# GOVERNMENT OF INDIA MINISTRY OF AGRICULTURE AND FARMERS WELFARE DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION

# LOK SABHA STARRED QUESTION NO. 76 TO BE ANSWERED ON 01/03/2016

# AGRICULTURAL UNIVERSITIES

# \*76. SHRI RAVNEET SINGH:

Will the Minister of AGRICULTURE & FARMERS WELFARE कृषि और कृषक कल्याण मंत्री be pleased to state:

(a) whether the Government has reviewed the performance of ICAR's Institutes/Agricultural Universities and if so, the outcome thereof;

(b) the funds sanctioned and utilised by various agricultural universities including Punjab Agriculture University during each of the last three years;

(c) the major researches undertaken by these universities during the said period;

(d) the outcome of these researches and the number of new technologies/seeds etc. evolved successfully and used in the fields by the farmers during the above period; and

(e) the steps taken for the development and promotion of agricultural universities in the country?

# ANSWER

# THE MINISTER OF AGRICULTURE AND FARMERS WELFAREकृषि और कृषक कल्याण मंत्री(SHRI RADHA MOHAN SINGH)

(a) to (e): A Statement is laid on the Table of the House.

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#### STATEMENT IN RESPECT OF PARTS (a) to (e) OF LOK SABHA STARRED QUESTION NO. 76 TO BE ANSWERED ON 01/03/2016 REGARDING "AGRICULTURAL UNIVERSITIES"

#### (a) Yes, Madam.

Robust monitoring and review system for Agricultural Universities is in place and monitoring is done regularly by following mechanisms:

- 1) West and Central Zone have been constituted with the approval of the competent authority to review and assess the impact of XII Plan scheme
- 2) DARE/ICAR has in-built system of undertaking appraisal and corrective measures Annual reports highlighting the achievements from the Universities
- 3) Regular visits of agricultural universities by ICAR officials
- 4) ICAR Nominee in Board of Management
- 5) Annual Vice Chancellors' Conference
- 6) Periodic Meetings of Deans
- 7) Periodic meets of the Comptrollers
- 8) Annual review Meetings of Niche Area of Excellence
- 9) Dynamic data management by National Information System on Agricultural Education Network in India (NISAGENET)
- 10) Oversight Committee visit and monitoring of special grants
- 11) Evaluation of effectiveness of training under capacity building Programmes.
- 12) Accreditation of the Universities for Quality Assurance and maintenance of standards.
- 13) Further, external independent committee constituted to review the progress of the utilization of the grants.

Five committees, one each for North, South, East for the implementation of the various research programmes/schemes under its umbrella.

The performance of the Research Institutes and Projects is regularly monitored and assessed through monthly, quarterly and annual progress reports (technical and financial). The monitoring of research programmes carried out in different institutes/research centers is also done by Quinquennial Review Team (QRT) constituted by ICAR after every five years, Research Advisory Council (RAC) and Institute Research Council (IRC) annually. These bodies evaluate the performance and suggest need based changes for the infrastructure development and thrust areas for research. The report of QRT is placed in the Governing body for approval. The report of RAC is approved by the DG, ICAR and the report of IRC is approved by the respective Director of the Institutes. More recently (2010 onwards) the Results Framework Document (RFD) system has also been introduced to effectively monitor the progress of various Institutes on the basis of assigned targets for the financial year. Based on the composite scores, they are rated from average to excellent. All the Institutes also have one Planning Monitoring and Evaluation (PME) Cell to prioritize, monitor and evaluate various projects of the Institutes. The Institutes also have their own Citizens' Charters for transparency and delivery to the public and stakeholders.

The review mechanism has indicated following focused areas for strengthening.

- 1) Development of Infrastructure.
- 2) Need to have centralized admissions, through All India Entrance examination, at UG (15%) & PG (25%) level to encourage overall merit and national integration.
- 3) Providing fellowships to attract talented students.
- 4) Promotion of cutting edge research in the Agricultural Universities through funding.
- 5) Rural Agricultural Work Experience (RAWE) at the UG level encouraged to gain rural life work experience.
- 6) Higher provision for international fellowships for Ph.D for research in reputed global laboratories
- 7) Provision for faculty exchange and adjunct faculty to address the faculty shortage in Agricultural Universities.
- 8) Need to encouraged participation of girls in agricultural education and ensuring gender mainstreaming
- 9) To provide much-needed skill and developing entrepreneurship and building confidence among UG students, Experiential Learning modules established in Agricultural Universities.

For maintaining and upgrading quality and relevance of higher agricultural education, a centrally sponsored plan scheme "Strengthening and Development of Higher Agricultural Education in India", is being implemented. The Scheme strives to plan, undertake, aid, promote and coordinate agricultural education in the country with an aim to enhance the quality and relevance of higher agricultural education to address the emerging challenges in the agriculture sector for which catalytic financial support is provided to agricultural universities (AUs), under various components. To improve the quality of research and for attaining excellence in specific strategic areas in education and research and capacity building the universities are being supported in specific **niche areas** under the XII Plan Scheme "Strengthening and Development of Higher Agricultural Education in India".

As such Central Government does not sanction any funds for SAUs as these are under the (b) administrative control of respective State Government except two Central Agricultural Universities. However, funds are provided under a centrally sponsored plan scheme "Strengthening and Development of Higher Agricultural Education in India". During XII Plan, total outlay of Rs. 2900 Crore including PAU has been made out of which, an amount of Rs. 533.48, 385.59 and 376.07 have been released during the years 2012-13, 2013-14 and 2014-15 respectively. The Scheme strives to plan, undertake, aid, promote and coordinate agricultural education in the country with an aim to enhance the quality and relevance of higher agricultural education to address the emerging challenges in the agriculture sector for which catalytic financial support is provided to agricultural universities (AUs), under various components. Further, an amount of Rs. 10 Crore each was released for setting up of new Universities viz. Sri Konda Laxman Telangana State Horticultural University, Hyderabad (Telangana) and Acharya N.G. Ranga Agricultural University, Hyderabad (Andhra Pradesh) during 2014-15 and amount of Rs. 37.5 crore each during 2015-16. Also funds were released for infrastructural development to various Agricultural Universities in the Country.

Moreover, to improve the quality of research and for attaining excellence in specific strategic areas in education and research and capacity building the universities are also supported

in specific niche areas under the XII Plan Scheme "Strengthening and Development of Higher Agricultural Education in India". The funds released for Niche Area of Excellence (NAE) during last three years including Punjab are given hereunder.

Name of the Scheme	2012-13	2013-14	2014-15
Development Grant	533.48	385.59	376.07
Niche Area of Excellence	31.21	18.94	20.94
AICRP	531.87	530.64	599.70
KVK	345.39	527.25	533.61
Total allocation	1441.95	1462.42	1530.32
Allocation to PAU Ludhiana during corresponding period		41.92	39.02

Table: Funds allocated to Agricultural Universities and PAU by ICAR during each of the previous three years (2012-13 upto 2014-15)

(c) The major research programmes that are under operation, funded by ICAR in niche areas for last three years at SAUs with ICAR are given as Annexure-I. Besides these ICAR has various commodity based 79 All India Coordinated Research Projects and Network Projects in collaborative mode with State Agricultural Universities (SAUs)to develop location-specific varieties/breeds and technologies as per the agro-ecological needs for enhancing the production and productivity.

(d) The outcome of these researches and the number of new technologies/seeds etc. evolved successfully and used in the fields by the farmers during the above period are given in Annexure II. The details of the crop varieties developed is given in Annexure III and the details of the breeders seed production figure in Annexure IV. The details of the ICAR funding from ICAR, major research programmes being run and the major research achievements in respect of PAU Ludhiana during past three years figures in Annexure V.

(e) For the development and promotion of agricultural university a Need based limited funding to Agricultural Universities (AUs) is done.

In this regard, a central sector Plan Scheme "Strengthening and Development of Higher Agricultural Education in India, with total approved outlay of ₹2900 crore "is being implemented to strengthen the agricultural universities. Need based limited part funding to Agricultural Universities (AUs), is done for strengthening of infrastructure and student amenities, strengthening and up-gradation of teaching and learning resources and excellence in teaching, research and capacity building through Niche Area of Excellence, instilling confidence Experiential Learning, Rural Awareness Work Experience, capacity building of teachers, fellowships curriculum delivery and holistic development etc. Important issues recently addressed include; establishing new Universities/ colleges , providing central assistance for strengthening higher Agricultural Education, defining UG & PG degree for general market needs and for specialized jobs and uniformity, restructuring UG practical for increased practical and practice contents, guidelines for assessing the training needs and performance of teaching faculty and the reforms in Governance in SAUs. Salient details are given as follows.

