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Demonstration on Management of Tomato Pinworm (*Tuta absoluta* L.) in Khammam District of Telangana, India

V. Chaitanya[1], J. Hemantha Kumar[1], B. R. Madhushekar[2], Jessie Suneetha,W[1], K. Ravi Kumar[1], PSM Phanisri[1], D.Nagaraju[1], R. Umareddy[3] and JV Prasad[4]

[1]Krishi Vigyan Kendra, Wyra, Telangana State, India
[2]DAATT Centre, Yadadri Bhuvanagiri, Telangana State, India
[3]Regional Agricultural Research Station, Warangal, Telangana State, India
[4]Agricultural Technology Application Research Institute, Zone –X, Hyderabad, India

Abstract

The front - line demonstrations were conducted in 30 farmer fields during three consecutive year's i.e 2019-2021 in Khammam district. In tomato cultivation pinworm was major pest especially during summer months. For management of these pest the following IPM practices were suggested to farmers i.e the installation of pheromone traps, collection and destruction of infested parts and spraying of Azadirachtin 10000 ppm 2-3 ml/lit 30 days after transplanting. Spraying of Emamectin Benzoate @ 0.4 g/ lit 10 days after first spray. Spraying of Rynaxpyr @ 0.3 ml/lit 10 days after the second spray was effective. The mean of the parameters in 30 demonstrations during three years (pooled) revealed that the percentage of leaf damage was 9.98% in demo field and 19.85 % in farmers' practice. The percentage of fruit damage 13.21% in demonstrated plots whereas 22.57% in case of check plots. Average fruit weight was high in demo plots i.e 65.11g when compared with check plots i.e 52.71 g. Higher marketable fruit yield (60.08 t/ha) and 9.95 % yield increase were noted in the demo field over farmers practice (54.67 t/ha) with a benefit -cost ratio of 2.68:1 and 2.23:1, respectively. It also observed that higher gross returns (430450/ha) and net returns (269552/ha) were recorded in the demo field than farmer's practice (395250 /ha and 218336/ha, respectively). The technology gap and extension gap enumerated from this study ranged 10.93 t/ha to 18.88 t/ha and 4.12-6.74 t/ha respectively with the technology index of 19.89 % during an average of three consecutive years. The pinworm incidence was high during March. The results clearly showed that the positive impact of front-line demonstrations over farmer's practices towards increasing productivity and reducing the cost of cultivation of tomatoes.

Keywords: *Tomato, Front line demonstration, pinworm, technology gap, technology index, extension gap*

Introduction

Tomato leaf miner or tomato pin worm, *Tuta absoluta* (Meyrick) is a serious pest on tomato (*Solanum lycopersicum*) in several nations in Latin America and the Mediterranean basin [3]. The aggressive nature of the pest, multi voltine character, short generation time, high biotic potential and augmented resistance to insecticide use are the motives for its key pest status in the new areas. It is a novel invasive pest and established in the Malnad and Hyderabad-Karnataka Regions of Karnataka, India and come into Telangana during November 2014. Crop loss to an extent of 50-60% in tomato was reported by [8] [5]. The primary host of *T. absoluta* is tomato, but it has been reported on other secondary hosts like brinjal (*Solanum melongena* L.), pepper (*Capsicum annuum*), potato (*Solanum tuberosum* L.), sweet pepper (*S. muricatum* L.) and tobacco (*Nicotiana tabacum* L.). It causes losses in yield and fruit quality, 50% to 100% loss in either greenhouses or fields, if control measures are not applied [2]. Plants are dented by direct feeding on leaves, stems, buds, calyces, young fruit or ripe fruit and by the invasion of secondary pathogens which enter through the wounds made by the pest. Introduced populations are probably resistant to the

*CorrespondingAuthor: Dr. V. Chaitanya
E-mail Address: chaitanya.hortico@gmail.com
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various groups of insecticides and basic studies like population dynamics, life cycle and reproductive biology are need of the hour to provide the information for devising management strategies [15] [4]. Keeping in view the above considerations, the present investigation was undertaken.

