

Large-scale implementation of IPM in basmati rice

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Extensive surveys of Basmati growing areas by National Research Centre for Integrated Pest Management (NCIPM) revealed excessive and injudicious use of pesticides and chemical fertilizers by farmers which aggravated the pest menace, secondary pest outbreaks, residue problems in grains, soil and water, environmental degradation and rejection of many export consignments. Among the insect pests, NCIPM has successfully validated integrated pest management (IPM) in Pusa Basmati 1, Taraori Basmati and Dehraduni Basmati in Uttar Pradesh, Haryana and Uttarakhand, respectively. Recently, the pest problem in Basmati rice has further been exaggerated due to appearance of bakanae [Gibberella fujikuroi (Fusarium moniliforme)] in a newly released variety, Pusa 1121, presently contributing highest area among different Basmati varieties. Crop loss due to bakanae was to an extent of 70% in a few fields. Inter-disciplinary team at NCIPM took up the challenge to address these problems through holistic IPM tactics. The technology was successfully validated in cluster of villages in Gautam Budh Nagar (around Bambawad village) in Uttar Pradesh.

Key words: Basmati, Integrated Pest Management, Rice

BASMATI rice is cultivated in about 1 million ha of northern states of India and fetches high price in domestic and export markets. The yield potential of commonly grown Basmati cultivars like Pusa Basmati 1, Taraori Basmati and Dehraduni Basmati is severely hampered due to substantial losses caused by biotic stresses as there is no inbuilt resistance in them to any of the pests. Among the insect pests, rice stem borer (*Scirpophaga incertulas*) is still the major rice field pest followed by rice leaf folder (*Cnaphalocrocis medinalis*), brown plant-hopper (*Nilaparvata lugens*) and white backed plant-hopper (*Sogatella furcifera*). Among the diseases, blast (*Pyricularia grisea*), brown spot (*Cochliobolus miyabeanus*), sheath blight (*Rhizoctonia solani*) and bacterial leaf blight (*Xanthomonas oryzae*) are the major diseases.

Selection of locations for IPM validation

Integrated Pest Management (IPM) validation trial was initiated at Baraut (District Baghpat, Uttar Pradesh) during 1997-98 in an area of 10 ha with Pusa Basmati 1. Selection of village was based on baseline information collected from the farmers which showed indiscriminate use of deadly poisonous chemical pesticides (phorate, endosulfan, etc.) to an extent of 4 to 6 sprays for suppression of insect pests and diseases. During 1999, trial was shifted to a nearby village, Shikohpur over an area of 40 ha which, in subsequent, years was extended to 120, 160 and 120 ha during 2000, 2001 and 2002, respectively. After the success of IPM validation at Shikohpur in Pusa Basmati 1, the technology was taken up to Haryana in Chhajpur Khurd (Panipat) village

with other Basmati variety i.e. Taraori local. At Chhajpur, a total of 28, 80 and 140 ha area was under IPM during *kharif* of 2002, 2003 and 2004, respectively. Gradually the technology by its own spread to 25 adjoining villages. Between 2005 and 2010, the technology was validated in Uttarakhand at Tilwari and Doodhali villages Dehradun in 40 and 25 ha, respectively, in Dehraduni Basmati (Type 3) and Kasturi.

During 2005, a high-yielding variety of Basmati i.e. Pusa 1121 was introduced by IARI, New Delhi and due to its higher yield, the variety became very popular among basmati growing farmers. However, the variety was highly susceptible to Bakanae disease. The problem became more serious due to increase in area under cv. Pusa Basmati 1121. Presently, this variety has spread over 84% of the total Basmati area in

Punjab, 78% in western Uttar Pradesh, 68% in Haryana, 30% in Uttarakhand, 8% in Jammu and Kashmir, and grown over 1,000 ha area in, Himachal Pradesh. To overcome the problem of Bakanae disease along with other pests, the IPM module was fine tuned and validated at two locations, Atterna and Sibouli (Sonipat, Haryana) in 40 ha each between 2006 and 2010. After achieving a great success, the technology was further extended in a cluster of villages (> 400 ha) between 2010 and 2016 in farmers' participatory mode at Bambawad and adjoining villages (district Gautam Budh Nagar, Uttar Pradesh).

