed to initiate fruiting structure.

Extension activities: A total of 8 one day (off campus & on campus) training cum awareness programme were organized. 477 male and 132 female (total 609) learnt production, protection and management of oyster, button and dudhia mushroom production technology. Eight short terms training programme of 3 days/7days were organized in which a total of 247 including (188 male and 59 female) were trained in mushroom production technology. One master-trainer's training programme of 15 days was organized in which a total of 04 male trainers were trained. One spawn production training programme was organized with a total of 09 including 03 female participants were trained in spawn production. One entrepreneurship training programme of 1 month was organised with 02 participants. All entrepreneurs trained during 2017-18 are growing oyster, button and milky mushrooms. Some of them earning Rs. 10,000-20,000 per month . In Mandal Kara Samastipur, 850 Jail inmates used mushroom in their diet twice a week up to 60 days. One Pratibha Jha started spawn production from March 2018 and produced 400 kg Spawn.

Dissemination of Mushroom Production Technology of Tribal Areas of Bihar. : A total of 4 one- day (off- campus & on- campus) training- cum- awareness programmes were organized. 108 male and 304 female (total 412) were trained on production, protection and management of oyster, button and dudhia mushroom-production technology. Three Short term training programme of 3 days/7days was organized in which a total of 232 including 164 female participants were trained in mushroom production technology.

Germplasm collection : The survey was by conducted during 2017-18 in Muzaffarpur and Darbhanga District in Bihar. A total of 2 germplasms were collected and identified as *Agaricus bisporus* and *Tricholoma giganteum* .

Evaluation of Button Mushroom Varieties : Six button mushroom strains were evaluated (IVT-01 to IVT-06) for yield potential. Result indicated that IVT-04 given higher yield i.e. 21.26 as compare to others.

Evaluation of *Pleurotus* strains : Four *Pleurotus* strains were evaluate (PL-17-01 to PL-17-04) for yield potential. Result indicated that PL-17-03 given higher yield i.e. 65.41 as compare to others.

Evaluation of Shiitake Mushroom : 5 strains of LE-01 to LE-05 were evaluated on saw dust, Litchi leaf, Maize stone and wheat straw. One strain LE-01 was successfully grown on wheat straw. With few fruiting body (160 gm. per 1 kg. straw).

Evaluation of Monkey Head (Hericium erinaceus): 3 strain of *Hericium erinaceus* will be evaluated on saw dust and wheat straw.

Brainstorming Meet: Brainstorming Meet on "Dissemination of Mushroom Production Technology in Tribal Areas of Bihar" was organized on 12-13 February 2018. A total of 347 tribal people and scientists participated.

Brainstorming meet on “Dissemination of Mushroom production technology in Tribal Areas of Bihar” was held on 12 – 13 February, 2018 under the chairmanship of the Vice-Chancellor, Dr. R.C. Srivastava, Eminent participants included Chief Guest Mr. S.K. Singh, Agriculture Production Commissioner, Govt. of Bihar, Dr. Manjit Singh, Former Director, DMR, Dr. V.P. Sharma, Director, DMR and deans, directors & faculty members of the university. The university has developed Mushroom production technology to produce mushroom throughout the year. 24 villages in 12 districts of Bihar have been selected for dissemination of mushroom production technology in tribal areas. Mushroom spawn labs have been established in 14 districts by entrepreneurs through assistance under NHM. Major recommendations of brainstorming Meet were:

1. Formulation of roadmap for mushroom production, processing and marketing after consultation with growers, scientists, policy makers and other stakeholders
2. Development of compost production (tunnel method) units at district level.
3. Development of one or two spawn production units in each district of Bihar for continuous and quality spawn supply to growers.
4. Mandatory labelling of spawn packet for spawn producer.

Dissemination of Mushroom Production Technology of Tribal Areas of Bihar : Three mushroom products were branded and registered.

FSSAI License No.: 20418331000294



RAJENDRA PUSA



RAJENDRA PUSA



RAJENDRA PUSA

Salient Achievements:-

1. Round the year mushroom cultivation under natural condition.
2. Variety available for summer 30⁰C to 38⁰C, Opt. Temp. (30⁰C for Mycelial growth and 35⁰C crop production).
3. End products of mushroom

8. FARM IMPLEMENTS & MACHINERY

Feasibility testing of Maize dehuskar cum Sheller were done: There is net saving of Rs. 306/q with respect to manual threshing. The dehusker machine attracts the farmers because of its characteristics to conduct dehusking and shelling operation simultaneously.

Feasibility testing of Inclined plate multi-crop planter (Sowing of paddy in dry and wet land, DSR by Inclined plate multicrop planter and Drum seeder): The inclined plate multi-crop planter was better than drum seeder in respect of benefit cost ratio. Both the machines for DSR method may be recommended to farmer in view of acute labour shortage.

Frontline demonstration of Manual Operated Paddy Transplanter: FLD of manual operated paddy transplanter was conducted at KVK Jale in total area of about 0.75 ha with the Rajendra sweta variety of paddy. The field capacity of machine was 0.024 ha/h. The cost of saving was about 4042 Rs/ha. More than 50 farmers were benefited.

Front line Demonstration of manual operated low land low land rice seeder (TNAU Make): Direct seeding of paddy cultivation with proper weed management and optimization of seed rate.

Front line Demonstration of Tractor operated Laser guided land leveler: If field undulation is more than 15 cm, then it is advisable to use manual scraper before using laser leveler for the sake of economy. Before using Laser Leveler in the field, it should be ploughed deep and pulverized well. The cost of leveling of field depending upon amount of soil cut.

Frontline Demonstration of Self propelled Reaper-cum-binder in paddy crop: In view of acute labour scarcity during pick season of harvesting reaper binder may be preferred for paddy harvesting.

A study on effect of depth of sowing of wheat by Tractor drawn Zero till seed cum fertilizer drill: Field capacity of zero till seed drill was slightly higher in case of T₁ in comparison to T₂ and T₃ due to shallow depth of sowing resulting in higher speed of the implement. Plant population and numbers of tillers / m² was higher in case of T₂. It was because of better emergence of plant

and better crop establishment in the soil. The yield was more in case of T₂ due to higher plant population as well as better tillering of crop. The sowing of wheat was found to be suitable and profitable in the depth range of 5-7 cm in sandy loam soil. The cost of sowing of wheat by zero till seed cum ferti drill found to be Rs 820/h and Rs1577 per ha.

Feasibility test of Self-propelled Reaper-Cum-Binder in different *rabi* as well as forage crops :

In addition to wheat Reaper cum binder can also be used for harvesting other crops like Mustard, Oat and Berseem. It was observed that cutting and binding of crop was excellent in wheat followed by mustard. However some shattering losses were observed in mustard due to over ripeness of crop. In case of Oat, the cutting was done with difficulty and minor damage to the cutter bar. This might be due to less strength of the stalk of the crop resulting in frequent wrapping of the stalk in the cutter bar. The cutting was satisfactory in case of Berseem crop but binding of the crop was not possible due to lower height of crop. The field capacity was maximum (0.51 ha/h) in case of wheat crop where as it was minimum (0.38 ha/h) in Oat crop. It was observed that undulation and higher bund formation in the field created hurdle in smooth operation of the machine. Saving was found to be maximum in case of wheat (Rs 5120/ ha) and minimum in Berseem (Rs 3839/ ha).

Feasibility test of Tractor drawn 3-row sugarcane sett cutter plante : The feasibility testing of this machine was conducted at village Rulahi west Chamapran farmers field in about 2.75 ha land. Actual field capacity and field efficiency were recorded as 0.28 ha/h and 75% respectively. Cost of use of sugarcane planting by this machine was found Rs 1577/h and Rs 5632/ha. Cost of sugarcane planting by conventional method was found Rs 7625/ha. There was net saving Rs 1993/ha by the machine over conventional method. The machine appears to be very useful for the sowing of sugarcane particularly from labour, time and energy saving point.

Front line demonstration of Zero till seed cum fertilizer drill : The total area covered by this machine was 12 ha. Actual field capacity and field efficiency were recorded as 0.51 ha/h and 72 % respectively. Weed which grow rapidly after tillage operation can be eradicated naturally due to no tillage. Time of wheat sowing can be advanced by 8-12 days using zero till techniques. There was an increase of yield in the range of 6-11 % under different varieties at different location in previous year.

Front line demonstration of Tractor operated Laser guided land leveller : The total area covered by this machine was 6.5 ha. The cost of leveling of field depending upon amount of soil cut. If the field undulation is more than 15 cm, then it is advisable to use manual scraper before

using laser leveler for the sake of economy. Before using laser leveler in the field, field should be ploughed deep and pulverized well.

Front line demonstration of Self-propelled Reaper-cum-binder : The total area covered by this machine was 12.75 ha. The average field capacity of reaper cum binder was found to be 0.4 ha/h and efficiency is 70 %. The average cost of operation of reaper cum binder along with the cost of twine was calculated to be rupees 2380.00 per ha. There were a saving of rupees 5120.00 per ha. The total area covered by this machine was 12.75 ha. The average field capacity of reaper cum binder was found to be 0.4 ha/h and efficiency is 70 %. The average cost of operation of reaper cum binder along with the cost of twine was calculated to be rupees 2380.00 per ha. There were a saving of rupees 5120.00 per ha.

9. POST HARVEST ENGINEERING TECHNOLOGY

Studies on quantitative storage losses in food grains (ICAR-FCI): After waiting for arrival of fresh stocks of wheat and rice, the actual stacking work for remaining 44 stacks at Patna and all 48 stacks at Gaya was started in March, 2015. However, the rice stacking was started in June, 2015 at Gaya FSD. The last stack was built up in June, 2015 at Patna and in September, 2015 at Gaya FSD. After getting direction from PC (PHETS), URS wheat stocks were also built up in May, 2015 at Patna (1 no.) and in June, 2015 at Gaya (2 nos.) FSD. These were liquidated in Aug., 2015 at Patna and in Sept. /Oct., 2015 at Gaya FSD. Till 10.03.2018, all regular 47 stacks (24 – wheat + 23 – rice) have been liquidated at Phulwarisharif FSD and 46 (22 – wheat + 24 – rice) stacks have been liquidated at Gaya FSD. Compiled data tables reveal that the mean percent storage losses at Phulwarisharif, FSD varied from 0.012 % to 1.169 % during 33 months of storage of wheat and from 0.249 % to 2.498 % during 33 months of storage of rice. Similarly, at Gaya FSD, the mean percent storage losses varied between 0.029 % to 2.291 % during 27 months of wheat storage and between 0.885 % to 2.957 % during 30 months of rice storage.

Development of ohmic heating unit for food processing: A prototype of continuous type ohmic heating unit was designed and fabricated for volumetric/processing capacity of 15±5 litres/hour and which could be able to elevate the temperature up to 25±5⁰C. The designed and fabricated ohmic heating unit was first tested for its performance in batch mode at potential difference of 220 V. The ohmic heating unit has been tested for four liquid foods i.e. sugarcane juice, milk, watermelon juice, and sweet lemon juice at frequency of alternating current at 40, 45, 60 Hz,

applied voltage of 25, 30, 35 V and volumetric flow rate at 12, 18, 24 lph. Temperature increase was measured at 3, 6, 9 min using different thermocouples. Box Behnken design of 3 factors with 3 levels was applied for experimentation with 17 combinations. All the observed data were used to calculate different dependent parameters i.e. temperature rise and system performance coefficient. The effect of different independent variables was seen on dependent parameters by developing multiple regression polynomial equations. TSS and microbial studies were also conducted on milk and sweet lemon juice. Total Soluble Solids (TSS) was not affected much by ohmic heating of milk and sweet lemon juice. Total plate count (TPC) was decreased after ohmic heating as compared to initial value before processing for milk and sweet lemon juice. The effect of ohmic heating was seen on Yeast and mold count (YMC) as decrease in its value after processing. The OHU has been found most efficient in time and money saving as compared to traditional heating method.

Development of value chain on Litchi including procurement and evaluation of Litchi peeling machine: One complete trial of testing was done on 08.06.2017 utilizing 1000 litchi fruits. Litchis were graded manually into two grades – large and small. The average diameter, length, bulk density, and true density were determined for both the grades. Only large sized litchis were used for testing purpose. Total input weight and weight of different output main products and byproducts was taken on digital electronic platform type balance. Different machine and processing parameters were calculated and total peeling efficiency was found 66.14%.

Development of value chain on maize: *Laxmi* variety was procured at moisture content of 17.68 % w.b., which was lowered down to 13.32 % by sun-drying. Dehusking and shelling was done in maize dehusker-cum-sheller of 500 kg/h capacity which gave 71.88 % shelling efficiency. Shelled grains were again dried in hot air tray drier. Dried grains were then cleaned/graded in two screen cleaner-cum-grader which gave 66.40 % cleaning/grading efficiency for final desired grains. Cleaned and graded grains were then put into the CIAE grain pearler to obtain pearled grains (84.06 %), brokens/dalia (0.80 %) and powder/flour (12.23 %).

