INTEGRATED PEST MANAGEMENT IN BASMATI RICE

Basmati is a long-grain aromatic rice grown in several States of India and Pakistan. *Basmati* rice is cultivated in about 2.0 million hectares in India. In 2014-15, out of the total production of 8.70 mt of Basmati rice from 2.10 million hectares, 3.7 mt worth INR 275.979 billion was exported (Http://apeda.gov.in/apedawebsiteon 20Dec2015,1405hrsIST). Punjab and Haryana account for about 70 per cent of total Basmati grown in India (http: //www.business-tandard.comarticle/market/basmatirice-acreage-to-go-uo-despite-lower-realization last-year-115053271.html). The yield potential of commonly grown *Basmati* cultivars viz., Pusa *Basmati*-1, Taraori *Basmati* and Dehraduni *Basmati* is severely hampered by biotic stresses as there is no inbuilt resistance in them to any of the pests. Extensive surveys of *Basmati* growing areas by ICAR: National Research Centre for Integrated Pest Management (NCIPM) revealed excessive and injudicious use of chemical pesticides and fertilizers by farmers that aggravated the pest menace, secondary pest outbreaks, residue problems in grains, soil and water, environmental degradation and rejection of many export consignments. Recently, the appearance of bakanae in the widely cultivated, cv. Pusa 1121 has exaggerated the pest problem. An inter-disciplinary and inter-institutional team took up the challenge at NCIPM to address these problems through holistic IPM tactics. IPM strategies were synthesized and validated at village level in *Basmati* growing areas of Uttar Pradesh, Haryana and Uttarakhand.

Validation of IPM module

IPM validation trial was initiated at Baraut, Dist. Baghpat, UP during 1997-98 in an area of 10 ha with cv. Pusa Basmati 1. Selection of village was based on use of chemical pesticides (phorate, endosulfan, etc.) to an extent of 4-6 sprays for suppression of insect-pests and diseases. During 1999, the trial was shifted to a nearby

village, Shikohpur over an area of 40 ha which in subsequent years were extended to 120 and 160 ha during 2000 and 2001 seasons, respectively. After success of IPM at Shikohpur in Pusa *Basmati*1, the technology was implemented in 28, 80 and 140 ha area of Chhajpur Khurd village in Panipat, Haryana during kharif 2002, 2003 and 2004 respectively, in Taraori *Basmati*. Gradually the technology spread to 25 adjoining villages. During 2005 to 2010 the technology was validated in 40 and 25 ha in Tilwari and Doodhali villages of Dehradun, Uttrakhand respectively, in Dehraduni *Basmati* (Type 3) and Kasturi.

During 2005 the high yielding variety of *Basmati* cv. Pusa 1121 introduced by ICAR-IARI became very popular among farmers. However, this is highly susceptible to bakanae foot rot disease (*Fusarium fujikuroi*). Hence, IPM module was fine-tuned to overcome the problem of bakanae along with other pests. IPM package was validated in Atterna and Sibouli villages of Sonipat, Haryana, in 40 ha from each, during 2006-2010. The IPM module was further extended to a cluster of villages (350 ha) during 2010-15 in farmers' participatory mode at Bambawad and adjoining villages *i.e.* Aakilpur, Hassanpur, Mahawad and Rajatpur of Gautam Budh Nagar, Uttar Pradesh (UP). Spread of IPM in *Basmati* Rice is shown below.

Year	**UP**	**Haryana**			**Uttarakhand**		**U.P.**	**Area (ha.)**
	Shikohpur	Chhajpur	Dharampur	Attema & Sibouli	Tilwari	Doodhali	Bambawad	
2000								120
2001								170
2002								250
2003								340
2004								360
2005								376
2006								440
2007								450
2008								490
2009								490
2010								510
2011								570
2012								610
2013								685
2014								765
2015								830

A basic IPM module as a part of integrated crop management was developed accounting the pest prevalence and the information available from literature. IPM strategies were based on key agronomic components like in situ soil incorporation of green manure (Sesbania / Vigna radiata), balanced use of fertilizers with more emphasis on supplementation of potash, application of zinc, and biotic stress management by regular crop and pest monitoring, conservation and augmentation of natural enemies, use of bio-pesticides and need (economic threshold level) - based application of chemical pesticides.

