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Impact of Front Line Demonstration on Integrated Management of Brinjal Shoot and Fruit Borer (*Leucinodes orbonalis* Guenee) in Nagarkurnool District, Telangana state

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ABSTRACT

The front line demonstrations were organised in 30 farmers fields during 2017–2020 in Nagarkurnool district. The IPM strategy included clipping and disposal of infested shoots, removal of fruits with boreholes, installation of pheromone traps @ 25 ha^{-1}, spraying of *Bacillus thurinjiensis* @ 1 g l^{-1} and Emamectin benzoate 5% SG @ 0.4 g l^{-1}. The mean of the parameters in 30 demonstrations during three years (pooled) revealed that shoot and fruit borer damage at a vegetative phase as shoot damage was 18.29% in demo field and 29.92% in farmers practice. Fruit damage was recorded low 23.02% in the demo field while in farmer's practice it was 47.37%. Higher marketable fruit yield was recorded 274 q ha^{-1} in demo field and 17.6% yield increased over farmers practice (233 q ha^{-1}) with benefit Cost Ratio of 2.97:1 and 2.11:1, respectively. Besides this, number of pesticide sprayings reduced significantly in the demo field (5.2 times) when compared to farmers practice (13.13 times). It is also observed that higher gross returns (₹ 264700 ha^{-1}) and net returns (₹ 201806 ha^{-1}) were recorded in the demo field than farmer's practice (₹ 264700 and ₹ 131496, respectively). The technology gap and extension gap enumerated from this study ranged 252-367.5q ha^{-1} and 28.5-63.81 q ha^{-1} respectively with the technology index of 54% during demonstration years. The results clearly showed that the positive impact of front-line demonstrations over farmer's practice towards increasing the productivity and reduce the cost of cultivation of Brinjal in Nagarkurnool dist. of Telangana State.

KEYWORDS: Brinjal, FLD, IPM, shoot and fruit borer

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1. INTRODUCTION

The Brinjal eggplant, *Solanum melongena* (L.) belongs to the Solanaceae (Night shade) family is native to the Indian subcontinent (Doijode, 2001), (Tsao, 2006). It is one of the most popular vegetables grown in India and S-E Asia (Thapa, 2010). The Brinjal was grown year-round, occupied an areaof 7.3 Lakh ha. with the production of 12.80 m MT and plays an important role in total vegetable production in India and as well as 2nd position in the world followed by China (Anonymous, 2018a). Even though the crop covers a considerable area (7.3 Lakh ha.) and the productivity is low (18.90t ha^{-1}) in India when compared with Iraq (66.0 q ha^{-1}), China (40.96 q ha^{-1}), Turkey (34.46 q ha^{-1}) and Japan (32.97 q ha^{-1}) (Anonymous, 2018b). Brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen) is the major pest of Brinjal (Latif et al., 2010; Chakraborti and Sarkar, 2011; Saimandir and Gopal, 2012) and is found in all brinjal producing countries (Dutta et al., 2011). It is the most important insect pest of Brinjal in Asia, especially in India, Pakistan, Sri Lanka, Nepal, Bangladesh, Thailand, Philippines, Cambodia, Laos, Vietnam (Anonymous, 1994). Areas having a hot and humid climate are conducive for its distribution and incidence (Srinivasan, 2009). The larvae, after hatching, bore inside fruit and the minute entrance hole is closed by the excreta of feeding larvae (Alam et al., 2006), making it unfit for human consumption (Baral et al., 2006). This pest attack is attributed as main reason for yield loss (Satpathy et al., 2005), where yield losses may varying from 37–63% in various states of India (Dhankhar, 1988) and the loss may reach up to 85–90% (Misra, 2008; Jagginavar et al., 2009; Haseeb et al., 2009). The brinjal growers in general used to resort frequent sprays of pesticides to kill the borer larvae (Alam et al., 2003, Rahman et al., 2006 and Yousafi et al., 2015). This result in increase costs of production, environmental pollution, outbreak of secondary pests, development of pesticide resistance in insect, adverse effects on beneficial insects, wild life and ultimately to human being through food chains (Pramanik et al., 2012).

Various chemical insecticides have been recommended for the control of this pest and the farmers apply insecticides of different class of chemistry, their combination products and cocktail mixture 15 to 18 times during the cropping season without any appreciable increase in yield. However, indiscriminate application of insecticides for the management of BSFB has resulted in the population build up of sucking pests like jassids (*Amrasca biguttula biguttula* Ishida) and whiteflies (*Bemicia tabaci* Genn.) in the brinjal growing areas which offers a new challenge to the farming community (Nayak et al., 2016). None ofthe single methods of pest management achieved control below the ETL level of this pest. In this context, all practically and easily available eco-friendly components atthe farmer level included in this IPM strategy module for Brinjal shoot and fruit borer control, reduce pesticide spraying and cost of cultivation.