Comparative studies on storage behavior of food grains in different storage bags: Hermetic bags performed best among all four bags tested with all experimental combinations which retained better quality; however food grains stored in only jute bags were almost damaged and lost their quality. It was also observed that the plastic and polythene bags may also be used for storage of food grains for a limited period only without compromising its quality. There was no requirement

of any chemical treatment of grains stored in hermetic bags as the micro environment developed is sufficient enough to restrict the growth of pests, insects and micro-organism.

10. WEED MANAGEMENT

Effect of weed management and water regimes on direct-seeded rice : – 3 Days after disappearance of ponded water under different water regimes and application of Pendimethalin 1 kg/ha (PE) *fb* bispyribac-sodium 25 g/ha at 20DAS or Pendimethalin 1 kg/ha (PE) *fb* Chlorimuron + Metsulfuron 4 g/ha at 20DAS or Chlorimuron + Metsulfuron 4 g/ha at 20DAS was found equally effective for reducing the weed count and weed dry weight and producing similar rice yield and fetching higher net return and B:C ratio to that of weed free (HW at 25 and 45 DAS) under direct seeded condition.

Effect of weed management and nitrogen on weed dynamics and yield of rice under aerobic condition : 140 kg N/ha and application of Pendimethalin 1 kg/ha (PE) *fb* Chlorimuron + Metsulfuron 4 g/ha at 20DAS or Pendimethalin 1 kg/ha (PE) *fb* bispyribac-sodium 25 g/ha at 20DAS or Chlorimuron + Metsulfuron 4 g/ha at 20DAS were found most effective for reducing weed count and weed dry weight and producing higher rice yield and fetching higher net return and B:C ratio under aerobic condition.

Integrated nutrient and weed management on growth, yield and quality of aromatic rice: 50% RDN through inorganic source + 50% RDN through vermicompost or 75% RDN through inorganic source + 25% RDN through vermicompost and application of Pretilachlor 1.5 kg/ha (P.E.) + Bispyribac sodium 20 g/ha at 20 DAT or Pretilachlor 1.5 kg/ha (P.E.) + 1 HW at 20 DAT were found equally effective for reducing the weed count and weed dry weight and producing similar aromatic rice yield and fetching higher net return and B:C ratio to that of weed free (HW at 20 and 40 DAT).

Integrated weed management in soybean : Application of Pendimethalin 1.0 kg/ha as PE + quizalofop- ethyl 50 g/ha as POE at 20-25 DAS or Imazethapyr 100 g/ha as PE + fenoxaprop 100 g/ha as POE at 20-25 DAS was found most effective for reducing weed count and weed dry weight and producing higher soybean yield and fetching higher net return and B:C ratio.

11. IRRIGATION WATER MANAGEMENT

To demonstrate and evaluate improved water management practice for rice (ORP) : Under OFWM activities in Village – Narha Panapur, Block – Tetariya, Distt.- East Champaran, it was found that improved water management practices for rice under SRI consisting of 3 days drying after disappearance of 3 cm of ponded water performed better with mean grain yield being 62.59 q/ha as compared to farmer's practices (conventional method) in which mean grain yield was 47.38 q/ha. Water use efficiency (WUE) was also higher in the SRI (208.63 kg/ha-cm) as compared to 112.81 kg/ha-cm in conventional method.

Effect of moisture regimes on direct seeded rice: Grain yield and water-use efficiency (WUE) of direct seeded rice was significantly influenced by irrigation levels. Significantly higher grain yield was recorded with irrigation at 1 day after disappearance of ponded water as compared to irrigation at 5 days and 7 days after disappearance of ponded water but was statistically at par with irrigation at 3 days after disappearance of ponded water. However, WUE was significantly higher with irrigation at 3 days after disappearance of ponded water as compared to irrigation at 7 days and 1 day after disappearance of ponded water but was at par with irrigation at 5 days after disappearance of ponded water.

Effect of irrigation management and method of establishment on performance of rice: Irrigation management could not influence the grain yield of rice significantly. The maximum grain yield (3722 kg/ha) was recorded with continuous submergence throughout the crop growth followed by saturation maintenance up to PI and 5 ± 2 cm after PI, and alternate wetting and drying (5 cm irrigation at 3 DADPW) up to PI and 5 ± 2 cm after PI. However, irrigation management significantly influenced the water-use-efficiency (WUE). Significantly higher WUE (37.90 kg/ha-cm) was recorded with alternate wetting and drying (5 cm irrigation at 3 DADPW) up to PI and 5 ± 2 cm after PI as compared to continuous submergence throughout the crop growth but was statistically at par with saturation maintenance up to PI and 5 ± 2 cm after PI. Methods of establishment significantly influenced the grain yield and WUE. Significantly higher grain yield (4053 kg/ha) was recorded under normal transplanting as compared to all other methods of establishment. There was statistical parity between direct wet seeding on puddled soil and direct dry seeding and both were significantly superior to broadcasting on un-puddled soil. WUE was significantly higher with normal transplanting as compared to all other establishment methods.

Direct wet seeding on puddled soil recorded the lowest WUE which was at par with broadcasting on un-puddled soil and both were significantly lower than direct dry seeding.

Study on safe utilization of gray water for sustainable crop production.: A field experiment was conducted with different irrigation treatments of gray water use on soil and growing tomato crop plants. The results revealed that tomato crop has responded positively and produced highest yield i.e. 6.47 t/ha with 50% fresh water + 50% gray water application followed by 25% fresh water + 75% gray water (5.63 t/ha). The maximum concentrations of micronutrients viz. Zn, Cu and Fe in tomato plants were found (35.13, 47.70 and 406.7 ppm), respectively with 50% fresh water along with 50% gray water irrigation whereas maximum Mn content was recorded in crop received 25% fresh + 75% gray water application. The highest uptake of Zn, Cu, Fe and Mn i.e. 0.225, 0.305, 2.62 & 0.138 kg ha⁻¹ were also recorded, respectively in combination with 50 % Fresh + 50% Gray water application. Out of the four heavy metals cations viz. Cd, Cr, Ni and Pb, only Cr and Pb contents were detected and maximum concentration of 4.13 and 26.33 ppm, respectively was recorded in plots receiving 100 % gray water. Hence, the results indicate that irrigation with 100% gray water may increase soil salinity, alkalinity contents of Na, Phosphorus, chloride and also reduced absorption and retention capacity of water.

Effect of partial root zone drying irrigation on *Rabi* Maize growth, yield and water use efficiency: Irrigation significantly influenced the yield of maize. Maize yield increased with the increase in level of irrigation. The pooled analysis of the data revealed that the yield of maize was found highest (10.31 t/ha) with the treatment T₁, followed by treatment T₂ (10.04 t/ha) and treatment T₄ (9.02 t/ha). DI 50 (T₃), 1 PRD (T₄) and 2 PRD (T₅) have significantly reduced yield compared to CI (T₁) treatments. The reduction in yield in 1 PRD (T₄) compared to control was 12.5 %. But in terms of yield, treatment 1 PRD (T₄) outperformed the treatment DI 50 (T₃) and 2 PRD (T₅) with higher yield of 11.8% and 17.9 %, respectively, which used the same amount of water. The highest water use efficiency (WUE) was found in treatment 1 PRD (T₄ – 282.3 Kg/ ha-cm) and the lowest water use efficiency one was recorded in treatment CI (T₁- 161.6 kg/ha-cm). WUE was significantly superior in treatment 1 PRD (T₄) compared to rest of treatments.

To demonstrate and evaluate improved water management practice for wheat (ORP) : Under OFWM activities in Village-Narha Panapur, Block-Tetaria, Distt- E. Champaran, it was found that improved water management practices for wheat consisting of 3 irrigations

at 25, 65 and 95 DAS of 6 cm depth by border method of irrigation with 75 % cut-off performed better mean yield (41.09 q/ha) as compared to control (36.19 q/ha). The water-use efficiency was higher (228.28 kg/ha-cm) in study block whereas in the control block, it was only 150.79 kg/ha-cm.

Effect of drip irrigation on performance of *Rabi Maize*: Method of Irrigation (Drip, Alternate Furrow and Furrow) and Irrigation levels (IW/CPE ratio of $I_1=1.0$, $I_2=0.8$ and $I_3=0.6$) significantly influenced the grain yield of *rabi* maize which was recorded in the range of 3.2 to 9.8 t/ha. Grain yield due to irrigation levels of I_1 (7.62 t/ha) and I_2 (7.51 t/ha) were statistically at par and both were significantly superior to I_3 (5.36 t/ha). Significant improvement in grain yield due to drip irrigation (8.77 t/ha) was also recorded as compared to control i.e. furrow irrigation (4.83 t/ha). Water use efficiency varied significantly with the method of irrigation. Drip irrigation method was significantly superior to other two methods of Irrigation. The highest value of WUE (297.2 kg/ha-cm) was observed in drip irrigation with IW/CPE ratio 0.6, followed by drip irrigation with IW/CPE ratio 0.8.

12. MICRO AND SECONDARY NUTRIENTS AND

POLLUTANTSELEMENTS IN SOILS AND PLANTS (MNS)

GPS based delineation of micro and secondary nutrient deficient areas: One hundred eighty-eight GPS based soil samples were collected from Gopalganj district were analysed for available micronutrient and S contents. The extent of micronutrient and secondary nutrient deficiency in followed the following sequence S (18.5%), Zn (12.7 %), Mn (10.1 %), B (7.9 %), Fe (2.1 %) and Cu (1.6 %). The extent of micro nutrient deficiency alone or in combination with other micronutrients revealed that the extent of deficiency of two elements were to the tune of 23.3 % while single element deficiency was 34.4 %. Even three (14.3 %) and four elements (4.2 %) deficiency were also observed.

Effect of changing cropping pattern and management practices on yield trend and micronutrients status of soil: The effect of four Zn amendments applied at alternate years was studied in rice-wheat-sorghum and rice-mustard-mung cropping systems in 35th year on rice yield. Under Rice-Wheat-Sorghum (R-W-S) the order of percent responses of Zn amendments on rice grain yield as compared to Zn control plots were: Zn (10 kg ha⁻¹) + FYM (10 t ha⁻¹) (55.3%) > Zn (10 kg ha⁻¹) + FYM (5 t ha⁻¹) (43.2.3%) > FYM (10 t ha⁻¹) (21.5%) > Zn (10 kg ha⁻¹) (11.3%). Under Rice-Mustard-Green Gram (R-M-G) the order was: Zn (10 kg ha⁻¹) + FYM (10 t ha⁻¹)

(41.7%) > Zn (10 kg ha⁻¹) + FYM (5 t ha⁻¹) (34.7%) > FYM (10 t ha⁻¹) (28.6%) > Zn (10 kg ha⁻¹) (17.3%)

Optimizing zinc levels and crop residue management under rice-wheat cropping system: The effect of various levels of initial application of Zn at four levels (0, 2.5, 5.0 and 10.0 kg ha⁻¹) and four levels of crop residue incorporation were studied in upland calcareous soil. Crop residue incorporation had significant effect on rice grain yield (var. Sahabhagi Dhan). Highest grain yield was obtained in 100% crop residue incorporated plot (3.72 t ha⁻¹) followed by 50% crop residue incorporated plot (3.25 t ha⁻¹). The increase in yield in 100% and 50% crop residue incorporated plots were 41.6 and 23.7% respectively. Most of the plots have become Zn deficient (0.56 – 0.74 mg kg⁻¹). Organic Carbon build up was 0.81% in 100% crop residue incorporated plots and 0.54% in no residue plots.

Effect of phasing of Zn application on fate of Zn pools in calcareous soil and rice wheat cropping system: The study was carried out in upland Zn deficient calcareous soil to determine the rate and frequency of Zn application in rice-wheat cropping system. Zn was applied in four rates (2.5, 5.0, 7.5 and 10 kg ha⁻¹) and in four modes (initial year, alternate year and every year) in a 6-year study. In the 6th year, significant increase in rice grain yield was found in Zn applications of 7.5 and 10 kg ha⁻¹ of alternate year and 5.0 to 10 kg ha⁻¹ of every year treatments

Effect of phasing of B application on fate of B pools in calcareous soil and rice - mustard cropping system : The study was carried out in upland B deficient calcareous soil to determine the rate and frequency of B application in rice-mustard cropping system. B was applied in four rates (0.5, 1.0, 1.5 and 2.0 kg ha⁻¹) and in four modes (initial year, alternate year and every year) in a 6-year study. In the 6th year, the responses of B application in the different treatments to rice grain and straw yields were non-significant

GPS based delineation of micro and secondary nutrient deficient areas : GPS based soil sampling and analysis has been completed for Siwan (575), West Champaran (271) and Sitamarhi (63) district. The soil samples were analysed for available micronutrient contents. The extent of micronutrient and secondary nutrient deficiency followed the following sequence: Zn (57.2%), B (39.0%), Fe (17.9%) in Siwan; Zn (57.6%), B (40.6%), S (27.3%) in West Champaran, and; B (38.9%), Zn (30.6%), S (16.1%) in Sitamarhi. GPS based soil sampling and analysis has been completed for 38 districts. Maps at district and block level completed for 32 districts

Effect of changing cropping pattern and management practices on yield trend and micronutrients status of soil: Among the superimposed treatments, highest responses of 35.7% in

wheat grain yield (var. HD 2733) in Rice-Wheat-Sorghum and 21.3% in mustard grain yield (var. Rajendra Sufalam) in Rice-Mustard-Green gram cropping systems were observed with 10kg Zn + 10t FYM/ha application as compared to the control plot. In summer, the responses of 37.8% and 32.2% were found in sorghum (green fodder) and Green gram grain yields (SML 668) respectively. Yield trends have been declining at varying fertility level receiving no superimposed treatment.