Baseline information

- Stem borer, brown plant-hopper and leaf-folder were the major insect pests, whereas blast, bacterial leaf blight (BLB) and sheath blight were the major diseases of Basmati rice of the said area.
- Farmers did not grow *Sesbania* (*Dhaincha*) for green manuring.
- No seed treatment was carried out by farmers.
- During transplanting, only one seedling was transplanted at one place in Haryana and Uttar Pradesh whereas in Uttarakhand, 6-7 seedling were transplanted at one spot.
- Farmers, in general, applied high doses of nitrogenous (N) fertilizers than the recommended dosages in Haryana and Uttar Pradesh. On the other hand, very low dosages of fertilizers were applied in Uttarakhand. No Zinc (Zn) was applied by farmers.
- Farmers were not able to identify insect pests, diseases and natural enemies. No pest monitoring was undertaken.
- For pest management, farmers follow the advices of pesticide dealers and rely on chemical pesticides. The 4 to 6 sprays (average) of chemical pesticides were undertaken by farmers to overcome pest menace.
- Common pesticides used were phorate, fipronil, endosulfan, monochrotophos, dichlorovos, methyl parathion, dithane,

carbendazim etc.

- Farmers showed their unawareness about the IPM.

IPM-module validated

Based on the baseline information collected, a basic IPM module was developed taking into account the pest prevalence and the information available in the literature. The holistic IPM strategy was based on key agronomic components like incorporation of green manure (*Dhaincha/ mung*) in soil, balanced use of fertilizer with more emphasis on supplementation of potash (K) and application of zinc (Zn) and biotic stress management by augmentation and conservation of natural enemies, regular pest monitoring, use of bio-pesticides and need-based (Economic Threshold Level) application of chemical pesticides.

Impact of the technology

Decline in the infestation of insect pests and diseases: In all the IPM validation trials, incidence of insect pests and diseases remained low (Table 1) in IPM when compared with farmers' practices (FP).

Reduction in the application of chemical pesticides: Application of chemical pesticides in IPM fields was reduced to 0.92 sprays (53.65 g/ha) against 1.92 sprays (730.75 g/ha) in farmers' practice.

Conservation of beneficial insects: IPM helped in conservation of natural enemies. In all the IPM fields, population of spider adults was significantly enhanced. Spiders are the important predators of BPH, WBPH and eggs of LF and YSB.

Yield and benefit cost ratio:

Implementation of IPM resulted in a significant increase in the yield from 26.24 to 36.01 q/ha during 2010-2014, and 31.41 to 37.83 q/ha during 2014-2016. Benefit: cost ratio was also enhanced in IPM as compared to FPs amply of Basmati grains collected from IPM and FP trials at Bambawad for analysis of carbendazim, phorate and buprofezin indicated the maximum residue level (MRL) remained below the detectable level (< 0.001-0.05 µg/g) in all the samples.

Components leading to success of the programme

Organizing farmers' field school: Organizing farmers' field school (FFS) at 10-15 days interval is the most important step for dissemination of a technology. It helps in developing strong linkages among farmers scientists, and extension workers. As the crop grows, farmers get educated at different stages of the crop especially for identification of insect pests, diseases and beneficial insects. During FFS, all the farmers were informed about the IPM interventions therefore the chemical are applied only when needed.

Pest monitoring: Imparting training to a few progressive farmers on identification and recording insect pests and diseases in a data sheet at weekly interval helped the farmers in understanding the concept of Economic Threshold Level (ETL). The farmers are using the pheromone traps for monitoring the population of YSB moths. This process empowers the farmers to take their own decision for need-based application of pesticides. For success

Table 1. Pest incidence in IPM and FP in Pusa Basmati 1121 at different locations

Insect pest/disease	Atterna		Sibouli		Bambawad	
	IPM	FP	IPM	FP	IPM	FP
Stem borer (%)	3.0	6.5	2.62	10.9	0.99	2.98
Leaf folder (%)	6.5	10.0	5.5	8.53	1.33	3.33
BPH (No./hill)	17.5	35.0	8.09	25.67	3.28	8.89
Blast (%)	7.0	18.0	6.75	14.28	0.03	0.15
BLB (%)	5.0	9.0	4.17	10.5	0.6	1.61
Bakanae (%)	3.5	8.0	1	17.5	1.28	15.16
Brown spot	-	-	-	-	0.25	0.43
Sheath blight	-	-	-	-	0.01	0.06

(Atterna- 1 year, 2008; Sibouli- Average of 3 yrs, 2008-10; Bambawad- Average of 7 yrs, 2010-16) IPM, Integrated Pest Management; FP, Farmers' Practice