#### New Infrastructure Developed:

• New Agricultural Universities/ Colleges have been established in states/regions where such strengthening was required. In this direction new IARI like institutes have been established in Jharkhand and Assam and new Agricultural and Horticultural Universities have been established in Andhra Pradesh and Telangana respectively. Six new agriculture colleges have also been started under Central Agriculture University, Imphal.

# Human Resource Development

- Centralized admissions, through All India Entrance examination, at UG (15%) & PG (25%) level to encourage overall merit and national integration.
- Awarding Junior Research Fellowships (JRF) and Senior Research Fellowships to attract talented students.
- Capacity building of faculty of National Agricultural Research System (NARS) in Cutting-edge-areas through Centers of Advanced Faculty Training (CAFT)/Summer-Winter Schools (SWS). Incentive for quality teaching given in the form of best teacher award.
- Promoting excellence and novel school of thought by National Professors and National Fellows.
- Superannuated scientists engaged in addressing key issues through Emeritus Scientist scheme.
- Rural Agricultural Work Experience (RAWE) at the UG level encouraged to gain rural life work experience.
- International fellowships for Ph.D for research in reputed global laboratories with an objective to developed competent human resource and showcasing the strengths of ICAR-AUs System.
- Catalytic support for faculty exchange and adjunct faculty is being provided to address the faculty shortage in Agricultural Universities.

# **Educational Planning**

- Strengthening and development of infrastructure of Agricultural Universities
- Encouraged and facilitated participation of girls in agricultural education and ensuring gender mainstreaming by supporting girls' hostels. In addition, support is also provided for boys' hostels in Agricultural Universities.
- Creation of educational museums in Agricultural Universities for showcasing of technologies.
- Support for modernizing and strengthening of academic facilities, laboratories, computer labs, internet connectivity, faculty improvement, course curriculum delivery, preparation of practical manuals, career placement and alumni interaction, smart classrooms for enhancing the quality of teaching, educational tours and contingency for practical learnings leading to improved/upgraded academic environment in Agricultural Universities.
- Holistic Development of students encouraged by providing funds to Agricultural Universities with focus on overall personality development and counseling with emphasis on extracurricular activities and refinement of soft skills.

- For excellence in teaching, research, consultancy and capacity building, niche area of excellence supported in specific cutting edge areas.
- To provide much-needed skill and developing entrepreneurship and building confidence among UG students, Experiential Learning modules established in Agricultural Universities.
- To enhance learning resources including writing of text books and preparation of quality instructional material and e-facilities, the libraries of Agricultural Universities and that of their constituent colleges strengthened benefiting the students across the country, leading to improved quality of postgraduate education and research.

## **Educational Quality Assurance and Reforms**

- For improving educational standards and assuring an acceptable institutional quality, the accreditation of AUs and their constituent colleges is being done at regular intervals by an Accreditation Board established by the Council with well defined objectives and functions.
- To ensure uniformity of structure, governance and efficiency of the AUs the Model Act for AUs was prepared and has been revised in 2009.
- To keep pace with the ever changing scenario in agriculture the norms, standards and course curricula are updated and revised as per need by constitution of Dean's Committees from time to time.
- Research and instructional capabilities of farms are being strengthened by providing support for modernization of farms of the Agricultural Universities.

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# List of ICAR sponsored major research programmes undertaken at different SAUs/DUs during XII plan including those based in Punjab.

S.No	Name of	Title
	University/Institute	
1.	IARI, New Delhi	Pilot scale processes for coarse Cereal Based Functional
		Foods through Extrusion Processing
2.	AAU, Anand	Metagenomic Analysis of Ruminal Microbes
3.	IVRI, Izatnagar	Development of Bio-Sensors for Diagnosis of Pest des
4		petites ruminants (PPR) and Brucellosis
4. 7	UAS, Bangalore	Capacity Building in Taxonomy of Insects and Mites
5.	PAU, Ludhiana	Creation of novel genetic resources through alien and
		exotic introgression for high productivitoy and resistance
6	DALL Ludhiana	In wheat and fice
0.	r AO, Ludinana	quality biotic and abiotic stress tolerance
7	PALL Ludhiana	Genetic improvement of Kinnow mandarin for fruit
7.		quality biotic and abiotic stress tolerance
8	GADVASU Ludhiana	Animal Disease registry and tissue bank
9	GADVASU Ludhiana	Inland Aquaculture in Punjab
10.	CSKHPKV, Palampur	Production and protection technologies for potential
101		vegetables and pulses under organic farming
11.	WBUAFS, Kolkata	Animal Disease registry and tissue bank
12.	CSAUA&T, Kanpur	Exploration and exploitation of Trichoderma as antagonist
		against soil borne pathogens
13.	TNVASU, Chennai	Improved and expanded vaccines for immunological
		understanding of avian viruses
14.	UAS, Dharwad	Exploitation of Microbial and a Genomic Resources for
		Plant Disease Management
15.	WBUAFS, Kolkata	Surveillance of Diseases of Aquaculture Finfish and
		Shellfish in West Bengal and Development of Disease
1.6	DINIAGUL N. J	Management Strategies
16.	DUVASU, Mathura	Toxic dynamic studies on impact of environmental
		pollutants on bovine reproduction with particular
17	Dr DDKW Altolo	Period a priod a priod a priod transformer part of the period of the per
17.	DI PDKV, AKOla	Rainwater management in rained agriculture
10.	KVAFSU, Bluai	Bollingtion management research in apples and other
19.	SKUAS&I, Sillagai	fruits in Kashmir Valley
20	IGKV Raipur	Farm Mechanization in rainfed agriculture
20.	GBPUA&T Pantnagar	Geo-informatics for natural resource management and
21.	Obi Oricei, i antilagai	precision farming
22.	RSKVV. Gwalior	Management of soil health and degraded land for
		sustainable agriculture
23.	UAS, Bangalore	Integrated Centre for drought research Genetic
		enhancement of crops by molecular approaches and
		phenol typing
24.	NDPCVV, Jabalpur	Wildlife Forensic and Health
25.	NAARM, Hyderabad	Technical Enhanced Learning in Agriculture Education
26.	NDRI, Karnal	Spore based sensor for monitoring pesticide residues in
		milk '

27.	IVRI, Izatnagar	Nutrition and Gut Health: Probiotics, Prebiotics and phytogenics as Functional to Augment Gut Health of Dogs
28.	TNFU, Thoothukudi	Fish safety and quality assurance
29.	MAFSU, Nagpur	Centre for Zoonosis
30.	SKAUST, Srinagar	Study of <i>Clostridium Perfringens</i> and <i>Dichelobacter</i> nodosus (Anaerobic Bacteriology)
31.	ANGRAU, Hyderabad	Molecular Breeding and Genetic Manipulation of Rice, Maize and Pulse crops
32.	BHU, Varanasi	Molecular breeding for improvement of major crops of eastern Indo-Gangetic plains
33.	BSKVV, Dapoli	Crop regulation for increasing productivity of Alphonso mango under changing climatic conditions in Konkan region
34.	SKUAST-Srinagar	Study of <i>Clostridium perfringens</i> and <i>Dichelobacter</i> nodosus

# The outcome of the research and new technologies developed seeds during last three years (2013-2015)

During the last three years (2013-15) total 261 high yielding varieties/hybrids of different crops including 116 of cereals, 39 of oilseeds, 28 of pulses, 6 of fibres, 13 of forages and 9 of sugarcane with fair degree of tolerance to biotic and abiotic stresses have been released after multilocational trials undertaken in various Agricultural Universities in collaboration with nodal ICAR Institutes for cultivation by the farmers during the last three years (2013-2015). The structured science and development programmes of ICAR led to production of 2.27 lakh q breeder seeds of different crops during the last six years (2013 upto 2015) that were supplied to different seed producing agencies so that quality seeds of improved varieties/hybrids could be made available to the farmers for cultivation and boost the productivity and production in major crops.

Improved varieties/hybrids of different crops released during the last five years and the current year

Crop-group	2013	2014	2015	Total
Cereals	70	47	49	116
Oilseeds	15	8	16	39
Pulses	8	12	8	28
Fibre crops	3	0	3	6
Forage crops	4	5	4	13
Sugar crops	6	2	1	9
Grand Total	106	74	81	261

#### Breeds seeds production during the last three years

Сгор	2013	2014	2015	Total
Cereals	40,315	37,194	33,501	1,11,010
Oilseeds	33,235	22,398	20,030	75,663
Pulses	14,429	12,128	10,817	37,374
Forage Crops	1336	823	762	2,921
Fibre Crops	121	55	70	246
Grand Total	89,437	72,598	65,180	2,27,215

- As a result of cooperative research efforts in NARS system, India has become the second largest producer of wheat and rice and is also amongst the top exporters of rice.
- Development and adoption of new varieties of oilseeds and complementary technologies significantly improved oilseeds production.
- India is first in the world to develop hybrid cultivars of grain pearl millet, pigeon pea, castor and safflower, and second to develop hybrid cultivars of rice and sorghum. Hybrid cotton is a landmark achievement in hybrid research.
- The improved varieties played a catalytic role in the adoption of improved technology package, such as fertilizers, pesticides, irrigation water
- Incorporation of resistance to pests and tolerance to abiotic stresses in high yielding background have enabled insulation of crop plants against these stresses and thus provided stability in food production and food security.