Optimizing zinc levels and crop residue management under rice-wheat cropping system:

Mulching with 100 per cent straw of rice significantly increased the wheat (var. HD 2733) crop yield by 11.1 per cent. The effect of initial Zn application was non-significant. Increase in organic carbon due to crop residue management was 27%, 31% and, 50% respectively in 25%, 50% and 100% crop residue management plots in comparison to control plot. Available Zn increased significantly by 32% with 100% crop residue management as compared to control plot.

Effect of phasing of Zn application on fate of Zn pools in calcareous soil and rice wheat cropping system:

Wheat grain yield (var. HD 2824) varied from 37.77 q ha⁻¹ in the control plot to 46.23 q ha⁻¹ in 7.5 kg Zn ha⁻¹ of every year applied plot. Wheat grain yield increased significantly in 5.0 to 10.0 kg ha⁻¹ of alternate year and all the doses of every year treatments as compared to control plot

Effect of phasing of Zn application on fate of Zn pools in calcareous soil and rice-maize cropping system:

The maize grain yield (var. Shaktiman 4) varied from 50.99 q ha⁻¹ in the control plot to 65.92 q ha⁻¹ in every year application of 5.0 kg Zn ha⁻¹. Maize grain yield increased significantly in 10 kg ha⁻¹ of initial year and all the doses of alternate and every year Zn application in comparison to the control plot

Effect of phasing of B application on fate of B pools in calcareous soil and rice - mustard cropping system :

Mustard grain yield (var. Rajendra Sufalam) varied from 8.66 q ha⁻¹ in the control plot to 12.39 q ha⁻¹ in every year application of 2.0 B ha⁻¹. Mustard grain yield responded significantly to 1.0 to 2.0 kg B at alternate and every year application as compared to the control plot.

13. SOIL TEST CROP RESPONSE CORRELATION (STCR)

Long Term Effect of Organic Manure, Crop Residues & Inorganic Fertilizer on Grain Yield of Rice (58th Crop): The results suggest that compost + crop residues could save 50 % recommended dose of NPK *i.e.* 60 kg N, 30 kg P₂O₅ and 20 kg K₂O/ha.

Complex Experiment to Develop Targeted Yield Equations for Hybrid Rice(Arize-6444) under Integrated Nutrient Management: N, P and K requirement of Hybrid Rice under integrated nutrient management (FYM) to produce one quintal of grain on an average were 2.30, 0.85 and 2.48 kg, respectively. Fertilizer-contribution in Hybrid Rice (Arize 6444) in calcareous soil were 34.65% for N, 42.77% for P and 133.53% for K and contribution of soils were 37.21% for N, 123.87% for P and 89.66% for K. Similarly, contribution of FYM was 23.52% for N, 5.31% for P and 28.80% for K. Targeted yield Equations developed:

$$FN = 6.85 T - 1.07 SN - 0.68CN$$

$$FP = 1.99 T - 2.90 SP_2O_5 - 0.12 P_2O_5$$

$$FK = 1.86 - 0.67 SK_2O - 0.22 CK_2O$$

Long -Term Front Line Demonstrations on Yield Targeting of Rice under Rice–Wheat cropping system in Calcareous Soil at Experimental Field, DRPCA, Pusa: One Verification trial on yield targeting of Rice under Rice – Wheat cropping system in Calcareous Soil indicated that the percent deviation between yield target and actual yield were –2.27 to + 7.08 and response ratios varied from 5.55 to 15.08 kg grain / kg nutrient. Benefit per Rs. investment on fertilizer varied from 3.06 to 10.70. It was observed that response of rice to STCR calibrated fertilizer doses and net profit due to soil test-based fertilizer dose at yield target 35 to 45q/ha under IPNS were greater than that of General Recommended Dose (GRD) and farmer's Practice (FP). The response of rice (kg/kg nutrients) to STCR calibrated fertilizers (10.61 to 11.75) increased further under IPNS (13.03 to 15.08) at 35 to 45 q/ha yields targets. Similarly, at the same targets net profits (Rs. 25053 to Rs. 38487) also increased under IPNS system (Rs. 28670 to Rs. 39003).

Long-Term Front Line Demonstrations on Yield Targeting of Rice under Rice–Mustard cropping system in Calcareous Soil at Experimental Field, RPCAU, Pusa: One Verification trial on yield targeting of Rice under Rice – Mustard cropping system in Calcareous Soil indicated that the percent deviation between yield target and actual yield were +0.04 to +9.30 and response ratios varied from 8.64 to 17.87 kg grain / kg nutrient. Benefit per Rs. investment on fertilizer varied from 4.76 to 8.15. It was observed that response of rice to STCR calibrated fertilizer doses and net profit due to soil test-based fertilizer dose at yield target 35 to 45q/ha under IPNS were greater than that of General Recommended Dose (GRD) and farmer's Practice (FP). The response of rice (kg/kg nutrients) to STCR calibrated fertilizers (10.62 to 11.74) increased further under

IPNS (13.90 to 17.87) at 35 to 45 q/ha yields targets. Similarly, at the same targets net profits (Rs. 30091 to Rs. 47120) also increased under IPNS system (Rs. 33170 to Rs. 49807).

Long -Term Front Line Demonstrations on Yield Targeting of Rice under Rice–Winter Maize cropping system in Calcareous Soil at Experimental Field, RPCAU, Pusa: One verification trial on yield targeting of Rice under Rice – Winter Maize cropping system in Calcareous Soil indicated that the percent deviation between yield target and actual yield were +0.74 to + 2.78 and response ratios varied from 9.20 to 20.07 kg grain / kg nutrient. Benefit per Rs. investment on fertilizer varied from 5.07 to 10.67. It was observed that response of rice to STCR calibrated fertilizer doses and net profit due to soil test-based fertilizer dose at yield target 35 to 45q/ha under IPNS were greater than that of General Recommended Dose (GRD) and farmer's Practice (FP). The response of rice (kg/kg nutrients) to STCR calibrated fertilizers (15.33 to 16.45) increased further under IPNS (17.92 to 20.07) at 35 to 45 q/ha yields targets. Similarly, at the same targets net profits (Rs. 36844 to Rs. 51310) also increased under IPNS system (Rs. 36327 to Rs. 51827).

Creation of fertility gradient : 0, 100 and 200% of recommended dose of fertilizer (120:60:40; NPK kg/ha) were added in 3 strips and wheat was grown as exhaust crop. The grain (14.00 to 55.00 q/ha) and straw (47.00 to 135.00 q/ha) yield of wheat increased with increasing fertility levels

Long-term front line demonstrations on yield targeting of Mustard under Rice – Mustard cropping system in calcareous soil at experimental field, RPCAU, Pusa : Targeted yield equations used:

$$FN = 6.45T - 0.20 SN - 0.30 CN$$

$$FP_2O_5 = 2.16T - 1.42 SP_2O_5 - 0.34 CP_2O_5$$

$$FK_2O = 2.78T - 0.10 SK_2O - 0.50 CK_2O$$

The percent deviation between yield target and actual yield were +3.85 to +9.09 and response ratios varied from 10.19 to 20.10 kg grain/kg nutrient. Benefit per Rs. investment on fertilizer varied from 9.44 to 18.62. It was observed that response of Mustard and net profit due to STCR calibrated fertilizer doses both with and without IPNS were greater than that of GRD and FP. The response of Mustard 10.19 to 12.73 to STCR calibrated fertilizers which increased further under IPNS 18.20 to 20.10 kg/kg nutrients at 15 to 25 q/ha yields targets respectively. Similarly, at the same targets net profits of Rs. 40300 to Rs. 83850 which without IPNS which increased from Rs. 40950 to Rs. 78000 under IPNS system.

Complex experiment to develop targeted yield equations for Maize & Potato (Maize + Potato) under integrated nutrient management : N, P and K requirement of Maize & Potato in Maize + Potato intercropping under integrated nutrient management (FYM) to produce one quintal of maize grain and one quintal of Potato tuber on an average are 5.83, 0.93 and 2.61 kg & 3.43, 1.02 and 2.19 kg, respectively. Contribution of applied nutrients in terms of fertilizer to the total uptake in calcareous soil were 85.97% for N, 51.06% for P and 214.92% for K and those of soils were 49.01% for N, 57.42 % for P and 52.13 % for K. Contributions of FYM was 14.27% for N, 3.13% for P and 7.72 % for K.

<p>Targeted yield Equations for Maize: $FN = 6.78 T - 0.57 SN - 0.17 CN$ $FP = 1.82 T - 1.12 SP_2O_5 - 0.06 CP_2O_5$ $FK = 1.21 T - 0.24 SK_2O - 0.04 CK_2O$</p>	<p>Targeted yield Equations (for Potato): $FN = 1.61 T - 0.38 SN - 0.12 CN$ $FP = 0.42 T - 1.01 SP_2O_5 - 0.03 CP_2O_5$ $FK = 0.22 T - 0.13 SK_2O - 0.01 CK_2O$</p>
--	---

Long-term front line demonstrations on yield targeting of Wheat under Rice – Wheat cropping system in calcareous soil at experimental field, RPCAU, Pusa : Targeted yield equations used:

$$FN = 6.86T - 0.53 SN - 0.75 CN$$

$$FP_2O_5 = 1.37T - 1.29 SP_2O_5 - 0.30 CP_2O_5$$

$$FK_2O = 1.91T - 0.33 SK_2O - 0.20 CK_2O$$

The percent deviation between yield target and actual yield were -5.26 to +6.67 and response ratios varied from 12.59 to 16.72 kg grain/kg nutrient. Benefit per Rs. investment on fertilizer varied from 5.57 to 13.36. It was observed that net profit due to STCR calibrated fertilizer doses both with and without IPNS were greater than that of General Recommended Dose (GRD) and Farmer's Practice (FP). The response (kg/kg nutrients) of wheat varied from 12.20 to 12.59 to STCR calibrated fertilizers, which increased further under IPNS from 9.25 to 16.72 at 35 to 45 q/ha yield targets, respectively. Similarly, at the same targets net profits of Rs. 40773 to Rs. 54653 per ha were obtained without IPNS, which increased from Rs. 44243 to Rs. 55520 per ha under IPNS system.

Long-term front line demonstrations on yield targeting of Maize under Rice–Winter Maize cropping system in calcareous soil at experimental field, RPCAU, Pusa : Targeted yield equations used:

$$FN = 3.76T - 0.39 SN - 0.89 CN$$

$$FP_2O_5 = 0.79T - 1.47 SP_2O_5 - 0.37 CP_2O_5$$

$$FK_2O = 1.09T - 0.23 SK_2O - 0.18 CK_2O$$

The percent deviation between yield target and actual yield were -2.27 to +10.28 and response ratios varied from 16.20 to 25.99 kg grain/kg nutrient. Benefit per Rs. investment on fertilizer varied from 8.15 to 13.62. It was observed that response of Winter Maize and net profit due to STCR calibrated fertilizer doses both with and without IPNS were greater than that of GRD and

FP. The response (kg/kg nutrients) of Winter Maize varied from 16.20 to 18.50 to STCR calibrated fertilizers, which increased further in majority of cases under IPNS 22.75 to 25.99 at 60 to 90 q/ha yield targets, respectively. Similarly, at the same targets net profits of Rs. 60563 to Rs. 91200 per ha were obtained without IPNS, which increased from Rs. 60563 to Rs. 95713 per ha under IPNS system.

Front Line Demonstrations (FLDs) on Wheat in Madhubani district (Bihar) under TSP:

Targeted yield equations:

$$FN = 5.05 T - 0.40 SN$$

$$FP_2O_5 = 3.0 T - 2.11 SP_2O_5$$

$$FK_2O = 2.10 T - 0.15 SK_2O$$

Six FLDs on Wheat yield targeting indicated that the percent deviation between yield target and actual yield were -4.02 to +4.55 and response ratios varied from 8.58 to 13.38 kg grain/kg nutrient. Benefit per Rs. investment on fertilizer varied from 5.70 to 7.02. In majority of cases, it was observed that response of wheat and net profit due to STCR calibrated fertilizer doses were greater than that of GRD and FP.