At present, In India, tomato is grown over an area of 8.30 lakh ha with an annual production of 203.00 lakh MT and productivity of 24.44 MT/ha [1]. In Telangana state 25 thousand ha with an annual production of 682 thousand MT and productivity of 27.28 MT/ha. In tomato growing blocks of Khammam district field survey was accompanied for the prevalence of the pest and its severity. For pinworm control, farmers are chiefly depending on synthetic insecticides and their indiscriminate use resulting in the expansion of resistance in target pests and destructive pesticide residues on fruits.

The FLD is a significant method of transferring of latest technology to farmers and the main objective of this programme is the demonstration of proven technologies of crop production and protection in large scale under real farming conditions in the farmer's field under diverse agro-climatic regions [10]. Hence, the contemporary study has commenced to study the difference between demo package and farmer's practices in pinworm management of tomato and to assess the effect of the frontline demonstrations in tomatoes for pinworm control by adopting the integrated pest management practices.

Materials and Methods

Field demonstrations carried out on integrated pest management strategies for management of pinworm in tomato at farmer fields of KVK, Wyra operational areas in tomato cultivating blocks and villages of Khammam district of Telangana state, India particularly Raghunadapalem, Khammam urban mandals and other tomato growing villages for three sequential years i.e 2019-20, 2020-21, 2021-22 during *kharif* season in an area of 24 ha in 30 selected farmer fields with intent to improves the knowledge on pin worm identification and management in tomato.

Farmer's selection was done based on farmer's participatory mode by KVK Scientists in tomato growing blocks for executing management modules against pinworm in the field. Each frontline demonstration was placed out on 0.4 ha area which was taken as demo while an adjacent 0.4 ha was taken as a control for comparison of farmer's practice. For the demonstration plot trellising along with all the suggested package of practices like installation of pheromone traps, spraying of neem oil and other need based chemicals. The traditional practices were taken as a control. In general, soils of the area under study were sandy to sandy loam with low to medium fertility status, and the average annual rainfall of this area is 1036 mm and temperature varies from 24 to 43°C with average temperature of 30°C.

Installation of pheromone traps

Pinworm adult population was observed immediately after transplanting of the crop. Pheromone traps were erect 0.5 m above the crop height. Five traps were installed earlier and the lure was altered every 4 weeks. Pest incidence was perceived regularly throughout the crop period.
IPM module was followed in demonstrated plots. Details of demonstrated and control plot was given in Table 1.

Table 1: Details of practices on management of pinworm in tomato

S.No	Demo	Check (Farmers practice)
1.	Removal and destruction of infested plants and alternate Solanaceous crops/ host with insect stages in the nursery and early stages both for monitoring. Integrated module: Installation of pheromone traps (10 per acre) Collection and destruction of infested parts. Spraying of Azadiractin 10000 ppm 2- 3 ml/lit after 30 days after trans-planting Spraying of Emamaectin Benzoate @ 0.4 g/ lit 10 days after first spray. Spraying of Rynaxpyre @ 0.3 ml/ lit 10 days after second spray was effective. In areas where Tuta incidence is high spray with Spinosad 45 SC @ 0.25 ml/l or Flubendiamide 480 SC @ 0.2 ml/l rotation at 2-3 weeks intervals. Coinciding with the peak emergence of the Tuta adults, a spray of deca-methrin 2.5 EC @1 ml/lit for killing adults.	Spraying of profenofos @ 2ml/lit and spinosad @ 0.25ml/ lit after pest occurance. Pheromone traps were not installed

The data on the pest incidence in the demo and check

Table 2: Level of use and gap in adoption of tomato pinworm technologies in the study area

