Indian Journal of Extension Education
Vol.46, No. 1 & 2, 2010 (120-126)

Participatory Analysis and Evaluation of IPM Practices in Tomato

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ABSTRACT

Farmers participatory trials were conducted for two years in four villages of two districts to identify the constraints in tomato cultivation and to introduce IPM technologies and evaluate their effectiveness through demonstration. Farmers identified nine constraints of which, increased severity of pests like fruit borer, leaf miner, cut worm and diseases like damping off, leaf curl and blight were the most important. Performance of eleven tomato varieties from various sources evaluated by farmers at their own field revealed that variety "Best of All" was best in preference, followed by "FI Hybrid-7610". Implementation of IPM package involving Trichoderma, NPV, marigold, imidachlorpid, crop staking and poison bait led to nearly 50 per cent reduction in the usage of pesticides. In IPM plots, observation revealed reduction in severity of diseases like damping off (from 12.38 to 1.65 per cent), fusarium wilt (from 6.46 to 3.23 per cent) and blight (7.79 to 4.00 per cent) and incidence of insect pests like leaf miner (from 21.61 to 8.50), fruit borer (from 12.88 to 5.75 per cent) and cutworm (10.36 to 3.84 per cent) when compared with non- IPM practices, four important component viz. Trichoderma applicant in nursery and main field, imidachlorpid (in nursery- root dip treatment and in main field), application of NPV and use of marigold (trap crop), staking of plants and use of poison bait were of significant importance since their impact was perceived to be maximum by farmers. Among the farmers perceived advantage of IPM , reduced incidence of insect pests and diseases was ranked the first followed by less plant mortality which resulted in optimum plant stand in field. Partial budget analysis revealed that the IPM practices increased the profit margin by Rs. 5498/ha in IPM plots when compared with the non- IPM plots.

Vegetables are grown on less than three per cent of the total cropped area but users 17.16 per cent of total insecticide used in the country (Singh and Kalloo, 1999), yet pests, continue to be the major problem. Pesticide use by most of the farmers has created many unwanted ill effects in the Agro-ecosystem. This warrants a need to bring in more protection technologies that are relevant , sustainable, eco –friendly and with in the reach of farmers. IPM is one of the strategies that addresses pesticide related problems therefore, it needs to be introduced, demonstrated and evaluated for popularization. Most of the technologies to be implemented at farm level need to location specific and users friendly. Mahapatra (1992) states that only 0.5 to one per cent of the available technology in the horticultural sector have reached the farming community in coastal area in Orissa. Tomato is grown in large scale throughout Orissa where in fruit borer, leaf miner, cutworm, wilt and damping- off have been reported to be key biotic stresses. Biotic constraints can be overcome by introduction and evaluation of IPM technologies with farmers participation and as such, the production and productivity of crops can be enhanced (Ooi, 1998). Indonesian model of IPM training and demonstration has shown that farmers can design and conduct experiments at their own fields to evolve management techniques for minimizing the damage by pests. The present work was initiated with a view to assess the constraints in tomato cultivation and to introduce,

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demonstrate and evaluate the efficacy of IPM technologies with farmers' participation in Coastal Orissa.

METHODOLOGY

Four villages from two coastal districts of Orissa namely Puri and Cuttack, were selected for the study. On the basis of their willingness, ten farmers from each village were selected for participation in programmes at the onset of the study. A list of constraints faced by tomato growers was prepared during village meetings and on the basis of group consensus data, 10 constraints were short- listed and ranked using Rank Based Quotient (RBQ) as given in the following formula (Sabarathnam, 1998):

$$R.B.Q.= [(\sum_{i=1}^{n} fi(n+1-I)/Nn)]\ 100$$

Where f_i is the frequency of respondents for the ith rank of a constraint; N and n denote the number of respondents and number of constraints, respectively. 'I' denotes the rank of the constraint.

While selecting a suitable variety out of many varieties of tomato available with the shopkeepers, farmers' choice usually depends mainly on shopkeepers' advice or sometimes on fellow farmers' suggestions. The target area is prone to bacterial wilt and no effective tool is available for the management of wilt except resistant varieties. Therefore, to identify a suitable variety for the region, a farmers participatory varietal evaluation trial was conducted including the varieties popular among farmers. All varieties (Table -3) were grown following uniform agronomic and cultural practices. The varietal selection parameters were identified in consultation with the growers. All 40 growers ranked the tomato varieties on 5 parameters i.e Most preferred (3), preferred (2) and Not preferred (1). The selected best variety was cultivated with an IPM package next year in two villages.