Front Line Demonstrations (FLDs) on Maize in Sitamarhi district (Bihar) under TSP:

Targeted yield equations:

$$FN = 3.55 T - 0.31 SN$$

$$FP_2O_5 = 2.10 T - 3.57 SP_2O_5$$

$$FK_2O = 1.50 T - 0.41 SK_2O$$

FLDs on Maize yield targeting indicated that the percent deviation between yield target and actual yield were -6.51 to -2.56 and response ratios varied from 11.22 to 14.63 kg grain/kg nutrient. Benefit per Rs. investment on fertilizer varied from 6.11 to 7.65. In majority of cases, it was observed that response of maize and net profit due to STCR calibrated fertilizer doses were greater than that of GRD and FP.

Long term effect of organic manure, crop residues & inorganic fertilize on grain yield of wheat (q/ha) 59th crop: Grain and straw yield of wheat (59th crop) increased significantly with increasing levels of fertilizers up to 150% NPK. Crop residues could substitute compost @ 10 t/ha, and compost + crop residues could save 50% NPK. The compost, crop residues, and compost + crop residues increased the grain yield of wheat 29.90, 19.35 and 40.95%, respectively and that of straw yield 16.00, 13.00 and 33.00%, respectively over control (no manure). Carbon management index (CMI) increased significantly from 123.46 in control (0% NPK) to 148.67 in 100% NPK, which was statistically at par with 150% NPK level (155.68). Due to manure levels, carbon management index varied from 113.04 (in no manure) to 165.8 (in plots receiving compost + crop residue), which was 25.49, 9.16 and 46.74% higher than treatments receiving crop residue,

compost @ 10 t ha⁻¹ and no manure application, respectively. Oxidizable organic carbon fractions in surface soil were in the order: NL (non-labile) > VL (very labile) > L (labile) > LL (less labile).

14 NATIONAL SEED PROJECT

(SEED TECHNOLOGY RESEARCH & BREEDER SEED PRODUCTION)
Standardization of seed production technology in green manure crops Dhaincha (*Sesbania aculeata*) : The effect of Pinching on all the characters under study was found non-significant except no. of Pods/Plant where highest value 83.90 was recorded with Pinching of Terminal Bud with highest Seed Yield (7.150 q/ha). Result also indicated that the effect of foliar application of different nutrients were found significant for Seed yield / Plant (g), Seed yield / Plot (g), Seed Yield (q/ha), seed recovery % and 100-seed weight. The remaining traits studied were found non significant in relation to foliar application of different nutrients. Treatments F₁ was significantly superior over control (F₅) for seed recovery % & 100-seed weight, for F₂ Seed Yield / Plant (g), Seed Yield / ha (q) & seed recovery %, for F₃ Seed yield / Plant (g) & seed recovery % and for F₄ Seed Yield / ha (q) & seed recovery %. Analysis of data also showed that the interaction effect (M+F) was found non-significant for most of the traits under studied except no. of Pods/Plant (0.346), for P₁F₂ & Seed yield / Plant (g.) (0.429), for P₁F₃. Thus, it is concluded that Foliar application of F₂ & F₄ with Pinching produced highest Seed Yield / ha (q).

Technology recommended: In Dhaincha, foliage application of DAP (20 g/10 L Water) incorporated with micronutrient mixture containing Zinc as Zinc sulphate (5g/L Water) + Boron as Boric acid (3g/L Water) at flowering stage and removal of terminal bud (pinching or nipping) enhances the number of pods/plant, root nodules and seed quality characters resulting in higher yield. Nipping should be done in dhaincha at 60 DAS, to break apical dominance and more branching. It was recommended in the AGM of AICRP on NSP-Crops, 2018.

Grow Out Test (GOT) of Paddy : Out of 6 varieties of Paddy tested under GOT, only in one variety i.e. R. Suwasini (0.05) off-type plants have found but not more than MSCS% of foundation seed (0.05%).

Grow Out Test (GOT) of wheat: Out of 4 varieties (HD-2733, HD2967, HI-1563 & DBW-39) taken under GOT, in one variety i.e. DBW-39 (0.06) off-type plants was found more than MSCS% of foundation seed (0.05).

Development of Technologies to Mitigate the Effect of Elevated Temperatures on Seed Set, Yield and Quality (Wheat) : Analysis revealed that the chemical treatment with Salicylic acid

(800 & 400 ppm), Ascorbic acid (10 ppm) plus citric acid 1.3% and α -tocopherol 150 ppm gave significantly superior seed yield q/ha over control in wheat variety HD 2733. Other traits were not affected by chemical treatment. Earlier sowing date gave significantly superior seed yield per ha (29.03 q/ha) over delayed sowing (27.49 q/ha). Interaction effect between date of sowing and chemical treatments was significant only for 1000 seed weight.

Monitoring and detection of rice bunt, false smut and bacterial leaf blight in Processed, unprocessed and farmer's seed samples :

a. Analysis of Rice Bunt (*Tilletia barclayana*) in seed sample: In a trial conducted during Kharif – 2017, a total no. of 89 samples from farmers field and university farm representing 18 varieties, 84 samples of paddy from Seed Processing Plant representing 16 varieties were collected and analysed for paddy bunt infection by NaOH Seed soak method. None of samples recorded bunt infection.

b. Analysis of False Smut (*Ustilagoideia virens*): Out of 91 farmer's fields observed for false smut in field condition. 21.97% samples were infected with false smut in the range of 0-3 on rating scale 0-9. The maximum false smut observed in Hybrid 6444, PB 71 followed by Rajshree etc. Out of 36 seed production plots, were observed for false smut in field condition. 30.55 % plots were infected with false smut in field condition, in the range of 0 – 1 on rating scale 0 – 9. The maximum false smut observed in Rajshree.

c. Analysis of Bacterial leaf Blight (*Xanthomonas oryzae* pv. *oryzae*): Out of 91 farmers fields observed for BLB in field condition. 64.83% samples were observed infected with BLB in the range of 0 – 3 in field condition on rating scale 0 - 9. The maximum was recorded in Hybrid 6444, Prabhat followed by PB 71, Rajshree etc. Out of 36 seed production plots, observed for BLB in field condition. 75 % plots were infected with BLB in the range of 0 – 3 on rating scale 0-9. The maximum was recorded in Prabhat followed by Pankaj, Rajshree.

Monitoring of emerging new diseases of seed borne nature : Between paper (rolled paper) and standard blotter paper methods were used for detection of new seed borne pathogens in rice and wheat samples. No new seed borne diseases recorded in rice and wheat samples in kharif 2017. However, Rice bunt caused by *Tilletia barclayana* has been recorded to the level of 0.1% in samples collected from seed processing plant, Dholi in Kharif 2016.

Studies on seed health status of farmers own saved rice seed : Total 89 samples of 18 varieties were collected and analysed for rice bunt infection by NaOH seed soak method. None of the samples recorded bunt infection. Only 4.49% samples showed the germination below MSCS. The fungi were observed in laboratory were *Aspergillus* spp., *Penicillium* spp., *Curvularia lunata*,

Drechslera oryzae, and *Fusarium moniliformae*. The seed discolouration was recorded in the range of 5 – 17%.

Studies on seed health status of farmers own saved wheat seed : Total 42 samples were observed for bunt infection. All the samples were observed free from bunt infection and 10 (23.80%) samples showed the germination below MSCS. Ear cockle, Loose smut & Karnal bunt disease was not recorded in the samples. The fungi were observed in laboratory were *Aspergillus* spp., *Penicillium* spp., *Curvularia lunata*, *Bipolaris sorokiniana*, *Alternaria* spp and *Fusarium moniliformae*.

Standardization of method of detection of seed borne pathogens of significance: Brown leaf spot of Rice, caused by *Drechslera oryzae*, is one of the important seed borne disease in this region. For detection of *Drechslera oryzae*, different methods like Towel paper, Blotter paper, and direct seed placement in PDA medium, seed washing method (Dilution up to 10^{-3}) were used. Among different method tested for detection of *Drechslera oryzae*, Blotter paper method showed best result.

Breeder Seed Production of different crops: Breeder Seed Production (BSP) unit, Dholi has produced **565.43 q.** breeder seed of different varieties of **Paddy** during kharif 2017 as per DAC Indent of **184.55 q** and lifted over by allotted agencies. During Rabi 2017-18 BSP. Unit has produced **1099.35 q.** breeder seed of different varieties of **Wheat** as per DAC Indent of **184.55 q.** A sum of Rs. 60, 95,438.00, has been received in Kharif 2018 by the sale of Breeder Seed of all the crops produced during kharif 2017.

UNIVERSITY FUNDED RESEARCH

A. FACULTY OF AGRICULTURE

University Campus Waste Management Strategies: For waste collection, green and yellow dust bins have been supplied to each household/premises to keep biodegradable waste in green bin and non-biodegradable in yellow bins. Awareness campaign organized, and hand bill distributed among the households. Wastes of different categories collected daily with the help of trolley and stored at vermicompost production unit for further segregation, composting and recycling. Compostable wastes utilized for vermicomposting and saleable non-biodegradable wastes are disposed through vendors while other wastes are disposed off as landfills. Based on nutrient content and recovery percent the household waste and cow dung in equal proportion (50:50) was considered for vermicompost production. Compostable waste is mixed with cow dung (50:50) and windrows are prepared. Till date 75 windrows of 1.5 t has been prepared. Cast from 30 windrows has been harvested and sold amongst the interested stakeholders. Raw material for 30 windrows is in stock. Windrows are inoculated with epigeic earthworm's species (*Esenia fetida*, *Eudrillus eugeniee*, *Perionyx excavatus*) @ 2 kg per ton. Incubation and pot culture study to understand the mineralization of vermicompost during rice growth period and effect of vermicompost application on soil properties are continuing. Vermicompost from household wastes and its effect on soil properties and crop growth

Population dynamics and bio management of mycophagous nematodes of mushroom by *Factor composticola* and its culturing and survival studies: Survival of *Fictor composticola*, a predatory nematode, on spent mushroom compost as *in vitro* and on *Aphelenchoides* spp., a mycophagous nematode as *in vivo* method, has been observed during off season. On spent mushroom compost, the predator survived the whole season from May to September. Their population first increased sharply in the first month but decreased in the next 15 days. After that it again increased in next 15 days but then the population decreased continuously. In *in vivo* method, the survival of predator, *F. composticola* was observed on the prey, *Aphelenchoides* spp. on 1 % water agar plates which was extracted from the button mushroom compost. It was observed that the population of predator first increased up to 35 days and then decreased and the population was finished after two months.

Selection and promotion of *Trichoderma* for crop health under sustainable agriculture : Sixty two samples were collected from rhizospheric soils of different crops at different location of Muzaffarpur and

Samastipur districts. At the time of soil sample collection the crop were Chickpea, Brinjal, Lentil, Tomato, Rajama, Carrot, Arhar, Bhindi, Yambean, Sweet potato, Pea, Potato, Chilli Brinjal, Papaya, Rice, Banana and Mustard. Soil samples were serially diluted and transferred on Trichoderma Selective Medium. Twenty selective Trichoderma isolates were transferred on to potato dextrose agar based on morphological and cultural characteristics.

Cultural and Morphological characteristics of *Trichoderma* isolates: In the cultural characteristics studies including growth, growth rate, sporulation, colony colour and growth pattern were examined. All the isolates grew rapidly on PDA and showed different characteristics on conidial masses. Initially mycelial growth was creamy white, uniform, fluffy which latter appeared in sector (2 no.) and turned dark green in colour. Most of the isolates conidiophores were much branched and form loose tuft, the main branches were mostly in groups of 2-3 and stand at 90° angle. Phialides arised in whorls of 3-5 and branched at 45°-50° angle in divergent verticillate fashion. Phialospores (conidia) were small, subglobose, smooth walled, pale green in colour.

Antagonistic Activity of *Trichoderma* Isolates: Results from the dual culture test showed that all isolates of *Trichoderma* inhibited mycelial growth of *Fusarium solani* f.sp. *ciceris* more than 50% at 28°C and 35°C. Among the 9 *Trichoderma* isolates, 3 *Trichoderma* isolates viz., Tricho 4, Tricho 6 and Tricho 8 showed statistically significant inhibition of mycelial growth of pathogen i.e., 74.04, 73.33 and 71.14 percent over control, respectively at 28°C temperature. At 35°C temperature, *Trichoderma* isolates viz., Tricho 6, Tricho 4 and Tricho 8 showed inhibition of mycelial growth of pathogen i.e., 64.44, 63.70 and 63.33 percent over control, respectively.

In vitro screening of *Trichoderma* species for tolerance to Thiram, Copper oxychloride, Mancozeb and Metalaxyl: Five fungicides viz., Thiram, Copper Oxychloride, Mancozeb and Metalaxyl were evaluated at four concentrations (100, 250, and 500 ppm) for their compatibility with *Trichoderma harzianum* 4. Among tested fungicides i.e. Copper Oxychloride, Mancozeb and Metalaxyl were found compatible with the test antagonist up to 500 ppm, as these fungicides did not adversely affect the growth of test antagonist. The growth inhibition by these fungicides observed was from 1.46-15.37 per cent only. Thiram, was not found compatible with antagonist.