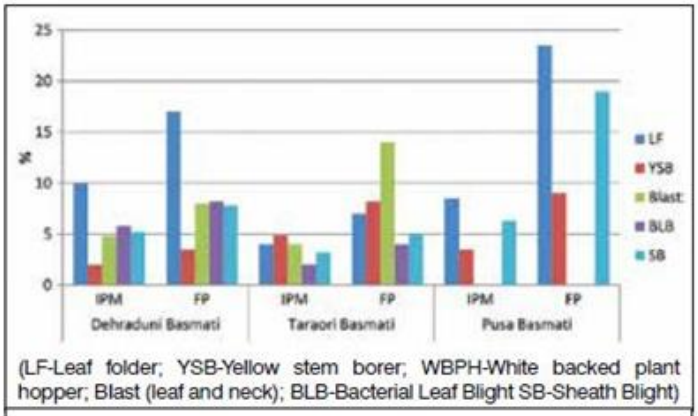
IPM strategies adopted as part of Integrated Crop Management

Crop stage	Target events/pests	IPM strategies (including crop management options)
Pre-*kharif* crop	Enriching soil nutrients	Sowing of green manure Sesbania/Vigna radiata. In situ trampling of green manure after 45-50 DAS after picking of mature pods Puddling of field
Nursery	Beds for healthy nursery	Nursery on raised beds of 10 X 1.5 sq. m. with a gap of 30 cm. FYM enrichment and use of recommended NPK
	Diseases Weeds	Use of certified seeds Soaking paddy seeds in 2% salt solution for about 15 minutes followed by discarding of floating seeds and washing the heavy seeds Seed treatment with carbendazim 50 WP @ 2g/kg Hand weeding
	Blast BLB	Need-based spray of carbendazim 50% WP @ 250-500 g/ha or isoprothiolan 40% EC @ 750 ml/ha or tricyclazole 75% WP @ 300-400 g/ha Need-based spray of streptomycin sulphate 9% + tetracycline hydrochloride 1% SP @ 100-150 ppm
Transplanting	Recommended dosages of fertilisers *Scirpophaga incertulas* (YSB), *Dicladispa armigera* (Hispa) Soil borne diseases(*) Uniform plant population Weeds	Basal fertilizer dose of N:P:K: 25:50:50; and application of ZnSO4 @ 25 kg/ha (after one week) Clipping of leaf tips of seedlings Seedling root dip in Pseudomonas fluorescens (3.0 X 1010 cfu; 5 ml/l of water) for 30 minutes Planting 2-3 seedlings/ hill with spacing of 20 and 15 cm between rows and hills, respectively. Hand weeding

Early to late tillering & Pre flowering till crop maturity	*S. incertulas* (YSB) Spider conservation YSB,*Cnaphalocrocis medinalis* (LF) Sheath blight (*Rhizoctonia solani*) BLB(*Xanthomonas oryzae pv. oryzae*) Blast(*Pyricularia oryzae*) WBPH (*Sogatella furcifera*)/BPH	Fixing of pheromone traps @ 5 traps/ha for monitoring Fixing of straw bundle @ 20/ha for conservation of natural enemies esp. spiders Release of egg parasitoid, Trichogramma japonicum @ 0.15 million/ha (affixed as Tricho cards) (based on pest monitoring). Apply validamycin 3% L @ 2000 g/ha or hexaconazole 5% EC @ 1000 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 at early root stage (subjected to appearance of symptoms) Remaining N in two split doses (30 kg/ha each) 30 and 50 days after transplanting As for sheath blight Spray of ethofenoprox 10% EC @ 500-750 ml/ha or acephate 75% SP @ 666-1000 g/ha or buprofezin 25% SC @ 800 ml/ha

Impact of the IPM strategy

In all the IPM validation trials, incidence of insect-pests and diseases remained low (Fig. 1; Table 1); whereas yield as well as benefit-cost (B-C) ratio remained higher (Table 2) in IPM as compared to farmers' practices (FP). Samples of *Basmati* grains collected from IPM and FP trials at Bambawad for residue analysis of carbendazim, phorate and buprofezin indicated the residual below (< 0.001-0.05 µg/g) Maximum Residue Level (MRL) in all the samples; this enabled the produce to fetch Rs 200/- per quintal more than the prevailing market price for *Basmati* rice



(LF-Leaf folder; YSB-Yellow stem borer; WBPH-White backed plant hopper; Blast (leaf and neck); BLB-Bacterial Leaf Blight SB-Sheath Blight)

Fig. 1 : Incidence of insect-pests and diseases in IPM and farmers' practices (FP) in different varieties of Basmati

Table 1: Pest incidence in IPM and farmers' practices (FP) in cv. Pusa Basmati 1121

Pest	Atterna		Sibouli						Bambawad									
	2008		2008		2009		2010		2010		2011		2012		2013		2014	
	IPM	FP	IPM	FP	IPM	FP	IPM	FP	IPM	FP	IPM	FP	IPM	FP	IPM	FP	IPM	FP