2. MATERIALS AND METHODS

A Front Line Demonstration (FLD) on IPM strategy module for Brinjal shoot and fruit borer was conducted in adopted villages by Krishi Vigyan Kendra, Palem during 2017–2020 in Nagarkurnool Dist., Telangana state, India. This FLD was conducted in a total area 12 ha. of thirty Brinjal farmers fields with active participation. The IPM module included easily available components to the farmers, those are deep summer ploughing, clipping and disposal of infested shoots, removal of fruits with bore holes, installation of pheromone traps @ 25 ha^{-1}, spraying of Azadiractin 1500 ppm @ 5 ml l^{-1} at 15-20 days interval, spraying of Bt formulation @ 1 g l^{-1} at 25–30 DAT and 45 DAT, spraying of Thiodicarb 75% WP @ 2 g l^{-1} or Chlorantraniliprole 18.5% SC @ 0.25 ml l^{-1} at above ETL of pest.

Adjacent to the IPM field, another plot was maintained as control where in farmers applied only insecticides and called as farmers practice. Farmers sprayed insecticides at least weekly once repeatedly viz., Chlorpyrifos, Profinofos, Lambda-cyhalothrin, Imidacloprid, Emamectin benzoate and Chlorantraniliprole, etc. against *L. orbonalis* Guenee on Brinjal. Paired plot design was adopted. Observation on healthy shoots and shoots drooped at vegetative phase and healthy fruits and fruits with bore hole during each harvest were made and then percent shoot and fruit damage were calculated.

Percent of shoot damage=(Number of shoots drooped/ total nunber of shoots)×100.

Percent of fruit damage= (Number of fruits with boreholes /total number of fruits)×100.

Total yield was recorded as cumulative marketable fruit harvest at regular intervals for the entire crop period and transformed into q ha^{-1}.

The statistical tool to estimate the technology gap, extension gap and technology index was worked out as per the formula suggested by Samui et al. (2000) and Dayanand and Mehta (2012) as given below:

1. Percent increase in yield=(Demonstration yield-Farmers practice yield / farmers practice yield)×100.

2. Technology gap=Potential yield-Demonstration yield.

3. Extension gap=Demonstration yield-Farmer's practice yield.

4. Technology index=(Potential yield-Demonstration yield) ×100/Potential yield.

2.3. Data analysis

The homogeneity of the data was tested through paired T-test.

3. RESULTS AND DISCUSSION

Front line demonstration (FLD)was conducted in a 0.4 ha plot area each in 10 farmer's fields for three years in different adopted villages of KVK, Palem during Rabi during 2017–2020 to demonstrate IPM module in comparison with farmers practice against *L. arbonalis* Guenee.

3.1. Impact of IPM module for the shoot and fruit borer in Brinjal (BSFB) during 2017–18

The mean of the demonstrations conducted during 2017-18 in 10 farmers fields revealed that there was a significant difference between demonstration (demo) and farmers practice (FP) for shoot damage (%), fruit damage (%) and no. of sprayings and yield (q ha^{-1}), which is indicated by calculatedt value (7.886, 20.591, 11.019 and 10.463) is greater than table t value (2.262), respectively (Table 1). It is found that shoot damage during the vegetative phase was 23.4% in demo and 38.6% in farmers practice. The fruit damage caused during the fruiting stage was registered to be 52.65% lower in the demo (24.4%) against farmers' practice (51.54%). Fruit yield was found to be 14.7% high in the demo (242 q ha^{-1}) when compared to farmer's practice (211 q ha^{-1}). Further, the IPM approach has been significantly reduced toxic pesticide sprays (5.5) over farmer's practices (14.2) (Table 1).

3.2. Impact of IPM module for the shoot and fruit borer in Brinjal (BSFB) during 2018–19

The mean of the demonstrations conducted during 2018–19 in 10 farmers fields revealed that there was a significant difference between demonstration (demo) and farmers practice (FP) for shoot damage (%), fruit damage (%) and no. of sprayings and yield (q ha^{-1}), which is indicated by calculated t value (17.006, 10.083, 10.759 and 11.033) is greater than table t value (2.262), respectively (Table 2). It is found that shoot damage during the vegetative phase was 19% in the demo and 29.56% in farmer's practice. The fruit damage caused during the fruiting stage was observed to be 46.39% lower in the demo (23%) against farmer's practice (42.9%). Fruit yield was found to be 13.97% high in the demo (232.5 q ha^{-1}) when compared to farmer's practice (204q ha^{-1}). Further, the IPM strategy has been significantly reduced toxic pesticide sprays (5.3) over farmer's practices (13) (Table 2).