- Development of short duration varieties of rice, sorghum, cotton, pigeon pea, chickpea, greengram, blackgram etc. has opened up awareness for multiple cropping systems and helped in enhancing cropping intensity.
- Spectacular success has been achieved in introduction and improvement of new crops, such as soybean and sunflower. India is now the fifth largest producer of soybean in the world.
- Improved varieties of sugarcane, wheat, rice, maize, sorghum, groundnut, mustard etc. Developed, have been used for commercial cultivation in many other countries. Developed experimental transgenics in cotton and rice by incorporating genes for insect resistance. Also developed protocols for micro propagation.
- The etiology, epidemiology and the management of major diseases/ insects pests have been worked out, facilitating the forecasting system and in developing location-specific integrated pest management (IPM) modules for sustainable crop production.
- Protocols have been developed for mass multiplication and release of biocontrol agents.
- Adoption of Integrated Pest Management modules has helped in lowering the quantum of pesticide requirements and promoting non-chemical eco-friendly approaches.
- About 0.20 million accessions have been conserved in the National Gene Bank at the National Bureau of Plant Genetic Resources, New Delhi It is one of the World's leading gene banks, for long-term storage of seed and other planting materials.
- Steady increase in breeder seed production resulting in enhanced supply of quality seeds to the farmers. About 25,000 q. of breeder seed is being produced annually and supplied for production of foundation seed and in turn certified seed.
- Hybrid seed production technologies for various crops refined

#### **Production Technologies developed:**

- Wheat crop grown on ridge with fertilizer application of 150: 75: 50 NPK/ ha and 10 kg/ha Zinc sulphate as basal dose was found the best integrated approach for enhancing seed yield & seed quality parameters.
- In DRRH-3 hybrid seed production, SRI method resulted in 16.05% improved seed yield.
- Unique SSR markers for rice hybrids DRRH3 (RM 228), KRH-2 (RM9310, RM9106) and KRH-4 (RM81057, RM10103, RM9a2) were identified to assess purity of parental lines.
- Under drip irrigation soil moisture depletion was high in the first 30 cm and thereafter the depletion declined with depth.
- Two seed quality enhancement technologies developed and four management practices for the control of seed borne diseases and storage pests evaluated.
- Two seed testing methods and two varietal purity testing protocols were standardized.
- Reniform and root-knot nematode have been found to be key nematode pests associated with vegetable, horticultural and pulse crops.
- *Apismellifera* was the most efficient pollinator of sesame, mango and litchi bloom.
- Research development popularization and increase in uptake of bio-control technologies among the farming community.
- Developed effective management tools for the management of birds in various crops in different agro-climates.
- Utilized techniques to exploit insectivorous birds through ecosystem management.
- Effective management tools developed for the management of rodents in various crops in different agro-climates and human habitation.

- For the management of white grub in groundnut, seed treatment with imidacloprid was found significantly superior and hence recommended to farmers.
- CAU-R1" a semi glutinous medium duration (130 days) high yielding rice variety (5.5 6.0 MT/ha) for wetland rice ecosystem of Manipur and similar situations of N.E.H. Region.
- CAU-R3" a very early (100 days) high yielding rice variety (4.0 4.5 MT/ha) as contingency rice crop of Manipur and similar situations of N.E.H. Region.
- CAU-R4" a medium long duration (145 days) semi-glutinous high yielding rice variety (4.5 5.0 MT/ha) for semi-deep water rice growing situations of Manipur valley and similar situations of N.E.H. Region.
- Front line demonstrations were conducted for Uttara, PL-4, rachana varieties in farmers field demonstration the production technologies.
- Standardized rain water harvesting and cultivation technologies of *rabi*pulses and oilseeds in rice fallow of Manipur Valley and similar situation of N.E.H. Region were demonstrated.
- Standardized Agro-Horti-Sylvicultural farming system for sustainable production in Manipur hills were demonstrated in farmer's field.
- Standardized drying systems of spices and vegetables using forced convection solar dryer for small farmers and households in N.E.H. region.
- Standardised orchid cut flower packing technology for increased shelf life up to 20 days for long distance marketing.
- Medium maturing red hybrid 2001-P-55 is recommended for release for eastern plains because it yielded higher than Kufri Lalima the local check and has moderate level of resistance to late blight and better keeping quality over Kufri Lalima.
- A white cream skin and oval tuber, high yielding medium maturing advanced hybrid, MS/5-1543 having moderate resistance to late blight with good keeping quality is recommended for cultivation in Indo-Gangetic (Northern and Eastern) plains of India.
- Black gram-potato-green gram crop sequence is recommended for high yield as well as returns in Kanpur region of central part of Uttar Pradesh.
- In potato-rice-rice cropping system at Kalyani in West Bengal, potato crop (Variety KufriJyoti) should be fertilized with 100% recommended dose of fertilizers (RDF) (200 kg N + 150 kg P<sub>2</sub>O<sub>5</sub> + 150 kg K<sub>2</sub>O /ha) for getting higher tuber yield and higher return. Other rotational crops (*kharif* and*boro* paddy) should also be fertilized with their respective RDF (60 kg N + 30 kg P<sub>2</sub>O<sub>5</sub> + 30 kg K<sub>2</sub>O /ha for*kharif* paddy and 120 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> + 60 kg K<sub>2</sub>O /ha for*boro* paddy).
- Application of 80 kg Ca/ha at the time of planting is recommended for higher tuber yield, net returns and B:C ratio. Calcium application also decreases the number of skin damaged tubers and improved the dry matter content at Kalyani (Hooghly District) in West Bengal and Jorhat in Assam.
- Potato cultivars KufriPukhraj, KufriBahar and KufriAshoka should be fertilized with 125% recommended dose of N+100% P and K (250 kg N+150 kg P<sub>2</sub>O<sub>5</sub> +150 kg K<sub>2</sub>O /ha) in Kalyani (Hooghly District) of West Bengal.
- Irrigation through micro sprinkler at 10mm CPE is recommended for higher yield and WUE especially in early planted crop in Western Haryana region.
- At Chhindwara, in medium black soils low in N, Medium in P & K fertility status and neutral pH, incorporation of soybean crop residue sprayed with 2% spray of sodium chloride @ 5t/ha + seed treatment with biofertilizers (1:1 ratio of Azotobacter and Phosphobacteria) @ 5g/kg seed tubers + Vermicompost @ 5 t/ha as soil application before planting gave yields

comparable to that under fertilization with 120:100:100 of N,  $P_2O_5$  and  $K_2O$  respectively through inorganic fertilizers. Hence this schedule is recommended for Satpura region.