Yellow stem borer (%)	3.0	6.5	2.5	6.0	3.5	17.1	1.9	9.6	4.5	14.5	0.05	0.5	0.69	1.7	0.14	0.8	0.07	0.7
Leaf folder (%)	6.5	10.0	7.5	9.5	4.5	7.5	4.5	8.6	8.7	21.3	0.05	0.3	0.13	0.3	0.09	0.3	0.14	0.3
BPH (No./hill)	17.5	35.0	15.0	38.0	1.5	6.5	7.8	32.5	7.5	35.5	6.9	8.7	1.25	1.4	0.49	0.8	0.49	0.8
Neck blast (%)	7.0	18.0	9.5	18.5	7.3	16.5	3.5	7.8	-	-	-	-	-	-	-	-	-	-
BLB (%)	5.0	9.0	3.5	7.5	4.1	11.4	4.9	12.6	4.2	11.3	-	-	-	-	-	-	-	-
Bakanae (%)	3.5	8.0	3.0	9.5	Tr	19.6	Tr.	23.4	Tr.	28.3	5.5	17.8	3.34	14.71	0	19.0	0.05	9.8

Table 2: Yield levels and economics in IPM versus farmers' practices (FP)

Parameters	IPM						FP					
	1st yr	2nd yr	3rd yr	4th yr	5th yr	Mean	1st yr	2nd yr	3rd yr	4th yr	5th yr	Mean
Pusa Basmati 1 at Shikohpur (Uttar Pradesh) (2000-02)												
Mean yield(q/ha)	58.0	57.4	51.6	-	-	55.7	48.2	45.6	43.5	-	-	45.8
Benefit/cost ratio	3.2	3.2	2.2	-	-	2.8	2.3	2.1	1.6	-	-	2.0
Taraori Basmati at Chhajpur, Panipat (Haryana) (2002-04)												
Mean yield(q/ha)	28.3	26.7	26.2	-	-	27.1	22.2	22.1	22.6	-	-	22.3
Benefit/ cost ratio	3.5	2.1	2.8	-	-	2.8	2.3	1.4	1.9	-	-	1.9
Dehraduni Basmati at Tilwarai, Dehradun (Uttarakhand) (2005-06)												
Mean yield(q/ha)	21.2	24.3	-	-	-	22.7	18.1	19.8	-	-	-	19.0
Benefit/cost ratio	3.0	3.4	-	-	-	3.2	2.90	3.3	-	-	-	3.08
Pusa Basmati 1121 at Atterna, Sonipat (Haryana) (2008-10)												
Mean yield(q/ha)	41.0	-	-	-	-	41.0	35.8	-	-	-	-	35.8
Benefit/cost ratio	6.4	-	-	-	-	6.4	5.3	-	-	-	-	5.3
Pusa Basmati 1121 at Sibouli, Sonipat (Haryana) (2008-10)												
Mean yield(q/ha)	36.0	53.5	48.5	-	-	46	30.5	43.6	38.5	-	-	37.5
Benefit/ cost ratio	5.5	7.5	5.8	-	-	6.3	4.5	5.8	4.0			4.9
Pusa Basmati 1121 at Bambawad, Gautam Budh Nagar (Uttar Pradesh)(2010-14)												
Mean yield(q/ha)	33.2	33.9	39.8	34.6	38.5	36.0	16.2	20.9	33.2	27.7	33.2	26.2
Benefit/ cost ratio	3.8	2.4	3.6	5.2	3.5	3.7	1.8	1.4	2.8	3.6	2.2	2.3


Indian Council of Agricultural Research

ICAR Award for Team Research in Agriculture and Allied Sciences for the Biennium 2005–2006

The ICAR Award for Outstanding Interdisciplinary Team Research in Agriculture and Allied Sciences for the Biennium 2005-2006 is presented to

Dr. D.K. Garg, Dr. M.D. Jeswani, Dr. R.K. Tanwar, Shri Vikas Kanwar, Shri S.P. Singh, Dr. V.P. Singh, Dr. Ashok Mehta and Dr. O.M. Bambawale

for their outstanding research contribution in

Crop Improvement

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ICAR AWARDS FOR OUTSTANDING INTERDISCIPLINARY TEAM RESEARCH IN AGRICULTURE AND ALLIED SCIENCES FOR THE BIENNIUM 2005–2006

CITATION

The ICAR Award for Team Research for the Biennium 2005–2006 is given to Dr D. K. Garg and his team for developing holistic IPM strategy to improve and sustain productivity of Basmati rice.

Extensive surveys of Basmati-growing areas revealed excessive and injudicious use of pesticides by farmers which aggravated pest menace, secondary pest outbreaks, residue problems in grains, soil and water, environmental degradation and rejection of several export consignments. Many of the desperate farmers were contemplating shifting to other crops due to fear of crop failure. The holistic approach included IPM strategy of incorporation of green manure in soil, balanced use of fertilizers, regular monitoring and spot application of pesticides that increased mean yield of Basmati cultivars to 20.9% and benefit : cost ratio to 31.9%. The IPM implementation resulted in decline in pesticide applications from 4–5 sprays to less than one spray, resulting in low residue level in produce and also succeeding in restoring natural enemy diversity.

The research work was conducted at the National Centre for Integrated Pest Management, Pusa Campus, New Delhi.