The IPM trial was conducted with Utkal Kumari (Bt- 10), a bacterial wilt resistant variety in first year and "Best of All" (found best in trial) in second year. African marigold nursery was raised 20 days before tomato nursery. Tomato nursery area was solarized using back polythene mulch, raised and added with Trichoderma enriched FYM, one week before sowing. Nursery was sprayed with imidaclorpid (0.3 ml/l) at 15 days after sowing (DAS) and again treated by root dipping for 5 minutes before planting. Fields were prepared using standard agronomic practices. One tonne of FYM, contributed by participants, was enriched with Trichoderma, 15 days prior to field application as per standard methodology (Krishna Moorthy et al., 2003). At the time of last ploughing this enriched FYM was shared by farmers and mixed with the rest quantity of FYM and applied in the field. Twenty five days old tomato and 50 days old marigold seedling were transplanted simultaneously in a pattern of one row of marigold after every 16 rows of tomato. At 15 DAP, imidachlorpid (0.3 ml/L) was sprayed and leaf curl and other virus affected plants were destroyed with the appearance of the symptoms. At 20 DAP, neem cake @ 250 kg/ha was applied in furrows. NPV (250 LE/ha) was sprayed at 28 DAP and thereafter repeated twice at one week interval. Endosulfan 2ml/lt was sprayed once in first year and twice in second year. In addition, fungicide was applied thrice in first year and twice in second year.

Tomato is normally cultivated without staking in the area. At fruiting stage the crop becomes heavy, clumsy and shady at ground level which provides ideal hiding place for cut worm (Spodoptera) and enables it to escape from the insecticide spray. Thus , even frequent spray becomes ineffective and damage by the cutworm is very high. In order to overcome the problem, staking of tomato plants was done and poison bait applied. Poison bait was prepared by using jaggery, rice bran and monocrotophos as per methodology standardized at IIHR, Bangalore (Krishna Moorthy et al.,2003). The bait prepared in the morning was sprinkled in tomato field uniformly in the evening. Simultaneously, non- IPM plots were maintained and all the plant protection practices adopted by farmers were recorded. Incidence of diseases, insect pests, number of sprays and yield were recorded in both the plots. During the study over two years period , a total of 19 training farmers to impart knowledge on identification of insect- pests, diseases and various IPM practices.

On the basis of group consensus weighted rank of various IPM practices was also calculated. At the end of the two IPM cropping season, a meeting was convened with all the tomato growers in the village. The probable impact and advantages of IPM in tomato were discussed. Growers were asked to note down all IPM practices and their impact as

perceived by them (Table- 5). On the basis of visible impact and perceived benefits, farmers ranked the IPM practices on a four point weighted rank (Table- 1).

On the basis of significance of impact, advantages and farmers' experience, critical IPM components were ranked (Table 6). Advantage of IPM as perceived by farmers were ranked using a three points scale of Most important (3), important (2), and Not important (1). Finally the importance of advantage was worked out as Mean score of each IPM practices =

$$[(\sum_{i=1}^{n} Si/3N)]$$

Where S = Score given by each farmer , N = total number of farmers and 3 is the maximum score for each advantage.

Partial budget analysis was also done to work out the economics of IPM of tomato on per hectare area basis.

Table 1. Weighted rank of IPM practices as perceived by the farmers

Advantage as farmersperceive	Stars to be given
Very high	****
High	***
Low	**
None	*

RESULTS AND DISCUSSION

Constraints in tomato cultivation as perceived and prioritized by the farmers are presented in Table-2. Increased severity of pests with special reference to fruit borer, leaf miner and cut worm and, diseases like leaf curl and early and late blight was one of the most Important problems that farmers were facing in thearea. Poor knowledge of pest and disease, IPM practices and non-availability of pest and disease resistant varieties led to higher losses. Although bacterial wilt was a major problem but now with the availability of bacterial wilt resistant varieties, the problem is solved to a great extent. Cost of inputs such as labour, fertilizer, seed and pesticides is high and many times there becomes the shortage of fund but sources of finance are manager.

Eleven Varieties /Hybrids were evaluated for performance. Observation on Arka Saurabh and Swarna vaibhav varieties were not recorded in the evaluation trial due to heavy mortality caused by bectarial wilt. Thus the performance of the only nine varieties was ranked based on the five parameters (Table 3). On the basis of performance with special reference to fruit shape, fruit size, fruit firmness, fruit yield and wilt resistant, the variety "Best of All" was found to be the best followed by "F1 Hybrid 7610".