Crop stage-wise integrated Crop management (ICM) interventions

Crop stage	Target	ICM options (including crop management options)
Pre-kharif crop	Enriching soil nutrient	Sowing of green manure ' <i>Dhaincha</i> ' / <i>Mung</i> burying of green manure after 45-50 days after sowing/ <i>Mung</i> residues after picking of mature pods and puddling of field.
Nursery	Nursery beds for healthy nursery	Make raised beds of 10 × 1.5m ² for nursery sowing with a gap of 30 cm. Enrich with farmyard manure and apply recommended N,P,K
	Diseases	Use certified seed When farmers using own seed it should be treated with 2% salt solution for about 15 min., discard floating seeds and wash the heavy seeds. Seed treatment with carbendazim 50 WP @ 2g/kg seed
	Weeds	Hand-weeding
	Blast	Spray carbendazim 50% WP @ 250-500 g/ha or isoprothiolan 40% EC @ 750 ml/ha or tricyclozole 75% WP @ 300-400 g/ha
During transplanting	BLB	Spray of streptomycin sulphate 9% + tetracycline hydrochloride 1% SP @ 100-150 ppm
	Recommended doses	Basal fertilizer dose N:P:K :: 25:50:50 ; and application of ZnSO ₄ @ 25 kg/ha (after one week of P)
	YSB, hispa	Clipping of leaves
	Soil-borne diseases	Seedling root dipping in <i>Pseudomonas fluorescens</i> (3.0 × 10 ¹⁰ cfu; 5 ml/litre of water) for 30 min.
Early to late tillering	Uniform plant population	Planting 2-3 seedlings/hill; spacing row to row 20 cm and hill to hill 15 cm.
	Weeds	Hand weeding
	YSB monitoring	Fixing of pheromone traps @ 5 traps/ha
	Spider conservation	Fixing of straw bundle @ 20/ha for conservation of natural enemies
	YSB, LFSh.	Release of egg parasitoid, <i>Trichogramma japonicum</i> @ 1.5 lakh/ha (affixed as <i>Tricho</i> cards) (based on monitoring).
	BIBLB	Apply validamycin 3% litre @ 2,000 g/ha or hexaconazole 5% EC @ 1,000 ml/ha or propiconazole 25% EC @ 750 ml/ha or propiconazole 10.7% + tricyclazole 34.2% SE @ 500 ml/ha Draining-off water
		Spray streptocycline 100 to 150 ppm solution at early root stage (subjected to symptoms appearance)
	Blast	Remaining N in two split doses (30 kg/ha each) 30 days and 50 days after transplanting As above
Pre flowering till crop maturity	WBPH/BPH	Spray of buprofezin 25% SC @ 800 ml/ha, dinotefuran 25% SG 150 g/ha, ethofenoprox 10% EC @ 500-750 ml/ha or acephate 75% SP @ 666-1000 g/ha or As above
	YSB and LF	As above
	FS, Sh. BI	As above
	BLB	As above
	WBPH/BPH	Spray as above

*Application of chemical pesticide was based on the ETL level: YSB-2 egg-mass/m² or 10% dead heart or 1 moth/m² or 25 moths/trap/week; LF-2 Fully damaged leaves (FDL) with larva/hill; BPH- 10-15 hoppers/hill; BLB -2-3 infected leaves/m²; Sheath blight-Lesions of 5-6 mm in length and 2-3 infected plants/m²; neck blast 2-5 neck infected plants/m².

Note: In present trial no chemical was used against LF and YSB as the pest never crossed ETL but cartap hydrochloride 4% granules @ 18750 g/ha or cartap hydrochloride 50% SP @ 1,000 g/ha or monocrotophos 36% SL @ 625-1250 ml/ha may be applied as the last option if the pest crossed the ETL.

of an IPM programme, availability of quality input in their local market or block office is important requirement. In the present programme, state agricultural department personnel were also involved, therefore, with the help of state biocontrol laboratory, the bioagents were made available at Block office.

Communication: During implementation of IPM programme, the mobile numbers of rice team members of NCIPM were given to progressive farmers so that they can interact with scientists and seek proper advice whenever needed.

SUMMARY

Adoption of IPM technology empowered the farmers in following ways:

- They understood the role of crop management practices in IPM (like judicious use of fertilizers, growing of *Sesbania* for green manuring).
- They are able to distinguish between harmful and beneficial insects (earlier all insects were considered as pests by them).
- They are able to identify major diseases (there was confusion about identity).
- Farmers of these villages now

understand the role of monitoring and concept of ETL and carry out need based application of pesticides (earlier, mere presence of any insect or disease was enough to go for pesticide application).

- Decision making for release of parasitoids/ pesticide application (prior to IPM programme, farmers were applying the pesticides indiscriminately).
- Farmers now adopt only spot application.

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