S. No	Integrated pest management practices for pinworm management	Level of adoption	
		FLD farmers	Non FLD farmers
1	Nurseries should be monitored as it starts from the nurseries	Adopted	Not adopted
2	Raise the tomato seedlings under nylon net (200 mesh size)	Adopted	Not adopted
3	Seedling root dip in Imidacloprid 17.8 SL @ 0.3 ml/l at the time of transplanting.	Adopted	Not adopted
4	Removal and destruction of infested plants and alternate solanaceous crops/ host with insect stages in nursery and early stages both for monitoring.	Adopted	Not adopted
5	Installation of Pheromone traps @ 10/acre for mass trapping with Tuta lure fixed at 2 feet height from the ground at the time of transplanting	Adopted	Not adopted
6	Mechanical Collection and destruction of infested parts.	Adopted	Not adopted
7	Spraying of Azadirachtin 10000 ppm @ 2 ml per lit of water at 30 days after transplanting	Adopted	Not adopted
8	*Tuta* incidence is high spray with Spinosad 45 SC @0.25 ml/l or Flubendiamide 480 SC@0.2 ml/l rotation at 2-3 weeks interval.	Adopted	Adopted but only after pest incidence became high
9	Coinciding with the peak emergence of the Tuta adults, Spray of decamethrin 2.5 EC @1 ml/l for killing of adults.	Adopted	Not adopted

plots were recorded. The data on the percentage of fruit damage was recorded from each plot at each picking until the last picking. Percent pinworm incidence on fruits was computed on the based on the total number of fruits per plot.

Pinworm incidence (%) = Number of fruits infested/ Total number of fruits ×100

The data of yield, pest management, production cost, and returns were collected by KVK scientists with frequent field visits during 2019-2021 from demonstration plots and farmers practice plots (control plot) and finally calculations were done as per the formula suggested by [13].

In the present study, data on yield, yield attributing characters, pest incidence, production costs, and gross returns, and data on gaps between the potential yield, demonstration yield, extension gap, technology gap and technology index were collected from demonstrated plots and local check plots of tomato for analysis and data interpretation. The statistical tools to estimate the technology gap, extension gap, and the technology index, the formulation as mentioned below was used as suggested by [13].

Per cent increase in yield = Demonstration yield - Farmers practice yield X 100 /Farmers practice yield

Technology gap = Potential yield – Demonstration yield

Extension gap = Demonstration yield - Yield under existing practice

Technology index = Potential yield - Demonstration Yield X 100 /Potential yield

Results and discussion

Adoption of improved practices in tomato crops from Table 2 shows that all the FLD farmers fully adopted the recommended package of practices with slight modifications.

A comparison of productivity levels between IPM practices in demonstration fields and farmers practice fields is shown in Table 5. The results indicate that relying singly on pesticides cannot control the pest and the adoption of integrated pest management strategies were effective in reducing the fruit damage caused by *Tuta absoluta* as there is the increase in yields in demonstration plots over farmers practice.

The perusal of data (Table 3) indicate that due to initiation of front line demonstrations in tomato % leaf damage was ranged from 9.98 to 13.21 in demonstration plots and from 19.85 to 22.57 in farmer's practice plot in three years of demonstrations conducted. An average leaf damage % 11.78 was obtained under demonstration plots as compared to farmer's practice plots 20.96% consecutively.

Table 4: Cost economics of FLD on Management of pinworm in tomato

S. No.	Parameters	2019-20		2020-21		2021-22		Pooled data	
		Check	Demo	Check	Demo	Check	Demo	Check	Demo
1	Gross cost	145000	132750	196592	174242	189150	175702	176914	160898
2	Gross returns	360350	394650	426840	456200	398560	440500	395250	430450
3	Net returns	215350	261900	230248	281958	209410	264798	218336	269552
4	B:C ratio	2.49:1	2.97:1	2.17:1	2.62:1	2.11:1	2.51:1	2.23:1	2.68:1

The percentage of fruit damage ranged 5.68 to 8.29 in demo plots and it was varied from 11.99 to 20.22 in check plots in three years of demonstrations conducted. An average fruit damage % of 14.92 was obtained under demo plots as compared to check plots 6.78% in consecutively.