- At Pantnagar, KufriSadabahar and Kufri Surya, varieties produced significantly high yields upto 150 kg N/ha and is recommended for Tarai region.
- At Pune, Kufri Surya, produced significantly high yield upto 150 kg N/ha and hence this dose is recommended for light textured black soils of Pune region.
- At Jorhat, KufriHimalini gave significantly higher yield over control with 225 kg N/ha while KufriGirdhari and KufriJyoti produced significantly higher yield over control at 150 kg N/ha, hence application of 225 kg N/ha for K. Himalini and 150 kg N/ha for KufriGirdhari and KufriJyoti is recommended.
- Kufri Surya at Deesa responded significantly to N application upto 150 kg N/ha. The net returns were also in favour of application of 150 kg N/ha, hence application of 150 kg N/ha for Kufri Surya is recommended.
- Significantly higher potato tuber yield was recorded with mulching. Irrigations at 20 mm CPE mulching with paddy straw @ 5 t/ha gave highest yield which was at par with irrigations at 25 and 30 mm CPE under mulching conditions. WUE and net returns were also higher with this treatment. Hence, application of paddy straw mulch @ 5 t/ha and irrigation at 30 mm CPE is recommended for Dohli.
- Model for predicting first appearance of late blight in Kalyani, West Bengal has been developed for both rainy and non-rainy years. The model specifies that if 7 day moving sum of ≥ 90% RH prevails for ≥105 hrs and 7day moving congenial temp (7.2 to 26.6°C) for ≥150 hrs, blight would appear within 14 days. For rainy years, if 5 day moving sum of ≥ 90 RH% prevails for ≥65 hrs with 5 day moving congenial temp. (7.2 to 26.6°C) for ≥105 hrs and sum of two consecutive rainfall events is ≥ 2.5 mm, blight would appear within 14 days.
- Late blight forecasting model developed for Pantnagar specifies that if 7 day moving sum of ≥ 85% Relative Humidity prevails for ≥85 hrs and 7day moving average congenial temp. (7.2 to 26.6°C) for ≥135 hrs, blight would appear within 14 days.
- Use of yellow sticky traps (12 no./ha) and seed treatment with imidacloprid 200 SL @ 0.04% (4ml/10ltr) for 10 minutes dip followed by foliar spray with imidacloprid @ 60 gm a.i./ha at emergence and second spray with thiamethoxam (25 WG) @ 100 g a.i./ha after 15 days of first spray is recommended for the management of whiteflies and aphids in Kalyani, West Bengal.
- Foliar spray of spiromesifen 240SC at emergence @ 96 gm a.i./ha (400ml/ha) followed by second spray with thiamethoxam (25 WG) @ 100 gm a.i./ha after 15 days of first spray and third spray of spiromesifen 240SC @ 96 gm a.i./ha (400ml/ha) after 15 days of second spray is recommended for the management of all sucking pests for Pune region of Maharashtra.
- Prophylactic spray with mancozeb @ 0.2%, followed by second spray of (fenamidone + mancozeb) @ 0.3% after seven days and a third spray with mancozeb @ 0.2% after seven days of the second spray is recommended for the control of late blight in West Bengal and Eastern Uttar Pradesh under moderate disease pressure.
- Biofumigation by incorporating one month old Indian Mustard crop (seed rate 5 kg/ ha) just before the planting of potato crop is recommended for management of black scurf and common scab in Central and Eastern Uttar Pradesh.
- Prophylactic spray with mancozeb @0.2% followed by second spray of (fenamidone + mancozeb) @0.3% after seven days and a third spray with mancozeb @0.2% after seven

days of the second spray is recommended for the control of late blight in Hassan and Pantnagar.

- Prophylactic spray with mancozeb @0.2% followed by second spray of (cymoxanil + mancozeb) @0.3% after seven days and a third spray with mancozeb @0.2% after seven days of the second spray is recommended for the control of late blight in Patna.
- Two high yielding single spore selections of white button mushroom (DMR-button-03, DMR-button-06) for controlled environment units, two high yielding strains of paddy straw mushroom, two high yielding strains of shiitake mushroom, one strain each of *Macrocybe* and milky mushroom were released in the year 2013. Two non-browning high yielding hybrids of button mushroom were released in 2015. A total of 10 new varieties of different mushroom were released and are being used by the farmers.
- Zero energy poly tunnel technology was developed for button mushroom compost preparation.
- Method for Indoor method of compost preparation was developed and standardized for pollution free composting method for white button mushroom
- Intercropping of Kalmegh (*Andrographispaniculata*) + pigeon pea at row proportion 3:1 recorded highest dry foliage and andrographolide yield, Kalmegh equivalent yield, land equivalent ratio, gross return, net return and B:C ratio. Also, intercropping of Safed musli (*Chlorophytumborivilianum*) + pigeon pea at row proportion 3:1 produced highest number of roots, length, girth, saponin content, fresh and dry root yield, Safed musli equivalent yield, land equivalent ratio, net return and B:C ratio followed by sole Safed musli.
- Fertigation technology for turmeric Application of 100% RDF with urea and potash as straight fertilizers and P as water soluble fertilizer weekly once. Standardization of water requirement of turmeric through drip irrigation Application of water through drip system at 80% pan evaporation (once in a day for 45 minutes).Rapid multiplication of turmeric through single bud rhizome in portray. Nutrient supplementation through organic manure in coriander Application of FYM 50% + vermicompost 50%.
- Standardization of water requirement for turmeric through drip irrigation Application of water through drip once in two days at 80% pan evaporation with 4 l/hr
- Nutrient supplementation through organic manure in coriander Application of FYM 50% + vermicompost 50%
- Nutrient management in off season coriander cultivation Application of NPK @ 30:40:20 kg per ha along with spraying of GA @ 15 ppm at 20 DAS.
- Use of micronutrients in coriander For saline soils with Zn deficiency (< 2 ppm) spraying 0.5% Zinc sulphate twice at 45 and 60 DAS.
- Control of rhizome rot of ginger by biofumigation Incorporation of crop residues of mustard and cabbage in soil (Biofumigation) and rhizome treatment with Metalaxyl + Mancozeb 1.25 g/litre of water for 15-20 minutes
- Micro irrigation management in fennel Application of irrigation water by drip at 0.8% IW/ CPE ratio on alternate days with paired row planting, saves 19% irrigation water in comparison to surface irrigation
- Micro irrigation management in fenugreek Application of irrigation water by drip at 0.6% IW/ CPE ratio on alternate days with paired row planting, saves 35% irrigation water in comparison to surface irrigation
- Technology for application of PGPR in Fenugreek, Coriander and Fennel In fenugreek, coriander and fennel, seed pelletizing with IISR PGPR strains either FK-14

(*Pseudomonasputida*) or FL-18 (*Macrobacteriumparaoxydans*) or combination of both is found as effective as talc formulation @ 1.5 kg/ha seed treatment.

- Nutrient supplementation through organic manure in ginger For integrated nutrient management in ginger the recommended fertilizer dosage is FYM @ 30t/ha + NPK 80:50:50 kg/ ha under Bihar conditions.
- Use of bio-fertlizer in turmeric soil application of inorganic N @ 150 kg/ha + *Azospirillum*@ 1.5 kg/ha + FYM @ 5 t/ha
- Integrated nutrient management in coriander Soil application of inorganic N @ 33 kg/ha + *Azospirillum*@ 1.5 kg/ha + FYM @ 5 t/ha.

#### Improved Engineering devices developed:

- Sugarcane bud chipping equipment
- Rotary assisted raised bed former-cum-seeder
- Tractor drawn turmeric rhizome planter
- Women friendly three row rice transplanter
- Spraying safety kit
- Pomegranate spraying system based on ultrasonic sensors
- Improved ladder for apple harvesting in Himachal Pradesh
- Personal protective equipment for women workers in fish processing units
- Generation of bio-char from crop residues
- Axial flow multi-crop thresher for hilly region
- Compact fruit grader
- Wood apple Pulper machine
- Insect Net for Net House for Vegetables Production
- Potential of fruit varieties of ber, Ziziphusmauritiana, for lac production
- Single-row tractor front mounted hydraulic operated sorghum harvester.
- Instrumentation system for measuring tractor implements performance in real field
- Solar power plant of 25 kWp installed with power output between 75-115 kWh/day.

