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## Monetary Benefits of Integrated Pest Management in Soybean [*Glycine max* (L) Merrill] Cultivation

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### ABSTRACT

Results of the Participatory Rural Appraisal (PRA) conducted in four selected villages in Mhow Tehsil of Indore district revealed that the lower soybean productivity was associated with incidence of insect-pests, in general, and girdle beetle in particular. Based on this information, interventions of integrated pest management (IPM) were evaluated for a period of four years. The results revealed that manual removal of girdle beetle infested plants on initiation of infestation at weekly interval is an effective intervention for resource poor farmers. Adoption of IPM package [soil incorporation of phorate 10 G (@ 10 kg/ha) at sowing, use of seed treated with Bt (3 g/kg seed) and *Trichoderma viridae* (3 g/kg seed), installation of pheromone traps (5-6/ha) and need based spray of triazophos (0.8 l/ha)] enhanced seed yield (ranged between 40 and 24 %), net income (between 49 and 27.5 %) during year 3 and 4, respectively over farmers' practice. The adoption of IPM practices increased the average yield between from 1.65 t per ha to 2.40 t per ha with percentage increase from 24.16 to 26.73, during the four years of experimental trails.

**Keywords:** Economics, girdle beetle, , IPM, seed yield, soybean

Soybean [*Glycine max* (L.) Merrill] is a major oilseed crop of the country grown predominantly during the rainy (*kharif*) season in the Central India. The crop is primarily popular among millions of small and marginal farmers and has been instrumental in bringing socio-economic transformation in the farming community of Madhya Pradesh (Dupare, 2009). It is popularly known as 'Soy State' because of its significant share in area (>51%) and production (>55%) in the

country (Nahatkar *et al.*, 2017). However, the average productivity of soybean is hovering around 1 ton per ha since last decade. Among the major constraints, biotic stress particularly infestation with insect-pests warrants serious efforts on their management to optimize productivity.

Among the insect-pests infesting soybean and causing yield loss, girdle beetle (*Obereopsis brevis*) alone has been reported to damage the crop plants

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between 3.5 to 15 per cent (Bhosale *et al.*, 2014). More *et al.* (2014) reported that at 10 per cent level of girdle beetle infestation, the losses in seed weight per plant varied from 3.17 to 5.26 and 35 to 56 per cent at 35 and 56 days of growth, respectively. In Maharashtra, Ramesh Babu *et al.* (2018) reported the yield losses in different soybean varieties up to 45 per cent due to insect-pests. ICAR-Indian Institute of Soybean Research has carried out pertinent number of technological interventions in its adopted villages namely Borkhedi, Ambachandan and Katkakhedi in Mhow block, Indore district through its outreach programme and results are reported in this paper.

## MATERIAL AND METHODS

The IPM interventions in soybean were identified based on Participatory Rural Appraisal (PRA) technique. The IPM practices were evaluated in selected Bhagora, Borkhedi, Ambachandan and Katkakhedi villages in Mhow tehsil of Indore district (Madhya Pradesh) for consecutive four years during *kharif* seasons. The number of selected of farmers was 55, which was 10 more than as suggested by Choudhury (1999). Through PRA, the problem-cause analysis for low yield of soybean was assessed and it was recorded through matrix ranking. The matrix ranking was prioritized the problems faced by the farmers and used to analyze the possible causes for those problems with the help of team of scientists from research institutes. It was conceived that the low yield of soybean harnessed by the farmers are due to the following.

Problem	Rank
Increased incidence of pest and diseases	01
Non availability of seed of improved varieties	02
Lack of technical know-how on the improved package of practices	03

The incidence of girdle beetle, stem fly and other pests constituted the major culprits, which is due to non-adoption of proper pest management measures and mono-cropping of soybean. Accordingly, three practices of IPM module were evaluated to manage girdle beetle during first two *kharif* seasons and subsequently during next two *kharif* seasons, covering 55 farmers (2001-30 Nos; 2002 - 10 Nos, 2003-5 Nos; 2004-10 Nos). During first two *kharif* seasons, the three practices included were (i) two sprays of quinalphos on incidence of pest as per prevailing farmers' practice, (ii) soil incorporation of phorate 10 G (@ 10 kg/ha) at sowing followed by triazophos (@ 0.8 l/ha) at flowering, and (iii) manual removal of girdle beetle infested plant/plant parts twice at weeks interval soon after the infestation was observed. During subsequent two years, the two interventions were (i) two sprays of quinalphos at incidence of the pest as per prevailing farmers' practice, and (ii) soil incorporation of phorate 10 G (@ 10 kg/ha) at sowing, use of seed treated with *Bacillus thuringiensis*- Bt (3 g/kg seed) and *Trichoderma viridae* (3 g/kg seed), installation of pheromone traps (5-6/ha) and need based spray of triazophos (0.8 l/ha). The volume for the spray of the

insecticides used was 500 litre per ha. The farmers of the identified village depend only on indiscriminate use of chemical insecticide to control of insect-pests without much consideration of appropriate recommended insecticide, quantity and dilution. It was recorded that two sprays of quinalphos during the pest incidence was practiced by the farmers. The rainfall received during 1, 2, 3 and 4 years of intervention was 675.6 mm, 585.5 mm, 700 mm and 680 mm, respectively.