The cumulative outcome of the demonstrated package over three years shown an average fruit weight of 65.11g compared to fruit weight in farmers practice is 56.02 g. The fruit yield per ha under demonstrated package was 64.07, 60.05 and 56.12 in demonstration plots compared to 57.33, 55.93, and 50.76 t/ha in control plots during 2019-20, 2020-21, and 2021-22 respectively. The cumulative effects of technological interventions over three years revealed an average fruit yield of 60.08 t /ha compared to 54.67 t/ha in control.

An average 9.95% of yield increase recorded in the demonstrated plots over farmers practice in three consecutive years.
The average yield of tomatoes is increased by 9.95% over the yield obtained under farmer's practices of tomato cultivation. The above findings are in similarity with the results of [6] [9].

Effect of IPM module on economics:

Economic indicators i.e. gross expenditure; gross returns, net returns, and BC ratio of frontline demonstrations on IPM in tomato were presented in Table 4. The data revealed that net returns from the demonstration plot were substantially higher than the control plot *i.e.* farmers practice during all the years of the demonstration. Average net returns from demonstration plot were Rs. 269552 /ha compared to Rs.218336/ha in control.

The average gross expenditure from the demonstration plot was recorded as Rs. 1, 76, 914 per ha compared to Rs. 160898 per ha in control plots. The average gross returns from the demonstration plot were Rs. 430450 /ha compared to Rs. 395250 /ha in control plots. The B.C ratio in the demo was recorded as 2.68:1 compared to 2.23:1 in farmer's plot.

Table 5: Fruit yield, extension gap, technology gap, and technology index on pinworm management in tomato

Year	Fruit yield per ha (t/ha)		Technology gap (t/ha)	Extension gap (t/ha)	Technology index
	Check	Demo			
2019-20	57.33	64.07	10.93	6.74	14.57
2020-21	55.93	60.05	14.95	4.12	19.93
2021-22	50.76	56.12	18.88	5.36	25.17
Average	54.67	60.08	14.92	5.41	19.89

Potential yield – 75 t/ha

Technology gap: The technology gap was 10.93 t, 14.95 t, and 18.88 t/ha during 2019-20, 2020-21, and 2021-22 respectively (Table 4). On an average technology gap under three year FLD programme was 14.92 t/ha. This may be due to the soil fertility, managerial skills of individual farmer's and climatic conditions of the selected area. Hence, location specific recommendations are necessary to bridge these gaps. These findings are similar to the outcomes of [14] in brinjal.

Extension gap: Extension gap of 6.74, 4.12, and 5.36 t/ha was observed during, 2019-20, 2020-21, and 2021-22 respectively. On an average extension gap under three year FLD programme was 5.41 t/ha. This emphasized the need to educate the farmers through various techniques for the adoption of improved agricultural production technologies to reverse this trend of wide extension gap. More and more use of the latest production technologies along with high yielding variety/hybrid will subsequently change this alarming trend of galloping extension gap.

Technology Index: The technology index shows the feasibility of the demonstrated technology at the farmer's field. The technology index varied from 14.57