Mass production of *Trichoderma harzianum* for demonstration on farm trials : Two *Trichoderma* isolates were mass multiplied on sorghum and prepared talc based formulation. The *Trichoderma* population (3.2×10^6) were maintained in the formulation. The formulation of both isolates has been

distributed at different university KVKs i.e. Vaishali, West Champaran, Piprakothi, Darbhanga and Biruali for demonstration on farm trials.

Substrate evaluation for mass multiplication of *Trichoderma* spp.

Solid substrate: Sorghum grain, Maize grain and Maize cob with or without additive such as Jaggery were evaluated as substrates for the mass multiplication of *Trichoderma harzianum*. Significant increased sporulation per gram was observed in Jaggery added substrate except maize stone. Among these three substrates, significant maximum sporulation per gram was observed in Sorghum grain+2% Jaggery (6.53×10^8) followed by Sorghum grain (5.15×10^8), Maize grain+2% Jaggery (2.61×10^8) and Maize cob+2% Jaggery (19.3×10^6).

Liquid Substrate: Banana pulp at different concentration (2, 4, 6, and 8%) with or without additive such as Jaggery is being evaluated as liquid substrates for the mass multiplication of *Trichoderma harzianum*.

Effect of different drought tolerant *Trichoderma* isolates on growth, nodulation and yield of Lentil (*Lens culinaris* Medik): On the basis of two years pooled data, it is concluded that among the different *Trichoderma* isolates used, *Trichoderma* isolate 3 proved the best in enhancing field emergence (84.38%), shoot height (35.55 cm), root length (13.10 cm), grain yield per plant (6.35g) and nodule per plant (10.32 no.) compare to untreated in pooled values of two consecutive years in Lentil.

Status of Bacterial Wilt Disease in Vegetable Crops and their Eco-friendly Management under Bihar Agro-Climatic Conditions: Samples of Bacterial wilt disease caused by *Ralstonia solanacearum* were collected from Samastipur, Muzaffarpur, Darbhanga district (Agro climatic zone 1) of Bihar. All the isolates of *R. solanacearum* were characterized on the basis of biochemical and pathogenicity test. Twelve strains of *R. solanacearum* isolated from potato were characterized into biovars, two biovars, i.e., bv2 and bv2T were found in Bihar to infect potato plants. The result of pathogenicity test showed that *R. solanacearum* isolates collected from wilted potato plant belong to race 3. However, the *R. solanacearum* isolates collected from wilted tomato plant belong to race 1 and biovars 3. In – vitro screening of resistance inducer chemicals against *R. solanacearum* R3bv2 and *R. solanacearum* R1bv3, causing bacterial wilt of potato and tomato respectively. The benzoic acid showed more toxicity effect than salicylic acid on the growth of *R. solanacearum* R3bv2 and *R. solanacearum* R1bv3 at 9mM concentration in both potato and tomato isolates. The beta amino butyric acid (BABA) showed toxicity effect on the growth of *R.*

solanacearum R3bv2 and *R. solanacearum* R1bv3 at 3Mm & 1mM concentration in potato and tomato isolates respectively after 24 hrs of incubation. Isolated the rhizobacteria from potato, tomato and brinjal plant rhizosphere and these rhizobacteria were tested for the bacterial antagonistic effect against *R. solanacearum* R3bv2 and *R. solanacearum* R1bv3. The rhizobacteria T3, T5, T12, T18, P5 & P13 were found effective to inhibit the growth of *R. solanacearum* R3bv2 and *R. solanacearum* R1bv3. Treated the tomato seed (variety Pusa Ruby) with resistance inducers chemicals like **beta amino butyric acid (BABA)**, **benzoic acid** and **salicylic acid** for 5 minutes, to study the effect on germination. None of the chemicals showed toxic effect on germination up to 9mM concentration. Further, the tomato seed (variety Pusa Ruby) was also treated with screened effective rhizobacteria **T3, T5, T12, T18, P5 & P13** against *R. solanacearum* for 5 minutes to study the effect on germination.

Studies on Rice-Wheat cropping system under changing climatic scenario: The project has been conceived for better understanding and prediction of relationship between two or more weather parameters and grain yield of crops for yield prediction before actual harvesting of the crop. Major climatic parameters involved in crop production are rainfall, temperature, light and photoperiod (Orkwor, *et.al.*, 1998 and Ekputa, 2004). Rice varieties differ greatly in the time required from sowing until harvest. Thus, optimum sowing time needs to be standardized for every agro-ecological situation for success of Rice-Wheat cropping system in the State.

Accordingly, seven high yielding wheat varieties were planted on four different dates as follows:

Sl. No.	Date of Sowing	Date of Harvesting
I	10/11/2017	24.03.2018
II	20/11/2017	02.04.2018
III	05/12/2017	07.04.2018
IV	25/12/2017	16.04.2018

List of wheat varieties with duration

Sl. No.	Varieties	Duration
1.	HD 2733, HD2967, HD 2824 and R AUW101	Timely sown
2.	RW – 1, DBW14 and RAUW - 6	Late sown

Seven high yielding wheat varieties were sown on four different dates in split plot design and their performance was assessed on basis of various agro-meteorological parameters. The preliminary

results showed that first date of sowing i.e. 10.11.2017 gave desirable results and as the sowing was delayed the yield of varieties went on decreasing and they took more time to flower and mature. Out of seven wheat varieties tested, HD 2967 out-yielded others by giving a yield of 53.61qt./ha. and took lesser time to flower and mature on first date of sowing. Apart from this, various meteorological indices such as Growing Degree Days (GDD), Photo Thermal Unit (PTU), Photo Thermal Index (PTI), Heat Use Efficiency (HUE) and Relative Temperature Depression (RTD) were also studied to assess and predict the performance of genotypes under certain weather situation.

Impact Assessment of Training on Vermi Compost conducted by KVKs : Recommendation based on concluded trials:

1. Extent of adoption related with vermi- compost technology was closely associated with level of knowledge and skill acquired by the trained farmers. Hence, the training courses and other extension and communicational strategies need to focused more on creating skill and enhancing knowledge on vermi-compost technology among farming community of these districts.
2. Level of knowledge, skill acquired and extent of adoption of vermi compost technology among farmers was found at moderate level. Hence, it is recommended that young farmers should be enrolled in KVK’s training programme and they should be motivated for bringing desirable changes in the adoption behavior of vermi- compost technology.
3. Since, young farmers are the future of the nation therefore; they should be equipped and enabled to educate the farmers about the importance of vermi compost technology which may reduce the cost of cultivation and enhance the income level of the farmers.

Development of Self- Reliant Banana Farming Module for Bihar: On an average, per plant finger weight was observed to be more in Grand Naine (27.8 kg) than Malbhog (19.6 kg).Pseudo stem length, sap content and scutcher waste were greater in Malbhog than Grand Naine, and their magnitude were 296.8 & 177.31 cm ; 3.98 & 2.25 L ; and 14.04 & 9.10 kg; respectively.

Parameters in Sap	Malbhog	Grand Naine
pH	4.83	5.24
EC (dS/m)	11.31	10.25
N (ppm)	105	
P (ppm)	183	
K (ppm)	965	
Zn (ppm)	0.48	1.90

Of the intercropped fodders NBG (Hybrid Napier) and Gunia grass performed better than Para grass, and were at par with each other, yielding on an average 306, 303 and 105 kg fodder in one cutting per acre. Proximate analysis of inflorescence of the cultivars: Muthia, China and Singapuri showed average percent value of moisture, protein, fat, ashes, calcium, salts, phosphorus, fibers, silica and sodium; 6.93, 14.28, 5.24, 16.39, 0.42, 0.43, 0.9, 15.25, 0.58 and 0.016, respectively. Ingredients of inflorescence-based banana feed were maize, wheat bran, peetha, litchi seeds, banana inflorescence, small broken pulses grain, salts & jaggery with their content (%) 50, 14, 6, 6, 10, 10, 1 & 3, respectively. Content (%) of protein, fat, ashes, calcium, salts, phosphorus, sodium and silica in inflorescence-based banana feed were 14.20, 3.12, 14.33, 1.03, 1.18, 0.06, 0.88 and 5.69, respectively

Screening of Stress Tolerant Rice Genotypes in Salt Affected Soils: The experimental site consists of Saline- Sodic soil having pH 9.64 and EC 2.12dS/m with Sandy loam soil texture. Among 88 rice genotypes, only 28 genotypes performed better as shown by their overall performances under stressed conditions. Based on yield performance of rice genotypes CR 3884-244-8-5-6-1-1, emerged as highest yielder (4.10t/ha) clearly indicating its highest resistance to tolerate the stressed condition followed by CSR 2016-IR18-15 (3.85 t/ha), and NDRK-11-24(3.60t/ha). However, 4 other genotypes namely, PAU 3835-36-6-3-3-4, CR 2851-S-B-1-2B-1, CR 3878-245-2-4-1 & PAU 5563-23-1-1 were produced the same amount of yield i.e. 3.5 t/ha. Beside this, some more genotypes showed the potential to resist the stressed soil condition by producing a quite good amount of yield. These genotypes are IR 84649-81-4-1-3B-CR3397-S-B (3.45t/ha), CR 3437-1*-S-200-83-1 (3,40t/ha), CR 3903-161-1-3-2 (3.40t/ha), CSAR -1604 (3.25t/ha) and CARI Dhan-7 with 3.25t/ha yield, too. In addition to this, rice genotypes CSR 2016-IR 18-6 and CSR 2016-IR 18-17 also emerged as good yielder as well as suitable for such stressed condition. While lowest yield was recorded in case of PAU 7114-3480-1-1-1-0 and RP 5694-36-9-5-1-1 where, each of them produced only 0.26 t/ha yield.

Efficiency of nitrogen carriers in calcareous soil under hybrid rice-wheat-green gram cropping system: a step towards Nutrient Expert[®] based 4R Stewardship plant nutrition approach: The grain yield of rice (Arize-6444) varied from 2.95 to 6.69 t/ha under unfertilized and S-coated prilled urea (S-PU) plot, respectively. The rice grain yield increased significantly in the entire treated plot with different N sources over control and N omitted plot. The chlorophyll content in terms of SPAD values recorded in flag leaf at different growth stages showed positive

relationship with rice grain yield ($R^2 = 0.98$). The nitrogen content and uptake by grain and straw and total N uptake by rice crop was found to increase significantly under all treated plots with different N sources over control and N omitted plot. The changes in available N in post-harvest soil were non-significant. Based on second year findings it can be summarized that application of neem-coated urea improves the agronomic efficiency of N (AEN) over prilled urea. But further coating of S on neem-coated urea (S-NCU) decreased the AEN. Thus, among different N sources, S-PU was the best source followed by neem-coated urea, calcium nitrate, prilled urea, AS, DAP and S-NCU.

Popularization of Bio-fertilizer (BGA, Azolla and VAM) production technology among farmers of Muzaffarpur district : Ten isolates of Blue Green Algae (Anabaena) were collected from Muzaffarpur and Samastipur Districts. The ARA (Acetylene Reduction Activity) of culture was estimated 160 millimole $g^{-1} h^{-1}$. After screening selected Anabaena isolates was multiplied in laboratory condition and mass multiplied through open pit method in 5' X 9' pit using 20 kg garden soil, 500 g SSP and 200 g Carbofuran. The Azolla fronds (Azollapinata) were collected from different locations of Muzaffarpur district. The multiplication of Azolla was faster when incorporated with Vermicompost @ 2 – 2.5 kg along with 500 gm SSP in 20 sq. ft. pit. The growth reduced by 50% at temperature above 35⁰C. However, their survival is observed even up to 43⁰C. The doubling time of Azolla was 8-12 days. VAM procured was multiplied on sorghum crop using sterile soil; sand and vermicompost through pot/raised bed method. The application of VAM in maize & cauliflower crop resulted in 10.5 & 12% increase in yield of maize and cauliflower, respectively. An increase of 7.45 to 12.5% was recorded in yield of paddy through BGA and Azolla. Azolla produced by the beneficiaries was dried, grinded and applied to the maize crop. It was observed that apart from the basal dose, no fertilizers were required for the successful production of maize, saving 40-50 kg N fertilizer per hectare. Feeding of Azolla at Livestock Unit, RPCAU, Pusa as food supplements for poultry birds had significant effect on body weight of the birds and on the health of milch cow, Buffalo, calf and goats. The use of vermicompost @ 2 to 2.5 kg per pit (app. 20 sq. ft.) resulted in 10% reduction in mass multiplication time of BGA, whereas, the doubling time of *Azolla* were reduced by 20-30%. Use of 500 gm SSP per pit (app. 20 sq. ft.) favored the growth of *Azolla*. Adaptability and sustainability assessment of technology was made during the months of October and November 2017 through a structured questionnaire in the project area. The bio-fertilizer producers were marginal farmers in

their middle (36 to 50 years) age, having below high school education and farming as main occupation. However, 18 out of 30 (60%) of the participating farmers were found involved in Azolla production and 2 out of 6 (33%) in BGA production during the survey however, none showed interest for continuing VAM production. About 60 % of Azolla produced was used in paddy crop, while around 30% in maize crop and the rest in vegetable and other crops and the cattle feed. The BGA was used mainly in paddy crop. The dried Azolla and BGA were being used in maize and paddy crops at the time of field preparation. After receiving the training on Azolla production under Aga Khan Rural Support Program India (Bihar), in Bochaha, Mushahari, Muraul and Sakra blocks of Muzaffarpur district, about 30-40 % of the respondents were found to be continuing with it and mostly utilizing it as livestock feed, especially for goats.