It is evident from the quantitative data on performance of IPM (Table 4).that there was considered reduction in the usage of insecticides and fungicides in the IPM plots when compared with non- IPM plots. The frequency of pesticides application was reduce to two or three times from five or seven applications of insecticide an four application of fungicides. The reduce need for pesticide application ,in itself, was observed to be a good achievement as it may directly address the residue problem and in hence the activity of natural predators making the IPM intervention more sustainable in the long run. There was reduction in the incident of disease like damping of (1.65 %) , bacterial wilt (3.23%) and blight (4.0%) in IPM plots when compared to non- IPM plots (12.38%,6.46%, and 7.79% ,respectively). Seed as an input is very costly therefore, each seedling is costly. Mortality due to damping of nursery can severely affect their cost of production and reduce the acreage. Present intervention reduced damping of from 12.38 to 1.65 per cent which enabled the farmers to sell the additional seedling for extra income. There was considerable decrease in the incidence of leaf miner (8.50 %) and fruit borer (5.75%) in IPM plots when compared with non- IPM plots (21.61% and 12.88% respectively).

Table 2. Constraints in tomato cultivation as perceived by participants

Sl. No.	Factors	RBQ Values	Rank
1.	Heavy loss due to pest and disease like leaf miner, fruit borer, leaf curl, blight etc.	93.1	I
2.	Poor knowledge of pests and diseases and IPM practices and non- availability of pest and disease resistant varieties.	88.5	II
3.	High cost of labour, fertilizer, seed and pesticides	81.3	III
4.	Shortage of timely advise in emergency	77.6	IV
5.	Shortage fund and meager sources of finance	77.1	V
6.	Imbalance fertilizer dosage	73.1	VI
7.	Shortage of irrigation water and salty water	63.4	VII
8.	Wide fluctuation in price of the produce and too low price at the time of glut	51.2	VIII
9.	Natural calamities especially at the time of transplanting	19.3	IX
10.	Non- availability of organic and bio pesticides (Soaps, Neem seed powder, Bt, NPV etc.) at the district level	11.1	X

Table 3. Performance of tomato varieties at farmer field as evaluated by farmers.

Sl. No.	Variety	Bacterial wilt	Fruit shape	Fruit size*	Fruit Firmness	Marketable yield (t/h)	Mean score	Rank
1.	Arka Saurabh	Susceptible	Round nipple tipped	Medium	High	**		Not Ranked
2.	Arka Abha	Resistant	Round	Medium	Medium	27.00	0.89	9
3.	Arka Alok	Resistant	Round	Large	High	33.00	0.76	4
4.	Utkal Kumari (Bt -10)	Resistant	Round	Small	Good	27.50	0.69	8
5.	Hybrid – 7610 (F1)	Resistant	Round	Large	Good	35.00	0.85	2
6.	Jyoti	Partially resistant	Round	Medium	Medium	31.00	0.64	5
7.	Best of All	Resistant	Round	Large	V. Good	36.00	0.98	1
8.	Swarna Naveen	Resistant	Oblong	Small	Good	29.50	0.61	7
9.	Swarna Lalima	Resistant	Round	Large	Good	30.00	0.55	6
10.	Swarna Samridhi	Resistant	Round rectangular	Medium	Good	34.50	0.53	3
11.	Swarna Vaibhav	Highly Susceptible	----	----	----	**		Not Ranked

* Small < 70 g, medium > 70 and < 100 g, Large > 100 g

**There was high mortality due to bacterial wilt ; hence observation on yield was not recorded.

Growing of marigold as a trap crop along with application of NPV (250 LE/ha) at 15 days interval in tomato has been recommended for control of Tomato fruit borer (Anon., 1999). Results revealed that staking and application of poison bait reduced cutworm damage 2.84 percent in IPM plots when compared with Non- IPM plots (10.36%) which was also evident from the visual impact on dead larvae in the field after two to three days to bait application. As a result of all IPM intervention packages put together the estimated marketable fruit yield in IPM plots was increased over non- IPM plots by 4.45 t/ha (Table – 4).