		2013	2014	2015
Cereals	6	Cereals :70	Cereals :47	Cereals :49
1.	Rice	Total: 28 CO4 (Hybrid), Sheethal, Siddhi, CNR 2, CR Sugandh Dhan 907, CSR 43, US 305, Ankur 7434, PAC 807, JKRH 401, SHIATS Dhan- 1, VNR 2375 Plus, DRR Dhan-40, Arize Dhani, Malviya Basmati Dhan 10-9, Vallabh Basmati-21, NP 218, NP 124-8, NP 209, US 314, 27P52, 27P63, KPH 199, KPH 371, GAR-1, Pratap-1, Pusa Basmati-1509, Pusa-6	Total: 16 CR Dhan 300;CR Dhan 303; ARB 6; CR Dhan 201; CR Dhan 202;CR Dhan 305; CR Dhan 505; CR Dhan 304; CR Dhan 407; Gangavati Sona; Gontra Bindhan-3; Shobhini; VL Dhan 68; VL Dhan 157 ; NP 107-5; PAC 801 (Hybrid)	Total: 21 Arize 6444 Gold, INH97288, RC Maniphou 12, Indira Aerobic-1, Basmati 564, 6129 (BS-129), BNKR-1, Pushpa, Vallabh Basmai-24, IR-64 Drt I (IET 22836), DRR Dhan 41,CO 51, Birsa Vikas Dhan-111, Samba Sub-1 (IET 21248), Birsa Vikas Dhan- 203, Vallach Basmati 23, Sabour Shree (RAU 724-48-33), PR-124 (IET 22767), Shalimar Rice-2, Shalimar Rice-3, SAVA 127
2.	Maize	Total: 15 CMH 08-282, Shalimar Maize Composite-3, KDM-438, Pant Shankar Makka-1, Pratap QPM Hybrid-1, P1864, Sun Vaaman, NSCH-12, NMH 1242, LG 32-81, BIO 605, KDMH 017, BIO 9544, S 6217, Bisco 97 Gold	Total: 10 P3522 (X35A019); CoH (M) 9 (CMH 08-350); CoH (M)7 (CMH 08-287); CoH (M)8 (CMH 08-292); DHM 121 (BH 41009); Vivek Maize Hybrid 47 (FH 3513); Vivek Maize Hybrid 53 (FH 3556); Vivek Maize Hybrid 51 (FH 3554); KMH-25K45 (2700) (BUMPER); GH 0727 (Shrushti)	Total: 6 CoH (M) 10 CMH 08-433, HM-13 (HKH-317), PMH 6 (JH 31292) Hybrid, NMH-713,P-3580 (X-35A180), PHM- 12 (JPMH-4)
3.	Wheat	Total: 13 HPW 349, WH 1105, HI 8713 (Pusa Mangal) (d), HW 5216 (Pusa Thenmalai), DBW 71, UAS 304, MP 3336, DBW 90, DBW 88, HD 3086, HD 3090, Narendra Wheat 4018, K0402 (Mahi)	Total: 08 WHD 948; SHIATS-W6 (AAI-W6); K0607; WH 1124; K 1006 (Shekhar New); NW- 5054; MACS 6478; HD 2967;	Total:11 Nilgiri Khapli, Pusa Kiran (HS-542), RSP 561, DBW 110, DBW 107, Pusa Vatsala (HD 3118), Pusa Anmol (HI 8737), Shalimar Wheat-2 (SKW-355), DBW 93, UAS 446, WH 1142
4.	Pearl Millet	<b>Total: 06</b> KBH 108, GHB 905, MPMH 17, HHB 234, Nandi 72, 86M89,	<b>Total :02</b> Dhanashakti (ICTP 8203 Fe 10-2); NBH 5061 (MH 1812)	Total:3 NBH 5767, 86M88 (MH-1816), 86M01 (MH-1790),
5.	Sorghum	<b>Total: 03</b> CSH 30, CSH 31R, Wani 11/6	Total :02 HJ 541; CSH 32 (SPH 1674/DJ 2004)	Total : 04 SPH 1635, Phule Suchitra (RSV 1098), NSH 55 (SPH 1703), CSV 32F (SPV 2128)

Year wise and crop wise list of varieties/hybrids released during 2013-2015

6	Barley	Total: 03	Total: 05	Total · 02
0.	Dancy	DWRB 91, RD 2786, NDB 1445	HUB 113 (Mahamana);	DWRB 101, BH
			Pusa Sheetal (BHS 400);	959
			BH 946; VL Jau 118 (VLB	
			118); DWRB-92	
7.	Finger	Total: 01		-
	Millet	HIMA	KMR 204; VL Mandua- 352	
			(VL 352), Phule Nachari-T (KOPN-235)	
8.	Oat	-	-	Total:2
0.				JO-03-93, OS-377
9.	Grain Amaranth	-	-	-
10.	Foxtail Millet	Total: 01	Total: 01	-
11	Barnvard	-		
	Millet			
12.	Kodo	-	-	-
	Millet			
10	Dilseeds	Uilseeds (15)	Oilseeds (08)	Oilseeds (16)
13.	Rapeseeu- Mustard	IOTAL: UO DRMRII 31 RH 0406 Rai Vijav Mustard-2 RH 0749 Pusa	•	I Otal :4 Guiarat Dantiwada
	Mustaru	Mustard 29, Pusa Mustard 30, RRN 573, Divva-33		Mustard-4.
				Albeli-1, RSPN 25,
				GSC 7 (GSC 101)
		7 ( ) 0(		<b>.</b>
14.	Groundnut	l Otal: U1 Dharani	-	I Otal :3 Guiarat Junagadh
		Dharani		GNut-18 Rai
				Mungfali-2 (RG-578)
				Phule Bharati (JL
				776)
15	Sesame	Total: 01		Total : 02
		HT-9713		Smarak (OSC
				560),
				Subhra (OSC 207),
16	Sovhean	Total: 03	Total · 06	Total · 04
10.	ooybean	Pant Sovbean 19 (PS 1368), MACS 1188, Pratap Sova 45 (RKS	JS 20-29: JS 20-34: Rai	NRC 86 (Ahilva 6).
		45)	Vijay Soybean 2001-04(RVS	KDS 344(Phule
			2001-4); MAUS-2 (Pooja);	Agrani), Pusa 12
			MAUS-162; DSb-21	(DS 12-13), DSB
17	Sunflower	Total: 01		- 21
		PAC 3794		
18.	Castor	-	-	-
19.	Linseed	-	-	Total :2
				Pratap Alsi-2, Tiara
20	Niger	_	Total · 01	(JKF-Z) -
20.	Niger		DNS 4	
21.	Safflower	Total: 01	Total : 01	Total :1
		PKV Pink	NARI-H-23	NARI-57
	Pulses	Pulses (8)	Pulses (12)	Pulses (08)
22.	Спіскреа	I OTAI: US CNIC 1058 CNIC 1060 Nhac 3		I OTAI:3 Bidisha (BC 1094)
			JG-12	Vallabh Kabuli
				Chana-1, Raj Vijav
				Gram 202
L	1	I		1

23.	Mungbean	<b>Total: 01</b> SML 832	<b>Total: 03</b> MH 421; DGGV-2; BGS-9 (Somnath)	Total:2 CO 8, Shalimar Moong-2 (SKUAM -300)
24.	Urdbean	<b>Total: 01</b> Pratap Urd-1	<b>Total: 01</b> DBGV-5	<b>Total:1</b> Vallabh Urd-1,
25.	Pigeon pea	<b>Total: 03</b> Rajeshwari, Rudreshwar, PKV TARA	Total: 02 BRG-4 (BRG 10-2); ICPH 2671(Hybrid)	-
26.	Lentil	-	- <b>Total: 01</b> Raj Vijay Lentil 31 (JL 31) S (\$	
27.	Field pea	- Total: 02 IPFD 10-12; HFP 715		<b>Total:1</b> Shalimar Pea-1 (SKUA-P-8)
28.	Cowpea	-	<b>Total: 01</b> DCS 47-1	-
29.	Cluster bean	-	-	-
30.	Horse gram	-	Total: 01 CRIDAHARSHA (CRHG 19)	-
31.	Rajmash	-	-	-
Fib	ore crops	Fibre crops (3)	Fibre crops (3)	Fibre crops (3)
32.	Cotton Total: 02 - CSHG 1862, RG 542		<b>Total :1</b> Nirmal-18 (NACH- 18)	
33.	Jute	Jute -		<b>Total:1</b> Rithika (JROG-1)
34.	Mesta	Mesta Total: 01 - JBM 71 (Shanti)		
35.	Sun hemp	n hemp		<b>Total:1</b> Prankur (JRJ-610)
For	age crops	Forage crops (04)	Forage crops (05)	Forage crops (04)
36.	Forage Bajra	-	<b>Total: 01</b> Nutrifeed (PAC-981)	-
37.	Forage oat	Forage oat Total: 02 - Shalimar Fodder Oats-1, NDO-2		<b>Total:1</b> Shalimar Fodder Oats-4(SKO-108)
38.	Forage Sorghum	-	<b>Total: 01</b> CSV 30F	-
39.	Napier Bajra Hybrid	-	<b>Total: 01</b> CO (BN)5 (TNCN 074)	Total: 01 BNH 10 (BAIF Napier Hybrid 10)
40.	Marvel Grass		<b>Total :1</b> Phule Marvel 06- 40	
41.	Guinea Grass	-	<b>Total: 1</b> CO (GG) 3 (TNGG 062)	-
42.	Anjan Grass	-	-	-
43.	Setaria grass	Total: 01: Palam Setaria-1	-	-
44.	Rice bean	Total: 01: Him Shakti	-	-
45.	Berseem	-	Total: 01 Hisar Berseem 2 (HB 2)	-
46.	Lucerne		-	Total:1 CO 2

Sug	gar crops	Sugar crops (06)	Sugar crops (02)	Sugar crops (01)
47.	Sugarcane	<b>Total: 06</b> Co 06027, Co 06030, Co 05009 (Karan-10), Uttara, Kanakamahalakshmi, Imarti (CoSe01421)	<b>Total: 02</b> Sankeshwar 049 (Co Snk 05103); Sankeshwar 814 (Co Snk 05104)	Total:1 CoP 2061