Table 1: Impact of IPM module for the shoot and fruit borer in Brinjal (BSFB) on shoot and fruit damage, yield during 2017–18

Treatment	Shoot damage (%)	% shoot damage reduction over FP	Fruit damage (%)	% fruit damage reduction over FP	No. of Sprays	Yield (q ha^{-1})	% yield increase over FP
Demonstration (Demo)	23.4*	39.37	24.4*	52.65	5.5*	242*	14.7
Farmers practice (FP)	38.6	-	51.54	-	14.2	211	-
SE(d)	1.93088	-	1.31785	-	0.7895	2.96273	-
Calculated t value	7.886	-	20.591	-	11.019	10.463	-

*10 farmer's fields mean. ; Table t value is 2.262 at 9 df and p=0.05.

3.3. Impact of IPM module for Brinjal shoot and fruit borer (BSFB) during 2019-20

The mean of the demonstrations conducted during 2019-20 in 10 farmers fieldsrevealed that there was a significant difference between demonstration (demo) and farmers practice (FP) for shoot damage (%), fruit damage (%) and no. of sprayings and yield (q ha^{-1}), which is indicated by calculated t value (8.774, 30.810, 24.222 and 10.987) is greater than table t value (2.262), respectively (Table 3). It

Table 2: Impact of IPM module for shoot and fruit borer in Brinjal on shoot and fruit damage, yield during 2018–19

Treatment	Shoot damage (%)	% shoot damage reduction over FP	Fruit damage (%)	%fruit damage reduction over FP	No. of sprays	Yield (q ha^{-1})	% yield increase over FP
Demonstration (Demo)	19*	35.72	23*	46.39	5.3*	232.5*	13.97
Farmers practice (FP)	29.56	-	42.9	-	13	204	-
SE(d)	0.62090	-	1.97360	-	0.71569	2.58306	-
Calculated t value	17.006	-	10.083	-	10.759	11.033	-

*10 farmer's fields mean; Table t value is 2.262 at 9 df and p=0.05

is found that shoot damage during the vegetative phase was 12.46% in the demo and 21.56% in farmer's practice. The fruit damage caused during the fruiting stage was observed to be 54.59% lower in the demo (21.65%) against farmer's practice (47.68%). Fruit yield was recorded 22.53% high in the demo (348 q ha^{-1}) when compared to farmer's practice (284 q ha^{-1}). Further, the IPM strategy has been significantly reduced toxic pesticide sprays (4.8) over farmer's practices (12.2) (Table 3).

3.4. Pooled impact of IPM module for shoot and fruit borer in brinjal (BSFB)

The pooled mean data of 30 demonstrations conducted during 2017–2020 in farmer fields revealed that there was a significant difference at 5% level between demonstration (demo) and farmers practice (FP) for shoot damage (%), fruit damage (%) and no. of sprayings and yield (q ha^{-1}), which is indicated by calculated t value (15.126, 26.743, 19.253 and 14.881) is greater than table t value (2.262), respectively (Table 4). It is found that shoot damage during the vegetative phase was 18.29% in demo and 29.92 in farmer's practice. The fruit damage caused during the fruiting stage was found to be 23.02% in the demo while in farmer's practice it was 47.37%. Fruit yield was recorded high in the demo (274q ha^{-1}) when compared to farmer's practice (233 q ha^{-1}). Further, the IPM strategy has been significantly reduced toxic pesticide sprays (5.2) over farmer's practices (13.1) (Table 4).

Table 3: Impact of IPM module for the shoot and fruit borer in Brinjal on shoot and fruit damage, yield during 2019–20

Treatment	Shoot damage (%)	% shoot damage reduction over FP	Fruit damage (%)	%fruit damage reduction over FP	No. of sprays	Yield (q ha^{-1})	% yield increase over FP
Demonstration (Demo)	12.46*	42.2	21.65*	54.59	4.8*	348*	22.53
Farmers practice (FP)	21.56	-	47.68	-	12.2	284	-
SE(d)	1.03720	-	0.84480	-	0.3055	5.80753	-
Calculated t value	8.774	-	30.810	-	24.222	10.987	-