Over all impact analysis revealed Trichoderma application in nursery and main field had impact on disease incidence and led to the saving on seed cost. Imidachlorpid application in nursery, seedling root dip and main field had great impact on leaf miner. This led to the reduction in incidence of pest in nursery and negligible incidence of leaf miner in main field. Use of NPV and trap crop of marigold reduced the incidence of fruit borer in main field which is supposed to minimize health hazards due to reduction in frequency and quantity of insecticide sprays. Further, the cost of insecticides and its spraying was saved. Staking was very effective in managing the cut worms as it created open space and larvae were exposed to poison bait due to non- availability of hiding place. Due to availability of limited space for hiding, cut worm larvae were congregated within a limited area near by root zone of tomato plants . Application of poison bait within a limited space near root zone in a concentrated manner was effective in killing maximum larvae. There were nine advantage of implementation of IPM as perceived by Farmers (Table -5 & 6). Reduced incidence of insect pests and diseases was the most visible advantage followed by less plant mortality and optimum plant stand in field. Evidently, farmers were more concerned about pest problem and rated it as the first advantage and increased yield as third advantage. Obviously farmers' participation in the programme led to better understanding of IPM tools , impact and advantage of IPM program. Net income of farmers increases in Participatory Pest Management intervention programme. Participatory IPM programmes have been reported to be implemented successfully in many countries like China (Wage, 1998) ; sub- Saharan Africa (Huis- A- Van et al, 1997) and Philipines (Stock, 1996).

The economic analysis for cost and monetary return of IPM over non IPM indicated that IPM components like Terichoderma, neem cake, NPV, imidachlorpid, staking, marigold and poison bait led to the increase in the production cost to the tune of Horticulture – Government of Orissa and Central Integrated Pest Management Centre (CIPMC), Bhubaneswar - Government of India for their help during the study . Authors extend their warm gratitude to selfless tomato growers who participated in the programme willfully.

Table 4. Performance of IPM field as against Non- IPM Field

Sl. No.	Particulars	IPM 2004	IPM 2005	Average	Non- IPM 2004	Non- IPM 2005	Average
1.	Frequency of insecticides	2	3	2.50	7	5	6.00
2.	Frequency of fungicides	3	2	2.50	4	4	4.00
3.	Leaf miner in nursery (% leaf affected)	1.31	3.35	2.33	6.23	8.14	7.18
4.	Leaf miner in main field (% leaf affected)	9.50	7.50	8.50	25.00	18.25	21.61

5.	Fruit borer (% fruit damaged)	6.15	5.36	5.75	11.52	14.23	12.88
6.	Cutworm (% fruit damaged)	3.32	2.35	2.84	9.36	11.36	10.36
7.	Incidence of damping off in nursery (%)	1.5	1.8	1.65	11.42	13.34	12.38
8.	Wilt (% plant affected)	3.21	3.24	3.23	6.54	6.37	6.46
9.	Alternaria blight (% leaf affected)	4.34	3.67	4.00	8.26	7.32	7.79
10.	Marketable Yield (t/ha)**	26.00	37.50	31.75	23.00	31.60	27.30

*Based on data from 15 plots, ** Marketable yield denotes fruits free from bore holes and damage symptoms.

Table 5. Impact of IPM practices as perceived by farmers

Sl. No.	Practices	Advantage from farmers point of view as per importance	Weighted Rank
1.	Terichoderma application	• Reduction in seedling mortality in nursery and low incidence of wilt in main field (1) • Saving in seed cost (2)	Very high (****)
2.	Imidachlorpid in nursery, main field and seedling root dip as prophylactic measure	• Less incidence of pest in nursery (1) • Very less incidence of leaf miner (2) • Preplanned spray, without waiting for the pests (3)	High (***)
3.	Use of NPV and marigold trap	• Low incidence of borer (1) • Saving in cost on insecticides (2) • Health hazard while spraying in reduced due to NPV (3)	Very high (****)
4.	Stacking and poison bait	• Larvae were exposed as they did not have place to hide (1) • Poison bait could kill even big size larvae (2)	Average (**)

CONCLUSION

On the basis of above study it is concluded that the tomato variety “Best of All” was best in performance followed by “F1 Hybrid -7610”. Implementation of IPM package involving Trichoderma, NPV, marigold, imidachlorpid, crop staking and poison bait led to nearly 50 per cent reduction in the usage of pesticides. Among the farmers perceived advantage of IPM, reduced incidence of insect pests and diseases was ranked the first followed by less plant mortality which resulted in optimum plant stand in field. Partial budget analysis revealed that the IPM practices increased the profit margin by Rs. 5498/ha in IPM plots when compared with the non- IPM plots.

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