# Breeder Seed Production by selected Universities/ Institutes including PAU Ludhiana during last three years

	(Figures in quintals)						
Sl.	Contro	20	12-13	2013-14		2014-15	
No	Centre	Indent	Production	Indent	Production	Indent	Production
1	SKUA &T, Srinagar	67.75	112.80	66.75	118.50	76.58	108.29
2	CSHHPKV,						
	Palampur	235.29	732.12	566.30	907.66	602.85	749.00
3	PAU, Ludhiana	3573.25	3896.51	3500.09	4721.76	4048.16	5369.20
4	CCSHAU, Hisar	2326.43	2162.82	2073.59	1967.88	1045.40	2641.17
5	GBPUAT,						
	Pantnagar	5662.15	5482.06	4232.87	3999.79	4982.99	6641.50
6	NDUA&T, Faizabad	1835.80	2260.72	954.50	1155.20	919.46	1228.06
7	CSAUA&T, Kanpur	3528.84	3930.19	3619.90	3400.38	1831.35	1808.22
8	BHU, Varanasi	258.95	503.80	138.80	248.12	251.20	374.57
9	AAU, Jorhat	146.50	454.89	195.00	354.41	205.00	376.98
10	BAU, Ranchi	214.76	103.73	280.50	129.50	175.50	183.08
11	RAU, Dholi	938.60	946.28	668.38	906.32	1153.10	1111.11
12	OUA&T,						
	Bhubaneswar	2054.90	1306.65	870.93	1460.66	1023.15	1783.63
13	MAF,AU, Kota	2331.30	3304.06	2450.90	2729.88	1810.30	2678.67
14	RAU, Bikaner	3883.45	3497.03	3374.17	3765.95	4663.50	5599.74
15	SDAU, S.K.Nagar	2014.54	2200.22	1841.74	2393.06	2358.31	2775.19
16	AAU, Anand	0.00	0.00	146.25	258.31	978.84	1073.26
17	JAU, Jamnagar	0.00	0.00	1.91	22.57	2483.50	2630.19
18	IGKV, Raipur	1634.94	1827.53	1295.19	1500.38	1682.35	1859.32
19	JNKVV, Jabalpur	28884.60	14841.26	18880.59	15239.03	51465.28	53221.87
20	MPKV, Rahuri	2358.11	2504.45	2213.30	2461.94	2050.75	2345.88
21	PDKV, Akola	1719.31	1812.03	1440.51	1124.22	1047.81	1222.34
22	MAU, Parbhani	1512.14	3773.68	1341.15	2903.55	3844.77	2461.27
23	UAS, Bangalore	795.40	1301.20	777.40	1082.43	765.29	1201.82
24	UAS, Dharwad	13708.55	17490.72	12313.70	12800.10	0.00	0.00
25	ANGRAU,					9424.40	10623.37
	Hyderabad	12210.51	13257.05	8798.71	9762.08		
26	TNAU, Coimbatore	897.08	551.50	775.33	467.43	1264.48	1410.51
27	KAU, Pattambi	47.49	96.08	37.21	87.52	9.21	62.40
28	PAJANCOA&RI,						
	Karaikal	7.85	23.98	5.35	31.10	0.00	0.00
29	KKV, Dapoli	43.23	181.66	35.93	184.70	69.23	186.13
30	UAS, Raichur	0.00	0.00	382.00	663.49	280.00	561.64
31	NAU, Navsari	0.00	0.00	0.00	0.00	88.55	174.65
	Total SAUs	92891.72	88555.02	73278.95	76847.92	100601.31	112463.06

ICA	AR, Institute						
32	VPKAS, Almora	213.35	215.40	141.48	179.75	65.53	120.30
33	IIPR, Kanpur	314.15	416.26	267.07	404.03	246.20	592.60
34	IGFRI, Jhansi	141.65	157.35	259.55	192.05	63.80	105.25
35	CRIJAF,						
	Barrackpore	17.40	18.54	17.40	18.54	10.87	11.90
36	CAZRI, Jodhpur	4.00	6.47	4.00	0.00	4.00	0.00
37	CRRI, Cuttack	496.80	433.60	519.60	517.40	623.30	682.90
38	DRR, Hyderabad	100.50	190.00	86.50	160.00	87.30	160.82
39	DSR, Hyderabad	18.13	56.98	11.30	49.50	449.40	731.45
40	CICR, Nagpur	0.94	0.94	0.42	1.90	0.00	0.00
41	IARI, Karnal	1267.79	1225.05	1294.55	1405.26	1469.58	1605.10
42	IARI, New Delhi	3332.15	3735.98	630.00	689.10	622.40	2896.02
43	ICAR RC NEH, Manipur	0.00	0.00	54.30	113.70	0.00	0.00
44	ICAR RC NEH,	0.00	0.00	2853.00	2853.00	0.00	0.00
45		0.00	0.00	2855.00	2853.00	16.00	15.30
46	ICAR-DSR Man	0.00	0.00	0.00	0.00	78.00	82.50
47	DRMR Bharatour	0.00	0.00	0.00	0.00	8.81	9.82
	Total ICAR	5906.86	6456.57	6139.17	6584.23	3653.89	<u> </u>
	Institute				··· <b>··</b>		
	Total (SAU +						
	ICAR)	98798.58	95011.59	79418.12	83432.15	104255.20	119316.20

#### Punjab Agricultural University, Ludhiana

The point-wise reply to the queries is given below:

# (b) The funds released by ICAR and utilized by the Punjab Agricultural University during the last three years

Year	Funds (Rs. In lakhs)
2013-14	5673.98
2014-15	5979.36
2015-16	5160.28

#### (c) Major Researches undertaken by Punjab Agricultural University Ludhiana

- The major research emphasis of the university is to develop improved varieties/hybrids having high yield, resistance to diseases and insect pests and acceptable quality in field and horticultural crops using conventional as well as biotechnological tools (Marker Assisted Selection)
- The university conducting research for efficientmanagement of soil and water resources for sustainable agriculture, increasing input use efficiency, use of biofertilizers, integrated management of pests, diseases and weeds developing farm machinery for precision and cost-effective agriculture including field and horticultural crops, agro/food processing particularly of vegetables and fruits for value addition, and producing high quality seed and plant saplings of fruits and forest trees.

#### (d) The outcome of these researches

The concerted efforts have resulted in the development and release of the following varieties of different field and horticultural crops with matching production and protection technologies. **New Varieties/ hybrids developed/ released** 

#### 2013-14

#### I. Field Crops

Сгор	Variety	Year	Remarks
Rice	PR 123	2013	Excellent cooking quality
Wheat	PBW 658	-do-	
Soybean	SL 958	-do-	
Pearl Millet	PHB 2884	-do-	
Rice	PR 124	2014	Also released at national level
Wheat	PBW 660	-do-	
Maize	PMH 9	-do-	
	PMH 10		
Canola GobhiSarson	GSC 7	-do-	Also released at national level
Raya	PBR 357	-do-	
Sesame	PbTil No. 2	-do-	
Chickpea	PBG 7	-do-	
Sorghum	PSC 4	-do-	
Oats	OL 10	-do-	
Wheat	PBW 677	2015	
	PBW 725		
Raya	RLC 3	-do-	
Sunflower	PSH 1962	-do-	
Napier Bajra	PBN 346	-do-	

#### **II. Horticulture Crops**

Сгор	Variety	Year	Remarks
Papaya	Red Lady 786	2013	For protected cultivation
Pomegranate	Bhagwa	-do-	
Fig	Brown turkey	-do-	
Bottlegourd	Punjab Barkat	-do-	
Chinese cabbage	SaagSarson	-do-	
Carrot	Punjab Black Beauty	-do-	Contains high anthocyanin
			content
	Punjab Red Carrot	-do-	
KasuriMethi	Kasuri supreme	-do-	
Peas	Mater Ageta 7	-do-	
Chilli	CH 27	2014	
Tomato	Pb. VarkhaBahar 4	-do-	
Muskmelon	MH 27	-do-	
Broccoli	PalamSamridhi	-do-	
Raddish	RB 21	-do-	
Kinnow	PAU Kinnow 1	-do-	
Tomato	Punjab Gaurav	2015	Suitable for protected
			cultivation under polynet house
	Punjab Sartaj	-do-	Suitable for protected
			cultivation under polynet house
	Punjab Red Cherry	-do-	Suitable for protected
			cultivation under polynet house
Brinjal	PBH 4	-do-	
Garlic	PG 18	-do-	
Pumpkin	PPH 1	-do-	Small and round fruits
	PPH 2	-do-	Small and round fruits
Chrysanthemum	Punjab Shyamli	-do-	

#### **Crop Production Technologies (2013-14)**

- Organic farming for fodder production in maize-berseem-bajra and maize-berseemmaize+cowpea cropping system has been recommended.
- Application of new native isolate *Bradyrhizobium* sp. (LSBR 3) culture enhanced soybean grain yield by 4-8 per cent.
- Application of *Rhizobium* culture as biofertilizer in pigeonpea improved yield by 5-7 per cent.
- Foliar application of zinc heptahydrate (0.5% solution) at anthesis and early milk stage enhanced zinc content in wheat grains.
- Two sprays of magnesium sulphate @ 1.0 per cent were recommended for the management of leaf reddening in cotton.
- Bed planting and furrow irrigation in spring maize saved 33 per cent irrigation water as compared to flood irrigation with flat sowing.
- First irrigation to spring maize should be applied at 25-30 days after sowing. The subsequent irrigations should be applied at 2 weeks interval upto 10th April and thereafter at one week interval upto maturity.
- Drip irrigation schedule has been given for spring maize which saved 40 per cent water and resulted in 20-25 per cent higher yield as compared to flood irrigation.