Table 6: Incidence of pinworm during crop period over three consecutive years

Month	2018-19 Leaf infestation (%)		2018-19 Fruit damage (%)		2019-20 Leaf infestation (%)		2019-20 Fruit damage (%)		2020-21 Leaf infestation (%)		2020-21 Fruit damage (%)		Pooled data Leaf infestation (%)		Pooled data Fruit damage (%)	
	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo
September	1.67	0.00	0.00	0.00	3.50	0.00	0.00	0.00	2.34	0.00	0.00	0.00	2.50	0.00	0.00	0.00
October	3.54	2.33	0.00	0.00	12.45	5.24	0.00	0.00	4.86	1.42	0.00	0.00	6.95	3.00	0.00	0.00
November	6.26	3.54	6.23	2.45	14.53	8.38	2.44	4.52	16.85	6.78	5.72	0.00	12.55	6.23	4.80	2.32
December	9.24	8.98	11.72	5.64	23.56	14.24	6.73	8.35	23.16	12.34	7.86	3.54	18.65	11.85	8.77	5.84
January	28.65	11.34	11.33	9.33	21.34	16.43	18.52	11.62	34.66	20.21	19.23	6.75	28.22	15.99	16.36	9.23
February	29.42	18.21	25.45	15.78	34.12	24.38	24.46	15.10	29.12	23.42	23.55	9.32	30.89	22.00	24.49	13.40
March	45.16	25.46	29.23	11.42	48.55	23.86	35.62	18.43	32.20	20.83	44.75	20.14	41.97	23.38	33.20	16.66
Mean	**19.85**	**9.98**	**11.99**	**6.37**	**22.57**	**13.21**	**12.54**	**8.29**	**20.46**	**12.14**	**20.22**	**5.68**	**20.96**	**11.78**	**12.51**	**6.78**

to 25.17 (Table 5). On an average technology index of 19.89 per cent was observed during the three years of FLD programme, which shows the effectiveness of technical interventions. This accelerates the adoption of demonstrated technical interventions to increase the yield performance of tomato.

The data presented in table 6 reveal that the incidence of pinworm on tomatoes initiated during the vegetative stage in September 2.50% leaf infestation in pooled data and reached at peak level in March i.e 41.97% in check plot. In case of demo plot the incidence of pinworm on leaves initiated in October 3.00 % and it was reached peak levels in March i.e 23.38 % in pooled data. The overall leaf damage percentage was 20.96% in demo plots and 11.78 % in the control plot.

The percentage of pinworm incidence on fruits was happening in November i.e 4.80 % over the average of three consecutive years and it was observed to peak in the March i.e 33.20 % in check plot. In demonstrated plots, pinworm incidence on fruits was initiated in November i.e 2.32 % over pooled data. The peak incidence of pinworm recorded in March i.e 16.66 % with overall mean damage of pinworm during the overall crop period being 6.78 % in demo plots and 12.51% in case of check plots. These results were similar with the findings of [7], [8] and [11].

Table 7: Extension activities carried out in the cluster villages

S. No	Name of activity	No.	Beneficiaries
1	Trainings conducted on campus	3	95
2	Trainings conducted Off Campus	1	36
3	Visits to farmer fields	12	132
4	Field day cum impact study	1	30
5	Method demonstrations on installation of phero-mone traps	2	25
Total number of beneficiaries			318

Considering the situation and dialogue with the farmers, KVK Scientists suggested the implementation of integrated pin worm management in tomatoes and pieces of trainings were conducted to interested farmers on pinworm life cycle, nature of the damage, and different host species. Table 7 Persistent follow-up visits were made; method demonstrations, and field days were organized. Total 318 members benefitted

through various extension methodologies carried out in cluster villages by KVK Scientists to import the knowledge on the management of pinworm in tomatoes. [12].

Conclusion

The results indicated that the higher average yield was obtained in the demonstration plots over the years compared to farmer's practice due to high adoption of integrated pest management practices for pin worm control in tomatoes i.e regular monitoring of nurseries, seedlings raised under nylon net, root dip with insecticide during transplanting, removal of infected parts and plants, installation of pheromone traps which were used for monitoring of pest incidence and reduces the indiscriminate use of insecticides, mechanical collection and destruction of infected parts, spraying of neem oil, spraying of chemicals, etc. but in case of low yields in farmers practice due to lack of knowledge on pest life cycle, symptoms, mode of infection, erection of pheromone traps & spraying of appropriate chemical.

KVK, Wyra scientists educate the Khammam district farmers on various aspects like on management strategies for pin worm in tomatoes identifying the pest, symptoms, right method, and time of control by conducting various training programmes, method demonstrations, scientists visits to farmer fields and by conducting field days at farmer fields which significantly increased the income of the farmers by reducing the losses due to pinworm in tomato and easily controlled this pest in future.

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