*10 farmer's fields mean; Table t value is 2.262 at 9 *df* and p=0.05

Adoption of the IPM module resulted in a reduction in shoot damage (38.87%) and fruit damage (51.4%) which lead to the increased fruit yield of 17.6% (Table 4). It has coincided with the results of Satpathy et al. (2005) that adoption of IPM strategies viz., clipping and disposal of affected shoots, removal of fruits with boreholes, installation of pheromone traps @ 12 ha^{-1} and release of *T. chilonis* and spraying of Bt formulation, Azadirachtin and need-based insecticide reduced the shoot and fruit borer damage. The results of the demonstration are in close conformity with the findings of Nayak et al. (2016) who reported that the bio-intensive modules (14.36–18.34% fruit damage) also found to be significantly reduced the borer incidence better than the farmers' practice (25.97% fruit damage) through an eco-friendly manner.

Table 4: Pooled impact of IPM module shoot and fruit borer in Brinjal on shoot and fruit damage, yield

Treatment	Shoot damage (%)	% shoot damage reduction over FP	Fruit damage (%)	% fruit damage reduction over FP	No. of sprays	Yield (q ha^{-1})	% yield increase over FP
Demonstration (Demo)	18.29	38.87	23.02	51.4	5.2	274	17.6
Farmers practice (FP)	29.92	-	47.37	-	13.13	233	-
SE(d)	0.7689	-	0.9108	-	0.4121	2.7621	-
Calculated t value	-15.126	-	-26.743	-	-19.253	14.881	-

*10 farmer's fields mean; Table t value is 2.262 at 9 *df* and p=0.05

The shoot and fruit borer adult activity was monitored using sex pheromone traps and the moth catch was recorded during the growing period. These results conform with the results of Srinivasan and Babu, 2000 who reported that sex pheromones are an important component of IPM programs and are mainly used to monitor as well as to mass-trap the male insects in India. The bio pesticide Bt formulation and Azadiractin were useful in IPM which have good efficacy against BSFB. These results confired with the findings of Patra et al. (2016) who reported that among bio-pesticides, highest mean marketable yield and fruit borer infestation reduction were recorded in *Bacillus thuringiensis* treated plots (114.45 q ha^{-1} and 52.02%) followed by Azadirachtin (101.11 q ha^{-1} and 28.47%), respectively. Adoption of IPM strategies resulted in a reduction in the no. of sprays to 60.4% (Table 4) which conforms with the findings of Baral et al., (2006) who reported that IPM adopters sprayed pesticides 52.6% less often than non-IPM farmers, respectively.

Front line demonstration of recommended IPM module obtained significant yield increase than farmers practice in Brinjal cultivation which is following the findings of Senthil kumar et al. (2018).

3.5. Technology gap, extension gap, technology index and productivity enhancement in brinjal due to integrated fruit and shoot borer

The data showed that the productivity of brinjal in Nagarkurnool district under IPM technology ranged 232.5 q ha^{-1}–348 q ha^{-1} with a mean yield of 274 q ha^{-1} (Table 5). The percent increase yield under the IPM module ranged 13.97–22.53% in respective years. The result revealed the positive effects and significant difference in yield of FLD over farmer's practices as it enhanced the yield of Brinjal in Nagarkrnool district of Telangana state. These findings were in line with the research of Senthil kumar et al. (2018) and Singh and Bisen (2020). The fruit yield increase was mainly because of high yielding hybrids, soil type and integrated management of crop as well as IPM technology.

The extension gap of 31 q ha^{-1}, 28.5 q ha^{-1} and 64 q ha^{-1} was observed during 2017–18, 2018–19 and 2019–20 respectively and the average extension gap was 41 q ha^{-1}(Table 5). This emphasized the need to educate the farmers through various techniques for the adoption of IPM technology and improved agricultural production technologies to reverse this trend of a wide extension gap. These findings are similar to Singh and Bisen (2020) and Chaitanya et al. (2020).

Table 5: Technology gap, Extension gap, Technology index and Productivity enhancement in Brinjal due to integrated fruit and shoot borer management

Year	Fruit yield (q ha^{-1})		Farmers practice	(%) increase in productivity	Technology gap (q ha^{-1})	Extension gap (q ha^{-1})	Technology index (%)
	Potential	Demonstration					
2017-18	600	242	211	14.7	358	31	59.67
2018-19	600	232.5	204	13.97	367.5	28.5	61.25
2019-20	600	348	284	22.53	252.02	64	42.00
Average	600	274	233	17	326	41	54

The technology gap, the differences between potential yield and yield of demonstration plots were 358, 367.5 and 252.02 q ha^{-1} during 2017–18, 2018–19 and 2019–20, respectively. On average technology gap under three years, FLD program was 326q ha^{-1} (Table 5). This may be due to the soil fertility status, nutrient management, varietal performance and climatic conditions of the selected area. This conforms with the results of Singh and Bisen (2020) and Chaitanya et al. (2020).