- Apply nitrogen in three equal splits at 3, 6 and 9 weeks after sowing in direct seeded basmati rice.
- Nitrogen application to direct-seeded rice should be made in three splits at 2, 5, and 9 weeks after seeding.
- Phosphorus (P) application to direct-seeded rice should be omitted wherein previous wheat has received recommended P dose.
- Application of 10 t ha<sup>-1</sup> rice husk ash and bagasse ash to wheat saved 30 kg  $P_2O_5$  ha<sup>-1</sup> without affecting system productivity.
- Sub-soiling in sugarcane improved cane yield by 16% over check where no sub soiling is done.
- Intercropping of three rows of garlicin between two rows of autumn sugarcanewere recommended to get higher returns.

# Plant Protection Technologies (2013-14)

- Large scale demonstration of temperature tolerant strain of *Trichogrammachilonis* and *T. chilonis*insugarcaneover an area of 4500 acres for the management of early shoot borer, *Chiloinfuscatellus* and stalk borer, *Chiloauricilius* revealed reduction of its incidence. Large scale demonstration on efficiency of *T. japonicum* against top borer, *S. excerptalis* over an area of 1020 acresreduced the incidence of top borer.
- The large scale demonstration of biological control of maize stem borer, *Chilopartellus* using *T. chilonis* @ 1, 00, 000/ ha brought down level of leaf injury and dead hearts.
- Large scale demonstration of biocontrol based IPM in *basmati r*iceover an area of 10 ha each with 7 releases of *T. chilonis* and *T. japonicum*each @ 1, 00,000/ ha proved as effective for the management of leaf folder and stem borer.
- Treatment of wheat seed with Vitavax Power 75WS (carboxin 37.5% + thiram 37.5%) @ 3g/kg of seed for management of loose smut, flag smut and black point.
- Soaking of rice seed in 10 litres of water containing 20 g Bavistin 50WP (carbendazim) and 1 g Streptocycline (streptomycin+tetracycline) for 8 to 10 hours before sowingfor the management of seed borne diseases of rice.
- Spray the rice crop as soon as the disease is noticed at boot stage with Lusture 37.5 SE (flusilazole12.5% + carbendazim) @ 320 ml/acrefor control of sheath blight.
- Spray Mortar 75SG (cartap hydrochloride) @ 170 g/ acre for the control of stem borers and leaf folder in Basmati and non- Basmati rice.
- Post-emergence application of Parimaze 10 SL (imazethapyr) @ 750 ml/ha at 15-20 days after sowing for weed control in soybean
- Spray Diafenthiuron 50WP @ 200 g/acre and Spiromesifen 240SC @ 200 ml/acre for the control of whitefly on cotton.
- Adoption of cropping sequence of cauliflower-onion-okra proved effective in managing root knot nematodes and significantly reduced root knot soil index in infested soils.
- Paddy straw mulch at 6.0 t/ha for weed control in autumn potato served as an alternate to herbicides.
- New formulations of mancozeb, Mass M-45 and Markzeb 75 WP and a copper oxychloride, Markcopper 50% WP, proved effective for the management of late blight of potato.
- Application of new fungicide Revus 250SC (Mandipropamid 23.4%) for control of late blight of potato.

- Pre-emergence application of either of Goal 23.5 EC (oxyfluorfen) 2400 ml/acre applied within one week of planting garlic or Stomp 30 EC (pendimethalin) @ 1.0 litre/acre applied within two days of planting garlic gave effective control of annual weeds.
- Pre-emergence application of Goal 23.5 EC (oxyfluorfen) at 200 ml/acre, within two days of sowing, provided effective control of annual grasses and broadleaf weeds in carrot.

#### **Post Harvest Technologies**

- Technology for the preparation, packaging and preservation of paste and slurry (puree) of onion
- Juice/pulp extraction and preservation were standardized for kinnow, guava, peach, pear, grape, lime, mango and plum.
- Technology has been given for the ripening of physiologically matured fruits of winter guava *cv*. Sardar.
- Grapes packed in low density polyethylene (LDPE) bag with single sheet of sulphur dioxide generating pad and kept in corrugated fibre board (CFB) boxes can be stored for 30 days at 0-2°C temperature and 90-95 per cent relative humidity with acceptable quality.

# **Crop Production Technologies (2014-15)**

- Green manuring has been recommended in basmati to omit urea application.
- Application of consortium culture of *Rhizobium* (LLR 12) and *Rhizobacterium* (RB 2) as biofertilizer in lentil enhances grain yield.
- Intercrop one row of maize or cowpea as fodder and summer moong as grain crop in *Bt* cotton.
- Intercrop one row of cowpea or maize as fodder and groundnut for pods in maize sown at row to row spacing of 60 cm.
- Sow the *kharif* mungbean crop in the second fortnight of July for obtaining higher grain yield.
- Application of Biozyme @ 8kg/acre at the time of sowing and again at the time of earthing up, followed by its foliar spray @ 200 ml/acre, improves the yield of potato.
- To improve germination of bittergourd seeds soak seed in Potassium dihydrogen orthophosphate 10<sup>-1</sup>M (13.6g/ litre of water) for 24 hr and then keep the seeds in moist gunny bags for 48 hr.
- In turmeric, apply 5 tonnes/acre FYM before planting and 25 kg N/acre in two equal splits at 75 and 100 days after planting.
- Two sprays of 15 g NAA (naphthalene acetic acid) in 500 litres of water once in second fortnight of October and again in second fortnight of November reduces the physiological fruit drop in 'Umran' ber.
- To rejuvenate senile guava trees (15 years old),head back the trees at 1.5 m from the ground level in the month of March leaving 2-3 primary scaffolds. Apply Bordeaux paste on the cut ends. In August, thin out the crowded and intermingled shoots and prune 50% portion of the newly emerged shoots from the top. This promotes to flowering and fruiting in winter season crop.
- To rejuvenate senile mango trees (30 years old) head back the trees at the height of 2 m from the crotch angle in first week of January by retaining four to five outward growing branches. Apply Bordeaux paste on the cut ends and exposed branches should be white washed. In June, retain 3-4 healthy outward growing shoots on each stub. Trees will start bearing fruits after three years of rejuvenation.

## Plant Protection Technologies

- Large scale demonstration of biological control of maize stemborer using *Trichogrammachilonis* in an area of 202 acres gave effective control of maize stem borer.
- Large scale demonstration of biocontrol based IPM in organic basmati rice over an area of 50 acres resulted in lower incidence of yellow stem borer and leaf folder.
- Application of Fame 480 SC (flubendiamide) @ 20 ml/acre was effective for the control of stem borer and leaf folder in rice and *basmati* rice.
- Application of Marktriazo 40 EC (triazophos) @ 350 ml/acre was found effective for control of stem borer and leaf folder in rice.
- Application of Marktriazo 40EC (triazophos) @ 600 ml/acre provided effective control of whitefly in cotton.
- Application of Nativo 75WP @ 80g in 200 litres of water/acre provided the effective control of sheath blight and brown spot in rice.
- Spray of Indoxacarb 14.5 SC @ 200 ml or Spinosad 45 SC @ 60 ml/acre at flower initiation stage was effective for the management of spotted pod borer in pigeonpea.
- Application of Bumper 25EC (propiconazole) and Orius 25.9 EC (tebuconazole) @ 200 ml/acre were effective for the management of sheath blight rice.
- For effective weed control in Napier Bajra, two hoeings should be done at 21 and 42 days after planting.
- Post emergence application of Parimaze 10 SL (imazethapyr) @ 180 ml/ha provided effective for the control of mixed weeds flora including grasses, broadleaves and sedges in soybean.
- Application of new brand formulations of Pendimethalin (Penda 30 EC @ 11itre /acre, Markpendi 30 EC@ 11itre /acre), Sulfosulfuron (Markosulfo 75 WG@ 13g /acre) and Clodinafop (Markclodina 15 WP@ 160 g /acre, Columbus 15 WP@ 160g /acre) were found effective for the control of *Phalaris minor* and of Sulfosulfuron + Metsulfuron (Markpower 75 WG@ 16g /acre) for the control of joint infestation of *P. minor* and broadleaf weeds in wheat.
- Application of 100 q/ha paddy straw mulch at the time of planting and if needed, one hand weeding at 3 months after planting was found effective for management of weeds in organic turmeric without straw mulch three hand weedings at 1, 2 and 3 months after planting are required.
- Application of Indoxacarb 14.5 SC @ 200 ml/acre provided effective for the control of tomato fruit borer.