Impact of organic farming on soil carbon sequestration, soil health and sugarcane productivity in calcareous soil of Bihar: The organic carbon content of different organic manures viz. FYM, biocompost and vermicompost varied 18.70-26.20 %. The maximum organic carbon was recorded in biocompost and minimum in FYM. The experimental soil was calcareous, low in organic carbon (0.44%) and available N, P & K - 217.4, 10.6 & 68.8, kg/ha, respectively. The results indicated that tillers, number of millable cane (NMC) and cane yield were significantly affected due to different treatments while, effect on germination, cane height , number of nodes, single cane weight were non-significant. The maximum tillers (175.82×10^3 /ha) at 150 days after planting (DAP) and NMC (130.7×10^3 /ha) were recorded in treatment receiving RDF while, minimum (tillers- 108.48 & NMC- 70.9×10^3 /ha) in control. The cane yield was significantly higher in all the treatments over control. Addition of different organics viz. biocompost @ 20 t/ha, vermicompost @ 5 t/ha and mixture of FYM, biocompost & vermicompost @ 20 t/ha gave cane yield of 91.09, 91.55 & 93.06 t/ha, respectively which was on par with RDF (104.40 t/ha). The maximum net returns (NR) of Rs. 188144 /ha and B: C ratio 2.64 were recorded due to application of RDF which was at par with treatments receiving FYM @ 20 t/ ha (NR - Rs. 155943 /ha & B: C ratio - 2.49) and green manuring with mung (NR- Rs. 151995/ha & B: C ratio - 2.56). However, addition of sugarcane trash @ 10 t/ha also showed B: C ratio (2.56) which was on par with RDF. The effect of different treatments on cane juice quality viz. brix, sucrose and purity percent was not significant. The maximum sugar yield (13.15 t/ha) was also recorded in RDF which was at par with treatment receiving biocompost @ 20 t/ha. Based on one year observations, it is concluded that organic farming was found beneficial for restoration of the soil organic carbon, sustaining the

soil fertility and sugarcane productivity. Among the different organic manure used in this study, application of FYM @ 20 t/ha and green manuring with mung (*Vigna radiata*) was found suitable for getting higher monetary returns and profitability in calcareous soil of Bihar.

Boron Fertilization on Yield and Quality of Sugarcane Plant- Ratoon System in Calcareous Soils of Bihar :

Objectives-

1. Effect of B fertilization on productivity and Juice quality of sugarcane plant- ratoon system.
2. To find out the economics of treatments under study.

Methodology: A field experiment will be conducted on sugarcane plant –ratoon system sites at University Research Farm under upland and low land situation in calcareous soil with 04 graded levels of B (0, 1.0, 1.5, 2.0 kg/ha) with mid-late variety (CoP 2061) in RBD with 03 replications.

Observations: The various parameters on yield attributes and yield will be collected. The initial and after harvest of cane soil samples (0-30cm) will be analyzed for various physico - chemical properties including B. The juice quality parameters viz. brix, pol, purity coefficient and juice recovery will be recorded. The plant samples will be analyzed for B concentration and its uptake. Data will be statistically analyzed

Expected outcome – Recommendation of dose of boron in calcareous soil for increasing productivity and juice quality of sugarcane in different land situation. The response of B on sugarcane will give proper information for augmenting system productivity and juice quality of sugarcane. The technology will be helpful in improving cane productivity and sugar yield for getting high return.

Performance of varieties at different seed rate under direct seeded rice: Varieties and seed rate have marked influence on grain yield of rice. Among the cultures tested, hybrid-Arize 6444 (43.77q/ha) out yielded the inbred varieties. Abhishek (39.73q/ha) was next best followed by Sahbhagidhan(36.16q/ha). The per cent increase in grain yield in hybrid was 10.2 and 21 over Abhishek and Sahbhagi, respectively whereas Abhishek has yield advantage of 9.8% over Sahbhagi. Grain yield increased significantly when seed rate was increased from 20 to 30kg/ha in case of varieties while it remained unaffected for hybrid

Performance of varieties at different dates of sowing under direct seeded rice: Varieties had significant influence on the productivity of direct seeded rice while date of sowing remained unaffected. However, early sowing (first fortnight of June) gave higher yield (40q/ha) over

delayed(15th July) sowing(38.76q/ha). Among the cultures tested, hybrid performed better over conventional owing to more number of effective tillers per unit area.

Plan of work for the ensuing season: Concluded

Performance of different weed management practices on direct seeded rice: Extent of yield reduction was 53.29% as compared to two hand weeding. Higher weed biomass, reduced number of effective tillers and less number of grains per panicle were responsible for decline in grain yield in different treatments .Among the herbicide interventions, application of two pst-em herbicide (Pyrozosulfuron+ Bispyribac sodium) recorded maximum yield while remaining at par with two hand weeding.

Influence of Integrated use of fertilizer and manures on productivity of direct seeded rice: Grain yield of rice were significantly affected owing to application of different sources and levels of Nitrogen.Among different sources of N substitution, maximum value was recorded with poultry manure. However, it remained statistically at par with vermicompost. Among the levels of fertilizer N,125%RDN(150kgN/ha) gave the maximum value.

Standardizing Dhaincha management for Brown manuring in direct seeded rice: Incorporation of concurrently grown dhaincha at 30DAS for mid duration and 25DAS for short duration variety at seed rate of either 30kg or 40kg/ha is beneficial for improving productivity of DSR. The per cent increase in grain yield due to seed rate of dhaincha was 5.3 and 2.3 under 40 and 30kg over 20kg across the varieties.

B. FACULTY OF BASIC SCIENCES & HUMANITIES

Exogenous application of plant growth regulator and antioxidants to improve the terminal heat tolerance of wheat cultivars grown in Bihar : Field experiment was conducted for identification of high temperature tolerant wheat cultivars grown in Bihar. Total seventeen wheat genotypes *viz.*, HD2643, HD2967, HD2285, HD2733, DBW14, DBW15, DBW39, DBW37, HI1563, HUW234, PBW343, PBW373, K9107, HP1744, RAUW4, RAUW6, and HW2045 were used in this study for detection of genetic variability in heat tolerance traits during rabi season of 2017-18. Staggered sowing (30th November, 2017, 15th December, 2017 and 2nd January, 2018) was done to study the effect of terminal heat stress in late sown crops. The wheat varieties were screened on the basis of physiological traits (total chlorophyll contents, membrane stability and chlorophyll stability index), heat susceptibility index, floret sterility percentage and yield. Genotypic variations were observed in all the studied parameters. Under late sown condition significant decrease in grain yield, chlorophyll contents, chlorophyll stability index and membrane stability index were observed. Based on their performance two relatively tolerant (HD 2967 and RAUW4) and two susceptible genotypes (DBW15 and HP1744) were identified.

Development of heat tolerant, high yielding and climate resilient wheat cultivars by utilizing genomics, molecular and physiological information and resources : A DH mapping population (cross KSG057 X KSG1186) of 200 lines was planted at two locations (RPCAU and GBPUA&T) under three date of sowing with three replication and phenotyped for their performances in normal, late and very late sown conditions. Under normal sown condition Jr4, Jr 193, Jr 125, Jr 20, Jr 28 were recorded as top performing lines at RPCAU, Pusa whereas Jr 91, Jr60, Jr109, Jr 4 and Jr 99 were recorded as top performing lines at GBPUA&T, Pantnagar with Jr 4 being common at both center. Promising DH Lines back crossed with PBW343 and a total of 1000 seeds were produced. Crosses also attempted between HD2967X Chiriya-3 and a total of 300seeds were produced. Maintenance breeding of segregating population (F₁, F₃, F₄, F₆ & F₇) was carried out. Germplasm collection of 350 genotypes was maintained through maintenance breeding. Promising genotypes trial: RWRT5 found significantly superior to checks whereas RWRT3 was found at par with one check (HD2967) and significantly superior to another (HI1563). Bioinformatics study of Starch Synthesis III (SS) gene promoter revealed a total of 27 motifs in wheat wherein ERE (Ethylene responsive) element was specific to wheat. Four novel conserved motifs e.g. ARE (anaerobic induction); GC-motif (anoxic specific inducibility); TGA (auxin-responsive element); TGACG

motif (MeJA responsiveness) were found in SSIII gene promoter consensus sequence but absent in the retrieved sequences. Total 72 SNPs were found in studied genotypes

Varietal Trial Performance Report: As per recommendations of the 3rd Research Council Meeting - 2017 the promising wheat genotypes namely RWRT-3(CRP-50) and RWRT-5 (CRP-18) were planted in replicated trial at KVK Vaishali, Sheohar, Bhojpur, Buxar, Begusarai, Piparakothi, Saraiya Muzaffarpur and also at research farm of RPCAU Pusa along with two check. The genotype RWRT-5 was found significantly superior to both the Checks HI 1563 and HD2967 with an average yield of 42.29q/ha with no major incidence of any diseases and pests. The performance of genotype RWRT-3 was found at par with Check HD 2967 but significantly superior to check HI 1563 with an average yield of 37.97q/ha and no major incidence of any diseases and pests. Yield data from KVK Saraiya Muzaffarpur could not be taken as trial destroyed completely by hailstorm. The two genotypes were also planted at five farmers field with an average yield of 44.12q/ha and 47.98q/ha respectively and no incidence of any major diseases and pest. As per recommendation the genotypes were also submitted to NBPGR and IC No. was obtained for each. E.g. RWRT-3 (IC 626047); RWRT-5 (IC626048).

Development of Hybrid Rice for Bihar: Research activities carried out under this project include generation of experimental hybrids involving Cytoplasmic Male Sterile (CMS) lines and fertility restorer pollen parents, conversion of sterility maintainer pollen parents into CMS lines, evaluation of genetic purity of CMS lines, multiplication of CMS lines and maintainer lines. Crossing of the two CMS lines under back cross substitution program in locally adapted genetic background was carried out using recently procured set of restorer lines and 30 experimental hybrids were generated. Additionally, using 5 CMS lines procured from different centres and 20 promising fertility pollen parents earlier identified in this research project, 22 experimental hybrids were generated. Sufficient amount of seeds of these experimental hybrids have been generated to observe their yield potential in progeny row at least on per plant basis. Complete pollen sterility showing back cross progenies were utilized for the conversion of their pollen parents into CMS lines. Altogether 70 back crosses were successfully made in the back cross substitution programme for the conversion of two prospective maintainer lines into CMS lines. Seedlings of 7 CMS lines and their maintainers were transplanted in the CMS multiplication block and confirmation of male sterility in CMS lines was ascertained by pollen sterility evaluation on individual plant basis. Maintenance of genetic purity of CMS lines was ascertained by hand

pollination. Molecular Profiling of various Rice varieties released by the University. Phenotyping of a set of 17 elite recombinant lines of rice for drought tolerance at vegetative stage led to identification of 12 recombinant lines including the check (Sahbhagi), which exhibited considerably higher degree of drought tolerance as per drought tolerance indices like stress tolerance level, stress susceptibility index, stress tolerance index and drought tolerance efficiency. Using a set of 32 SSR primers, molecular profiles of these elite recombinant lines have been generated. An analysis of the molecular profiles resulted in identification and classification of the 12 recombinant lines into three drought tolerant groups with high efficiency (87.5%). These recombinant lines have been developed by the university and molecular profiles of these lines can be used as distinct molecular tags for their biological individualization.

Genotyping of landraces and improved varieties of aromatic rice, in addition to promising fragrant lines, altogether 28 in number, have been carried out in three different studies using altogether 48 SSR primers and molecular profiles have been generated. Microsatellite markers have also been identified and validated for genetic purity evaluation of four aromatic rice varieties (Rajendra Suwasini, Basmati 370, Pusa Sugandh-1 and Pusa Sugandh-3).

Fingerprinting of 18 locally adapted rice varieties including 14 rice varieties developed by the university (Prabhat, Rajshree, Rajendra Bhagwati, Rajendra Shweta, Dhanlakshmi, Richharia, Gautam, Rajendra Mahsuri, Satyam, Rajendra Suwasini, Rajendra Kasturi, Vaidehi, Sudha, Super Sugandha) has been carried out using 30 SSR primers and their molecular profiles have been documented. These molecular profiles can be used for their biological authentication.