The technology index shows the feasibility of the demonstrated technology at the farmer's field. The technology index varied from 42–61.25% (Table 5). On average technology index of 54% was observed during the three years of the FLD program, which showed the efficacy and easinessto adopt the IPM module for yield increase. These findings were in line with the findings of Singh and Bisen (2020).

3.6. Comparative B:C analysis of IPM module for Brinjal fruit and shoot borer

To ascertain the economic feasibility of the demonstration technologies over farmer's practice, some economic indicators like the cost of cultivation, net return and B:C ratios were worked out. It was found that the cost of production of Brinjal under demonstration varied from ₹ 67,338-1,30,902 ha^{-1} with an average of ₹ 1,09,695 as against ₹ 79,100-1,60,261 with an average ₹ 1,33,204 under farmers practice (Table 6). The additional cost increased in the demonstration was mainly due to more cost involved in pesticide sprays.These results are following the findings of Senthil kumar et al. (2018). The IPM strategy gave a higher net return of ₹ 1,74,663 ha^{-1}, ₹ 1,48,156 ha^{-1} and ₹ 2,82,598 ha^{-1} in the year 2017-18, 2018-19 and 2019-20 respectively with an average net return of ₹ 2,01,806 ha^{-1} which was lower in farmer's practices (₹ 1,31,496 ha^{-1}), indicating the importance of need-based plant protection (Table 6). Rai et al. (2005) also showed an increase in productivity in Tomato, Brinjal and Chilli due to the adoption of improved technology by the farmers through FLDs in the farmer's field. The benefit-cost ratio of Brinjal ranged 2.13-3.60 in demonstration plots and 1.53-2.67 in farmer's practice during three years of demonstration with an average of 2.97 in demonstration and 2.11 under farmer's practices (Table 6 and Figure 1). The B: C ratio of Brinjal crop under demo was higher than farmers practice. It showed the impact of IPM practices in Brinjal. The factor responsible for the low

Table 6: Comparative B:C analysis of IPM module for fruit and shoot borer

Year	Cost of cultivation		Gross returns (₹ ha^{-1})		Net returns (₹ ha^{-1})		B:C Ratio	
	Demo	FP	Demo	FP	Demo	FP	Demo	FP
2017-18	67338	79100	242000	211000	174663	131900	3.60	2.67
2018-19	130844	160250	279000	244800	148156	84550	2.14	1.53
2019-20	130902	160261	413500	338300	282598	178039	3.19	2.13
Average	109695	133204	311500	264700	201806	131496	2.97	2.11

1 US$= 75.24 INR, 2022

B:C ratio under farmer's practice was poor adoption of all the recommended packages of practices for Brinjal crop in the region. These results are following the findings of Senthil kumar et al. (2018). Thus, Front line demonstration of recommended IPM technology revealed that the yield potential and net income of the Brinjal crop can be enhanced to agreater extent.

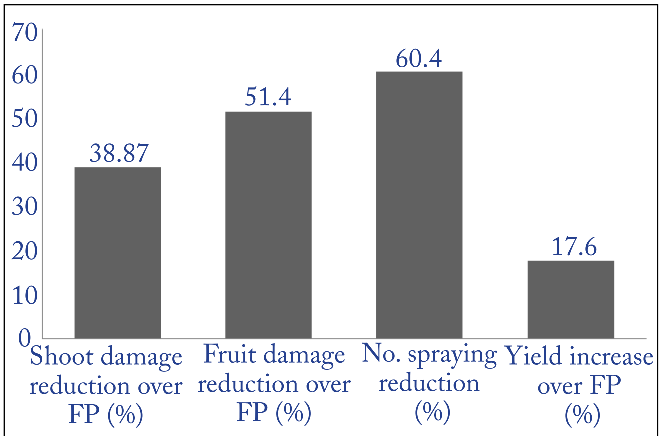

Figure 1: Impact of adoption of IPM module during three years (20017-20)

4. CONCLUSION

The adoption of IPM strategies for Brinjal shoot and fruit borer reduced the shoot damage (38.87%), fruit damage (51.4%) and also reduced the pesticide usage by 60.4%, which lead to an increase in fruit yield by 17.6% and higher benefit-cost ratio. Hence, FLD is proven potential and profitability of the IPM module under the real farming situation. Therefore, target-oriented training programs and multiple demonstrations were required to enhance the knowledge and skills of growers for adoption of the IPM module.

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