# **Post Harvest Technologies**

- Packaging of bell pepper fruits in paper moulded trays followed by wrapping with heat shrinkable film or cling film improves shelf life, maintains quality and enhances consumer appeal under super market and ordinary market conditions for 10 and 7 days, respectively, as against 5 and 2 days with unpacked. This minimizes the postharvest losses of bell pepper during retail marketing.
- Winter season tomatoes, free from bruises and diseases, packed in plastic crates lined with newspaper can be ripened in 7-10 days in ventilated polyhouse conditions or ripening chamber (20°C temperature and 85-90% RH). The fruit attains uniform colour and quality during ripening.
- A bioprocess for production of debittered citrus juices and beverages using naringinase enzyme ( $\alpha$ -L-rhamnosidase and  $\beta$ -D-glucosidase), produced by yeast *Clavisporalusitaniae*, was developed.
- Scale up studies on grape (var. Perlette) vinegar at 50L revealed vinegar production in 27 days with a volatile acidity of 5.1% (w/v) and a recovery of 68%.
- Button mushrooms were efficiently processed into paste, which can be packed in plastic containers and polypropylene bags.

# Crop Production Technologies(2015-16)

- Real time nitrogen scheduling using leaf color chart (LCC) saved 12 kg N /acre in maize, and 6-20 kg/acre in wheat.
- Use of bio-fertilizers containing Arbuscularmycorrhizal fungi improved wheat yield.
- Application of consortium culture of *Rhizobium* (LSMR-1) and Rhizobacterium (RB 3) as biofertilizer in summer mungbean enhances grain yield.
- Drip irrigation in pea results in saving of 30% water over conventional method of irrigation. Fertigation helps save 20% fertilizer. 30 % higher yield with drip irrigation system as compared with conventional irrigation system.
- Drip irrigation with plastic mulch in brinjal results in saving of 50% water over conventional method of irrigation. Fertigation helps save 20% fertilizer. 40% higher yield with drip irrigation system as compared with conventional irrigation system.
- Use of consortium biofertilizers for maize and wheat was recommended @1.25 Kg/ha for seed treatment and for turmeric, onion and potato @10 Kg/ha as soil application for enhancing yield and improving health of soil.
- Sow the crop in the second fortnight of July for obtaining high grain yield.
- Raised bed planting of *kharif* mungbean and pigeonpea not only saves irrigation water but also saves the crop from adverse effect of heavy rains.
- The application of biozyme @ 8kg/acre at the time of sowing and again at the time of earlthing up followed by its foliar spray @ 200 ml/acre improves the yield of potato.
- To improve the germination of bittergourd seeds under optimal and suboptimal temperature, it should be soaked for 24 hour in Potassium dihydrogen orthophosphate 10<sup>-1</sup>M(13.6g/ litre of water) and then keep the seeds in moist gunny bags for 48 hours.
- Bud forcing is a technique to induce early scion bud break and faster growth of nursery of Kinnow and Kagzi lime and provides early saleable nursery plants.
- Mango can be propagated through wedge grafting from end-July to end-August on rootstock of same or greater diameter than the bud stick under open field or protected conditions.
- Wheat variety WH 1105 should be preferred over other varieties for sowing in poplar plantations. This should be sown in first fortnight of November for getting higher productivity.
- The fertilizer dose, timing and its method of application to plantations of clonal eucalyptus during different growth years were standardized for obtaining higher productivity from plantations.

#### **Plant Protection Technologies**

- Cotton IPM technology was disseminated in 47 villages of different districts of Punjab viz. Fazilka, Sri Mukatsar Sahib, Abohar and Mansa. The scouts from these adopted villages were trained in various aspects of IPM technology. Surveillance was also carried out on whitefly incidence in the cotton growing areas of Punjab.
- Large scale demonstration of temperature tolerant strain of *Trichogrammachilonis*, eight releases of *T. japonicum* and biocontrol based IPM technology for the management of early shoot borer, stalk borer and top borer in sugarcane, reduced their incidence by 54.1 to 60.2; 55.2 to 59.6 per cent and 52.31 to 54.4 per cent, respectively.
- Large scale demonstration of biological control of maize stem borer using *T. chilonis* rendered net returns over control of Rs. 8630/- as compared to Rs.10978/- in farmers' practice.
- Large scale demonstration of biocontrol based IPM in organic *basmati* rice resulted in lower incidence of yellow stem borer and leaf folder with higher cost: benefit ratio.

- The biocontrol based IPM module proved effective in minimizing the population of *Pierisbrassicae* on cauliflower and also enhanced the population build up of natural enemies in the field.
- MAK Bharat Petroleum Horticultural mineral oil @ 1.25% has been recommended against citrus psylla and citrus aphid on kinnow.
- Two sprays (first at boot stage and second after 15 days interval) with Nativo 75 WG (Tebuconazole+Trifloxistrobin) @ 80 g in 200 litre of water per acre are effective formanagement of sheath blight and brown spot of rice
- Indoxacarb 14.5 SC @ 500 ml/ha has been recommended against tomato fruit borer in tomato.
- Spray of indoxacarb 14.5 SC or spinosad 45 SC at flower initiation stage helps in effective management of spotted pod borer in pigeonpea.
- Eco-friendly management of fruit flies in mango orchards can be done by fixing PAU fruit fly traps @ 16 traps per acre in the 3<sup>rd</sup> week of May
- Yellow rust of wheat has emerged as a serious disease problem in the state, its occurrence and development during different months has been investigated and found that it initially appears in sub mountainous areas of the Punjab during December and January and then spreads to other areas in February. Management of yellow (stripe) and brown rust of wheat with sprays of Stilt 25 EC @ 200 ml in 200 litres of water per acre
- Bumper 25EC and Orius 25EC have been recommended for the management of sheath blight of rice; Compass 25EC and Markzole 25EC have been recommended for the management of yellow and brown rusts of wheat; Raxil60FS and Seedex 2DS have been recommended for the management of loose and flag smuts of wheat
- A potent isolate of *Trichoderma*bioagent has also been identified for managing muskmelon wilt and *Phytophthora*foot rot of kinnow
- Application of sulfosulfuron at 24.4 g/ha as early post emergence (14-21 days after sowing), before first irrigation, provides effective control of *P. minor* in wheat.
- Application of bispyribac-sodium at 25 g./ha at 15- 20 days after nursery sowing of rice provides effective control of mixed weed flora.
- Early post emergence application of Granite 240 SC (penoxsulam) at 25g a.i./ha applied at 10-12 DAT for effective control of weeds in transplanted rice.
- Post emergence application of Ricestar 6.7 EC (fenoxaprop) at 67.0 g a.i. / ha applied at 20-25 DAT for effective control of *Leptochloa* and *Ischaemum* weeds in transplanted rice.
- Post emergence application of Ricestar 6.7 EC (fenoxaprop) at 67.0 g a.i. / ha applied at 20 DAS for effective control of Leptochloa, *Dactyloctenium*, *Eragrostis*, *Digitaria* and *Echinochloa* weeds in direct seeded rice.
- Post-emergence application of sulfosulfuron 25 g, metsulfuron 5 g, sulfosulfuron + metsulfuron 30 g, pinoxaden 50 g, mesosulfuron + iodosulfuron 14.4 g and carfentrazoneethyl 20 g /ha, based on weed flora in the field, at 30-35 days after sowing wheat in autumn sugarcane-wheat intercropping system effective for control of annual weeds.

# Post-Harvest Technologies

- For advance marketing of summer crop, Baramasilemon can be degreened in 6-7 days at room temperature by dipping in 1250 ppm ethephon solution for 5 minutes.
- Mango fruits of Dusehri and Langra packed in CFB boxes with paper lining can be ripened at 25°C, five and four days after harvesting, respectively
- Punjab soft pear fruits dipped in calcium chloride (2%) for five minutes can be stored for 60 days at 0-1°C and 90-95% RH.
- Packaging of bell pepper fruits in paper moulded trays followed by wrapping with heat shrinkable film or cling film seems to hold promise in improving shelf life and maintaining the quality and enhancing the consumer appeal under super market and ordinary market

conditions for 10 and 7 days respectively as against 5 and 2 days in case of control (unpacked).

• Winter season tomatoes, free from bruises and diseases, packed in plastic crates lined with newspaper can be ripened in 7-10 days in ventilated polyhouse conditions or ripening chamber (20°C temperature and 85-90 % RH). The fruit attains uniform colour and quality during ripening.

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