Using 281 diverse rice accessions and employing genome wide association analysis, five candidate genes most likely to be involved in zinc transportation and accumulation have been proposed.

Using a panel of six salt stress response related microsatellite primers; molecular level polymorphism was examined in sixteen rice genotypes. Among the four clusters generated, two contained moderately tolerant genotypes and each one of another two clusters consisted of highly tolerant and highly susceptible genotypes, respectively and exclusively. Results indicated that successful pyramiding of different salt tolerance components can be achieved by inter-crossing diverse genotypes from microsatellite markers based different clusters.

C. COLLEGE OF AGRICULTURAL ENGINEERING

Design and Evaluation of Drainage cum Recharge Structure under North Bihar condition :

Artificial recharge of ground water has become very important for Indo-Gangetic Plain due to its overexploitation. Keeping the importance of the artificial recharge a filter has been fabricated and tested with various filter combinations. Three new filter combinations have been introduced (Coloured Gravel + Sand + Rice Husk, Coloured Gravel + Sand +Saw Dust, Coloured Gravel + Sand + Active charcoal) for the study. The new filter combinations were tested with the runoff water. The study revealed that filter combination consisting of Coloured Gravel + Sand + Saw Dust has reduced Total Suspended Solid from 1400 mg/L to 165 mg/L and Turbidity from 550 NTU to 71NTU. The turbidity reduced by 87.10 % after passing through this filter combination. The filtration rate was 2080L/h. The filter combination consisting of Coloured Gravel + Sand + Rice Husk has reduced Total Suspended Solid from 1400 mg/L to 180 mg/L and Turbidity from 550 NTU to 78 NTU. The turbidity reduced by 85.10 % after passing through this filter combination. The filtrate rate with this filter combination was 3331 L/h. A study was carried out related to clogging of filter over the time. Rate of filtration was tested with two different concentration of runoff water. The results indicated that filtration rate reduced by 29.20 % after 50 days with runoff water having TSS 600 mg/L and reduced by 31.30 % after 52 days with runoff water having TSS 1250 mg/L as input. The study indicated that there is need of cleaning of filter after every 50 days

Assessment and prevention of post harvest losses in wheat & maize in selected districts of Bihar through community participation:

: In Bihar, 2 districts (Samastipur and Begusarai) were selected for the study in wheat and maize crops. Two blocks were selected in each district and each block has eight villages for PHL study. About 10-15 households/farmers were selected for storage study trials in each of the 19 villages in Mansurchak & Chaurahi block of Begusarai district and Tajpur & Shivajee Nagar block in Samastipur district. Super grain bags were provided to selected farmers in the first week of May-2017 & first week of July-2017 for Wheat and Maize respectively. Changes in moisture content were observed on monthly basis in the bags during the storage study. Moisture content of maize stored on traditional mud bins and Metal Bins were also recorded on monthly basis to compare the result with the hermetic bags. The least variation in moisture content in hermetic storage bags (Super grain) is due to generation-of the aerobic metabolism of insect pests and microorganisms-of

an oxygen-depleted and carbon dioxide-enriched inter-granular atmosphere of the storage ecosystem. No visible damage was observed for without treated maize and wheat samples under Hermetic bag storage for 9 & 11 months storage period respectively. The mud bins and Metal bins are extensively used as storage structures in the villages. This mode proves to be an effective method of protecting grain from rodents but leads to weight loss/gain as the environmental relative humidity decreases/increases. Experiments were conducted on the dryer with 60 °C drying air for wheat and maize at various levels of initial moisture content. It was seen that the dryers was able to remove moisture at the rate of 2.15 to 2.66 % (w. b) per hour for wheat crop and at the rate of 2.30 to 2.85 % (w. b) per hour for Maize crop. For drying 500 kg grain required Rs 80.18/hr 0.16 Rs/kg/h

Standardization of Irrigation and Fertigation Schedule for Capsicum crop under Polyhouse :

Depending up on the climatic parameter the water requirement varies from 0.33 to 2.75 l/p/day. The response of plasticulture application on vegetative growth in capsicum under poly house condition was recorded. The average plant height and average canopy spread was found 110.5 cm and 60.5 cm in treatment 120 % RDF with 100% WR through drip with plastic mulch. In other hand in control treatment i.e., 100 % RDF with 100% WR without plastic mulch the plant height 95.6 cm and canopy spread 60.5 cm was recorded. Similarly, yield attributes the such as avg. length of fruits, avg. circumference of fruits, avg. number of fruits/plant, avg. weight / fruits (grams) and yield(kg)/plant were also recorded as 12.30 cm, 22.70 cm, 14.50, 168.00 gram and 2.44 kg respectively. In other hand in control treatment they were 7.50 cm, 16.7cm, 9.5, 99.18 gram and 0.94 kg/plant respectively

Technical Recommendations: On the basis of two years yield data it was founds that the yield of capsicum (variety: Indra) inside poly house can be achieved up to 90.50 t/ha with application of 120 % RDF with 100% WR through drip with plastic mulch with B: C ratio 4.98 as compared to control treatment 53.93 t/ha with B: C ratio 2.78.

Standardization of Irrigation and Fertigation schedule for Okra with plastic mulching under open field condition :

The average plant height, canopy spread, average length of fruits, average number of fruits/plant, average weight per fruit and yield per plant highest is treatment 100 % RDF with 100% WR through drip with plastic mulch to the tune of 145 cm, 82 sq. cm, 16.30 cm 35.00, 15.60 gram and 0.55kg, respectively. On the other hand, in control treatment i'e,100 % RDF with 100% WR through surface method without plastic mulch they were 105 cm, 55.0 cm, 12.10cm, 25.00, 12.98 gram and 0.32 kg respectively .

Standardization of irrigation and fertigation level through drip for Onion : The experiment was consisting with 10 treatments. It was observed that the maximum average number of leaves and height was 15.69 and 51.29 cm respectively in treatment 100 % RDF with 100% WR through drip, where as in control treatment it was 9.0 and 30.35 cm respectively. Tuber formation starts after 75 days of transplanting. The average yield 2.14 kg/sqm in treatment 100 % RDF with 100% WR through drip where as in control treatment i.e. 100 % RDF with 100% WR through surface method it was 1.28 kg/sqm.

D. COLLEGE OF COMMUNITY SCIENCE

Empowering Mahadalit youth through Multiple approaches: An Action Project : A total number of 200 respondents from Scheduled Caste from Milky and Theda villages of Purushottampur Annu Panchayat of Khanpur block of Samastipur district were selected with major objective to bring changes in their socio economic status to lead healthy productive lives and lift themselves out of hunger and extreme poverty. Keeping above facts in mind three technologies from different units of DRPCA, Pusa have been preferred by the respondents from various options of technologies presented before them. The preferred technologies are: 1) Mushroom Production 2) Goat Rearing and 3) Skill Development. During the period of report priority was given on formation and strengthens of Self Help Groups (SHGs) with collaboration of JEEVIKA, a partner of government. So far 16 Self help Groups (SHGs) have been formed and remaining formation of Self Help Groups (SHGs) is in progress. Thereafter, capacity building by imparting training on Goat Rearing for 60 trainees and Skill Development on Pappad making on 32 women participants at KVK, Birauli and training for the same group on Candle and Packet (alternate use of polythine bag) making at Milky Farm and 19 participants on Mushroom Production training was done. Pre and post test of knowledge of participants were done, details of training imparted is mentioned in the Table 1. From pre-post report. It was observed that majority of participants were interested and inclined in upgrading their knowledge and skill from the technologies given to them, accordingly impact assessment was done phase wise to measure development.

Effect of enzyme pre-treatment on eco-friendly natural dyeing: In textile Enzymes are more focussed for wet processing as they are bio degradable, conserve energy, eco-friendly, work under mild conditions and do not cause harmful chemical effluent problems. In order to improve the dye fastness silk samples were treated with optimized conditions of enzymes. Fastness is the resistance of a textile material to specific chemical agencies. Poor colour fastness in textile products is a

major source of customer complaint so, a dye to qualify for apparel use, it has to be colour fast. Silk samples both treated (with and without enzyme) were also separately with solutions of different mordant alum, copper sulphate, ferrous sulphate, potassium dichromate and stannous chloride for 30 minutes at 45⁰c were dyed for the comparative study. The pre-treated samples were dyed with natural dye in an ultrasonicator at a temperature of 50⁰c for 1 hour. Conventional dyeing was also carried out. Samples were tested for colour fastness to washing and light on 5 point scale as per BIS standards Test methods. Litchi leaves dyed samples with Papain enzyme showed the maximum colour fastness to washing, i.e. excellent (5) and very good (4.5) fastness to light as against the standards i.e. (without enzymes). Onion peels showed maximum fastness of (5) with protease as against the standard (3.0). Pomegranate rind showed very good (4.5) washing and light fastness with Pepsin and Pectinase did not show the improvement over standard (4.0). In Bamboo leaf natural dyed samples trypsin showed (4.5) very good washing and light fastness. In case of Annato washing and light fastness showed improvements over standards. Enzymatic treated samples when compared in two methods of dyeing conventional and ultrasonicator showed 10-20 % increase in dye exhaustion except in Bamboo leaf dyed samples.

Male- Migration in Rural North Bihar and its impact on Women Empowerment : To assess the impact of male-migration on physical participation and decision making role of women of rural North Bihar at home and farm, an exhaustive survey schedule has been prepared under the research to assess the performance of women in related sectors including the areas of household, agriculture and live-stock activities and decision making . It has included the assessment of financial management aspect under the twin areas as well in presence as well in absence of husband of the respondent. Four district of North Bihar, namely, Samastipur, Muzaffarpur, Saran and East Champaran have been selected for the purpose of study to include the impact of cultural variability. Five villages each from two blocks of all the districts have been selected for the purpose, thus comprising a total number of eight blocks. In this way, forty villages comprising a sample of 10 women respondents each village have been selected for the purpose; the total number of respondents being four hundred . Purposive sampling technique is being applied in order to collect meaningful data and have meaningful interpretations. The Blocks selected are, Samastipur and Pusa from the district, Samastipur , Muraul and Sakra from the district , Muzaffarpur, Daryapur and Dighwara from the district ,Saran; and the work for East Champaran will start soon. About 160 families have been surveyed so far, and the survey is continuing. The respondents selected are the wives of unitary family who are left behind with their children or alone when their husbands

migrated to distant destinations for employment for long-term and they are the sole-decision-makers and workers in their families in absence of their husbands. Master-sheet for 150 household is also ready by now.

COLLEGE OF FISHERIES

Popularization of freshwater giant prawn *Macrobrachium rosenbergii* (de Man) farming: The project work is being continued. Another 5000 no. of PL 20 has been stocked in separate pond in order to rear them under polyhouse to grow them to juvenile stage for stocking in ponds of Dhab area in the month of February. In order to study the effect of different stocking density in the order x, 2x, 3x 6x on survival and growth of the giant prawn under pond polyhouse, 06 no. of ponds of an area of 100m² are being excavated. Low cost pond polyhouse shall be constructed on each pond to rear them during winter months. The prawn population stocked earlier, are being fed with pelleted feed and water quality parameters are being monitored fortnightly. Those prawns grew up to a weight of 120g to 170g within a period of 8 months. However the percentage of different morph types were found to be 15% for blue clawed male, 25% for orange clawed and 32% were runt males and rest were of small size ranging from 6.00gm to 10.00gm in weight. Female were only 12% of the total population in the samples studied.

Culture and propagation technique of freshwater prawn *Macrobrachium rosenbergii* dayanum (Henderson) in ponds.

Brief high light: The project work is going on. As already conveyed that the truly freshwater small sized species of prawn, *M. dayanum* have established themselves in confined conditions in pond and have started breeding. This species of prawn has only abbreviated stage of larvae, so they grow in to juvenile directly. The juvenile have been stocked in separate pond in order to study their age at first maturity and breeding. Though the species is prolific breeder, it was observed that female take 3- 4 months time to get matured during monsoon.