For economic evaluation of the interventions, the prevailing rates of inputs, farm operations and the cost of produce were utilized. The incremental cost benefit ratio (ICBR) was calculated as follows (Bang and Zhao, 2016).

$$\text{ICBR} = \frac{\text{Additional income (Rs/ha)}}{\text{Cost of intervention (Rs/ha)}}$$

The cost of cultivation was worked out for both, prevailing farmers' practices and implemented IPM practices. The cost of seeds, fertilizers, pesticides and other inputs were added as input cost. Similarly, the return of income received from through sale of soybean grains were calculated as gross returns. The cost of expenditure on inputs was deducted from gross returns to obtained net returns. Benefit cost ratio was worked out by dividing total gross income with total cost of cultivation. Further, the scientifically validated and approved interventions under IPM for soybean were implemented during *kharif* 2003 and 2004 and compared with prevailing farmers' practice.

## RESULTS AND DISCUSSION

Impact of intervention conducted during first two *kharif* seasons revealed (Table 1) that increase in seed yield of soybean due to chemical pest management over farmers' practice was 11.46 per cent, whereas in case of mechanical removal of girdle infested plant/plant parts twice at weeks interval was 34.2 per cent. The lower seed yield during second year (*kharif*) than first year (*kharif*) was on account of lower rainfall and its ill distribution during cropping season. Manual removal of girdle infested plants/plant parts twice in a weeks' interval was also effective in curtailing yield loss, whereas marginally higher yield than this treatment was observed in soil incorporation of phorate followed by spray application of triazophos at flowering. The two intervention also led to higher net income (Rs 1,283 and 873/ha; Rs 3,020 and 3,335/ha) and ICBR (2.86 and 3.18; 4.48 and 7.65) during first year and second year. The results indicated that mechanical removal of girdle beetle infested plant/plant parts twice at weeks' interval soon after the infestation was an effective strategy for resource poor farmers.

During the subsequent two *kharif* seasons, the IPM intervention such as soil incorporation of phorate 10 G (@ 10 kg/ha) at sowing, use of seed treated with Bt (3 g/kg seed) and *Trichoderma viridae* (3 g/kg seed), and need based spray of triazophos (0.8 l/ha) and installation of pheromone traps (5-6/ha) led to 40 and 24 per cent increase in seed yield over the farmers' practice during

**Table 1. Performance of IPM practices on seed yield and economics of soybean during first two *kharif* seasons (2001 and 2002)**

Intervention	Seed yield (t/ha)		Increases yield over farmers' practice (%)		Cost of intervention (Rs/ha)		Additional income (Rs/ha)		Net income (Rs/ha)		ICBR	
	<i>Kharif</i>	<i>Kharif</i>	<i>Kharif</i>	<i>Kharif</i>	<i>Kharif</i>	<i>Kharif</i>	<i>Kharif</i>	<i>Kharif</i>	<i>Kharif</i>	<i>Kharif</i>	<i>Kharif</i>	<i>Kharif</i>
	1	2	1	2	1	2	1	2	1	2	1	2
Two sprays of quinalphos on incidence of pest as per prevailing farmers' practice	1.44	0.84	-	-	-	-	-	-	-	-	-	-
Soil incorporation of phorate 10G (@ 10 kg/ha) at sowing followed by triazophos (@ 0.8 l/ha) at flowering	1.64	1.13	13.89	34.52	690	867	1973	3887	1283	3020	2.86	4.48
Manual removal of girdle beetle infested plant/plant parts twice at weeks interval as soon as the infestation was observed	1.57	1.13	9.03	34.52	400	500	1273	3825	873	3335	3.18	7.65

**Table 2. Impact of IPM application on seed yield and economics of soybean during subsequent two *kharif* seasons (2003 and 2004)**

Intervention	Seed yield (t/ha)		Cost of cultivation (Rs/ha)		Gross income (Rs/ha)		Net income (Rs/ha)		B:C ratio	
	<i>Kharif</i> 3	<i>Kharif</i> 4	<i>Kharif</i> 3	<i>Kharif</i> 4	<i>Kharif</i> 3	<i>Kharif</i> 4	<i>Kharif</i> 3	<i>Kharif</i> 4	<i>Kharif</i> 3	<i>Kharif</i> 4
Two sprays of quinalphos on incidence of pest as per prevailing farmers' practice	2.0	1.95	7000	7000	33400	32398	26400	25398	4.77	4.62
Soil incorporation of phorate10 G (@ 10 kg/ha) at sowing, use of seed treated with Bt (3 g/kg seed) and <i>Trichoderma viridae</i> (3 g/kg seed), installation of pheromone traps (5-6/ha) and need based spray of triazophos (0.8 l/ha)	2.8	2.42	7874	7874	47096	40253	39222	32379	5.98	5.11

third (*Kharif*) and fourth (*Kharif*) year, respectively. The net income due to IPM application was higher and ranged between Rs 32,379 and Rs 39,222 as compared to farmers' practice (Rs 25,398 to 26,400) for year 3 and 4. The incremental benefit:cost (B:C) ratio as well followed a similar trend.

The results of the interventions brought out that manual removal of girdle beetle infested plant/plant parts twice at weeks' interval soon after the infestation was observed to effectively manage the losses due to infestation of

girdle beetle, particularly for resource poor farmers with small and marginal holdings. Adoption of IPM package encompassing soil incorporation of phorate 10 G (@ 10 kg/ha) at sowing, use of seed treated with Bt (3 g/kg seed) and *Trichoderma viridae* (3 g/kg seed), installation of pheromone traps (5-6/ha) and need based spray of triazophos (0.8 l/ha) was found effective and helpful in managing the girdle beetle and other pests. It could optimize productivity and profitability of farmers addressing the environmental concerns as well.

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