F. TIRHUT COLLEGE OF AGRICULTURE, DHOLI

ASSESSMENT OF SOIL CARBON STOCK AND NUTRIENT STATUS IN MANGO AND LITCHI ORCHARDS : The study focused on the estimation of carbon stock and comparative study of nutrients status between soils of mango and litchi orchards. The soil samples were collected at depth 0-30 cm from mango and litchi orchards. A comparison of the mean soil nitrogen value for each land use showed that the litchi orchard had higher available nitrogen content, 193.4 and it was ranges from 109.2-306 kg ha⁻¹ while, the mean value (149.7 kg ha⁻¹) of N in mango orchard had ranged 71.7-215 kg ha⁻¹. When taking into account of the available soil N values, litchi orchards had marginally higher than the mango as because it had rather higher range of soil organic carbon 1.11- 0.51 with mean value 0.76 percentage as compared to mango which contained 0.26-0.78 with mean value 0.54 percentage organic carbons. The mean value of phosphorus in mango and litchi orchard soils were recorded with 29.16 & 23.85 kg ha⁻¹, which accounted 22.26 percentage more in mango orchard. The available potassium in soil of mango and litchi orchards ranged from 30.91-138.43 and 44.35-198.91 kg ha⁻¹ with mean value 62.92 and 74.92 kg ha⁻¹. The percentage of available potassium in litchi orchards was rather high with 19.07 percentages. Sulphur content in mango and litchi orchard was recorded with mean value 16.85 and 30 mg kg⁻¹ and the mean boron concentration was recorded 0.99 and 0.94 mg kg⁻¹ which showed at par results. The micronutrients vis. Cu, Zn, Fe and Mn content was found in mango and litchi orchards with mean value 1.32, 1.02, 6.53 and 7.13 mg kg⁻¹ and 1.09, 1.01, 8.34 and 6.19 respectively. Among the micronutrients, Cu, and Mn concentration was found more in mango orchard soils whereas, iron content was notice more in litchi soils

Development of Dhab Area for Enhancing Livelihood through Agricultural Interventions : To enhance the profitability and sustainability of Dhab area, 7.5 acres of area under Bairiya dhab has been utilized for seed production of Wheat (Var. HD 2967). Altogether, 100 q. foundation seed of wheat was produced. Five acres of land were utilized for seed production of Rai (Var. Raj. Suflam) to utilize available moisture in the Dhab area for its proper germination and to save initial irrigation requirements and 13 q. Rai T/L seed was produced and handed over to Directorate of Seed and Farm. 2.0 Acres of land under Til Cultivation (variety- Krishna) and 1.5 acre land under Green gram (Var. HUM 16) were utilised to produce foundation seed of 1.25 q and 1.50 q., respectively. In 0.5 acres, Cucurbitaceous Vegetable crops like Bottle gourd (Var. Kashi Ganga) , Pumpkin (Var.

Kashi Harita) and Okra (Var. Kashi Kranti) were grown with help of horticulturist. Comparison of insect pest damage in the normal cultivated area and Dhab were made for crops grown in the Dhab area. Infrastructural facilities such as threshing floor (30x40 sq ft.) have been completed and installation of tube well (3 H.P. submersible) is under process.

Formulation and evaluation of liquid inoculants on pulse productivity and soil health.:

Among four polymeric molecules and two bio-molecules used as additives for lentil *Rhizobium* (*Rhizobium leguminosarum*) and PGPR *Bacillus* isolates in Yeast Extract Mannitol (YEM) and Nutrient Yeast Salt Media (NYSM), highest Optical Density during the storage period of nine months was recorded with chemical additives @10mM Trehalose for the *R. leguminosarum* and @1% Poly Ethylene Glycol (PEG) for *Bacillus sp.*. In case of bio-molecules, best results were found with potato starch @1.0 and 0.25% for *R. leguminosarum* and *Bacillus sp.*, respectively. Highest population count (cfu/ml) during the storage period was recorded with chemical additive @0.25% PEG for *R. leguminosarum* and @1.0% PEG for *Bacillus sp.*. Whereas for bio-molecules, cassava starch @0.5 and 1.0% was found best additive for *R. leguminosarum* and *Bacillus sp.* population count, respectively. Indole Acetic Acid (IAA) production by both inoculants was found entirely different (10.8-18.5µg/ml for *R. leguminosarum* & 32.8-46.0µg/ml for *Bacillus sp.*) but remains static during the storage period.

G. COLLEGE OF HORTICULTURE & FORESTRY

Yield and morpho-physiological response of semi-indeterminate and determinate tomato (*Solanum lycopersicum* L.) varieties under protected condition: Polyhouse experiment conducted with 15 varieties of tomato, collected from different ICAR institutions -IIVR, IIHR and IARI. The parameters were observed, flower initiation, initiation of fruit setting, chlorophyll contents (in terms of SPAD value), TSS percentage, fruit weight and yield per plant. Flower initiation of different varieties was varied between 30-40 days after transplanting, fruits setting was varied between 50-55 days from transplanting, chlorophyll content ranged from 40-44 (SPAD value), fruit weight ranged from 70-90.2g and yield per plant varied from 1.75kg -3.0 kg. Among varieties Kashi Amrit performed superior in terms of yield per plant, fruit weight TSS and leaf chlorophyll content. The fruit weight (90.23g), yield per plant (2.95kg), TSS (5.79 %,) and chlorophyll content (43.50) of Kashi Amrit was significantly higher than other varieties. On the

basis of observation Kashi Amrit was found superior followed by K. Vishesh, K.Anupam, Arka Meghali and Arka Alok under poly house condition.

H. FACULTY OF VETERINARY & ANIMAL SCIENCES

Improvement/development of poultry farm at APRI, Pusa Into a Model Instructional

poultry unit: Under the project construction of elevated poultry houses and brooder housed is being done by NPCC. Renovation of old poultry sheds including hatchery room has been completed. Japanese quail and desi birds are being reared for production of fertilized eggs. A full flagged hatchery unit with two setters and two hachers has been installed. Hatching of fertilized eggs produced by Japanese quail, Vanaraja chickens and ducks at farm are being done successfully in hatchery machine. Soon hatching of fertilized eggs of layer birds (CARI-Priya), indigenous chicken like Kadaknath, Naked neck, frizzle, and duck *etc.*, will be done. Training programme for poultry farmers is being organised periodically.

Establishment of Regional Centre of Excellence for Indigenous Breed (CoEIB) : India is world leader in milk production since last 21 years. It is only because of more number of animals. But, productivity of our dairy animals is much lower due to their poor genetic potential, lack of advance breeding technologies and AI (Artificial Insemination) coverage *etc.*. Keeping in view these facts, for faster genetic improvement of dairy animals in the area, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India has approved this project proposal for Establishment of Regional Centre of Excellence for Indigenous Breed (CoEIB) under RPCAU, Pusa at KVK, Piprakothi, East Champaran. Under the project site selection has been done at KVK, Piprakothi, East Champaran. Fund of Rs. 13.52 crores has been released for the year 2018-19. For civil work including construction of ETT and IVF labs (Embryo transfer technology and In-vitro fertilization), animal sheds and training center, requisition has been sent to NPCC for estimate of construction work at proposed site. Inauguration of CoEIB is expected on 25th December, 2018.

Challenged feeding to diara buffalo to get maximum potential yield in terms of Fat and SNF

content : Challenged feeding to early lactating diara buffalo 2 kg/day increases fat% and SNF% by 1.1% and 0.6% respectively, besides increase in milk yield, especially during peak lactation period. Roasting of concentrate mixture increases Rumen-Un-degradable (RUD) fraction which ultimately digest in lower intestine to increase milk fat and SNF.

Extension:

The university has developed adequate infrastructure and efficient system for dissemination of technology through Directorate of Extension Education and Agriculture information Technology Centre (ATIC), Agro advisory service at headquarter level and 13 KVKs at different districts under jurisdiction of the university. During the year 2018-19 , farming community were trained in the area of Mushroom production, Honeybee, Vermi-composting etc. by way of training, demonstration, field visit, KisanGosthiand KisanMela etc. organisation of KisanMela during Bihar Diwas at Patna, ChamparanMahotsav at Motihari and at Ziradei, on 3rd December, 2018 at the birth place of Dr. Rajendra Prasad are some of the important extension activities of this year. Under Agro-met Advisory Service, about 1.60 lacs farmers were given mobile SMS, every month, related to weather forecast and value added information for climate smart agriculture decision making.

Extension activities	No. of events/farmers
Training of farmers	49336
KisanMela organized	3
FLDs-	5704
OFTs	78



Agricultural Education Day cum Kisan Mela at was organised at Ziradei on 134th birth anniversary of our first President Dr. Rajendra Prasad and foundation day of RPCAU



Sri Jag Deo Prasad Kushwaha, a progressive farmer of East Champaran district, awarded by AbhinavKisanPuraskar - 2018 at RPCAU, Pusa on 26 Jan 2019 was honoured by KVK, Piprakothi. (29 Jan 2019)



Critical inputs were distributed to children (6 months to 1 year) by KVK Begusarai for OFT.(29 Jan 2019)



Field day on demonstration of Lentil by KVK, Sheohar



Training programme was organised by KVK Darbhanga on "Mushroom production"



Training and Demonstration of Daal Mill by KVK Begusarai. (11 Jan 2019)



Skill Development training on Quality Seed Grower was conducted at KVK Birauli. Nodal officer, KVKs inaugurated the programme. (10 Jan 2019)



Field day of CFLD on lentil and Mustard (R shuflam) was organized by KVK,Sheohar. (8 Feb 2019)

Award/Recognition: 39

Best KVK Award : 01



Received Best Poster Award on New Initiative: University Campus waste Management Strategies” in National conference on Organic Waste Management for Food and Environmental Security, held at Indian Institute of Soil Science, Bhopal during 8-10 February,2018.



AlpanaKusum a M.Sc.(Ag) student Received 2nd prize in Oral Presentation in All India Post Graduate Student Research Convention in Soil Science, held at BAU, Sabaur during March15-16,2019



Dr SK Singh, Professor (Plant Pathology) and PI, ICAR-AICRP (Fruits) received best presentation award during 6th Group Discussion of ICAR-AICRP on Fruits held at Assam Agricultural University, Jorhat on 16.02.2019

Infrastructure Development / Renovation :

The university has initiated / developed proper infrastructure to address the issue of climate change, water management, cattle breed improvement, horticulture development, health issue of resident etc., some of the important infrastructure initiatives is mentioned below :-

Developed :

1. Girls Hostel, Dholi



2. University Plaza



Renovation completed :

1. Farm Machinery Testing Centre
2. Boys and Girls Hostel, Pusa



3. College of Fisheries



4. Residential Quarters



5. VidyapatiSabhagar



6. Approach Road and Street Lighting



Initiated :

7. Centre for Advance studies in climate change
8. Centre of Excellence in Water Management
9. Embryo transfer technique centre of excellence
10. Indigenous cattle breed conservations
11. Banana Research Centre
12. Vegetable seed production
13. Agri.-business and rural management

University Campus Waste Management Strategies:

Household persons as well as hostellers and other residents are instructed to keep biodegradable waste in green bins and others in yellow bins. Besides these, existing installed bins and brick pits are also utilized for collecting organic waste only. Waste of different categories are collected daily with the help of present system and one additional tractor trolley mounted two different coloured large bins (green and yellow) for respective categories of waste and are dumped at garbage yard of Vermicompost Unit for further composting and recycling. Compostable waste are utilized for vermicomposting, whereas, plastic waste, after recycling, are disposed through vendors and other waste will be disposed of as landfills.



Different units for Entrepreneurship development program:

1. Mushroom (production, medicinal value and value added products)
2. Vermi-compost(production, supply to farmers)
3. Beekeeping
4. Gur Processing
5. Dairy Unit
6. Seed Production Unit



Training on Beekeeping



Glimpses of Training on Vermicompost



Mushroom Farm

New initiatives taken by the University

(a) Administrative reforms

- Administrative reforms have been introduced by implementing Technical Service Rule, Administrative Service Rule, division of the non-teaching staff into supporting, technical and administrative categories, approval of the CAS scheme, constitution of different Councils and Boards etc.
- Cadre creation for Technical, Skilled Supporting and Administrative staff
- Service rules and Recruitment rules,
- DPC, promotion through CAS

(b) New appointment:

- Faculty – 56; SMS -32

Financial Overview:

Rs. in Crore

Sl. No.	Particulars (Head)	(2018-19)
1.	DARE	
	Grant-in-aid Salary	75.20
	Grant-in-aid General	9.00
	Grant-in-aid Capital	45.36
2.	ICAR	0
	ICAR-AICRP	5.22
	ICAR-KVK	19.31
	ICAR scholarship	1.91
	GOI, Research	0.52
	GOI, Fellowship	0
	ICAR Development	0.62
	Govt. of India (CCC Scheme)	3.05
	GOI, Other	2.06
TOTAL		162.25

Promotion of *Rajbhasa* :

To organize *Hindi Pakhwada* from 10.09.2018 to 24.09.2018 various committees were constituted vide O.O.01/ Rajbhasa/RPCAU, Pusa dated 21.08.2018 and the opening ceremony was inaugurated by the Vice-Chancellor on 10.09.2018 at *VidyapatiSabhagar*, RPCAU, Pusa. During the period (10.09.2018 to 24.09.2018) the different committee organized essay, debate, *antakshari*, general knowledge, painting competitions among non-Hindi and Hindi-speaking students of different schools, colleges and faculties separately. Hindi technical article competition among teachers/scientists & Hindi official notes writing competition among administrative/supporting staff were also organized during the *Hindi Pakhwada* period. A Hindi *KavyaGosthi* with the help of artist of AIR, Patna was also organized on 23.09.2018. The valedictory function was held on 24.09.2018 in which 52 winners of different competitions (46 students / 03 scientists and 3 administrative/supporting staff) were awarded with certificate and memento by the Hon'ble Vice-Chancellor, Dr. R. C. Srivastava.



Hindi Pakhwada during 10.09.2018 to 24.09.2018.