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Bio intensive approach for the management of tomato fruit borer, *Helicoverpa armigera* (Hubner)

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ABSTRACT : Field investigations were undertaken to know the effecacy of integration of bioagents and Neem Seed Kernel Extract (NSKE) in the management of tomato fruit borer, *Helicoverpa armigera*. All the bio-agents showed enhanced effect in reducing the larval population. The data revealed that insecticide treatment excelled over rest of the treatments in both the years in reducing the larval population except *Nomurea rileyi* + NSKE (37.66%), *Ha*NPV + NSKE (30.53%) treatments after application. Spraying of *N. rileyi* (49.79 % decrease over control) and *Ha*NPV (73.08 % decrease over control) combined with NSKE were found significantly superior to all treatments either alone or combined with NSKE except endosulfan (80% decrease over control) in reducing the fruit damage. Further the highest yield and net profit was recorded with *N. rileyi+ NSKE* and *Ha*NPV+ NSKE treatments.

Keywords: Biopesticides, *Helicoverpa armigera,* tomato

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular and commercially important vegetable crops in India. Among many factors responsible for low yields of tomato, insect pests are major ones that have been reported to attack tomato at all stages of crop growth. Among insect pests, the damage caused by fruit borer, *Helicoverpa armigera* Hubner surpass the loss caused by all other insect pests together and it has been reported that the loss due to this pest range from 20-50 per cent. Tomatoes being a commercial vegetable crop, the farmers have a tendency to indiscriminately use insecticides to control this destructive pest. Consequently it has led to many problems like build up of insecticide resistance, pest resurgence, replacement of natural enemies and insecticide residue in the tomato fruits. Keeping these points in view, the present investigation was undertaken to know the effect of combination of bioagents and the neem seed kernel extract **(**NSKE) on tomato fruit borer, *H. armigera.*

MATERIALS AND METHODS

Present investigations were carried out in the farmer's fields of Narendra village, Dharwad taluka, Karnataka State in order to make relative assessment of bioagents in combination with botanical insecticide (NSKE) against *H. armigera* in tomato eco-system. A randomized block design was used with thirteen treatments replicated thrice with a plot size of 5.40m x 4.80m. Variety PKM-1 was transplanted at a spacing of 60 cm between plants and 60 cm between rows. The nursery beds and crop was raised following the recommended agronomic practices (Anon, 1999), except the plant protection schedule for the management of fruit borer. Treatments were imposed on the crop in the evening hour using high volume knapsack sprayer. Tween-80 at the rate of 0.01 per cent was added to all mycoinsecticides as a dispersing agent, jaggery (0.1%) and boric acid (0.01%) to *Ha*NPV as a phagostimulant and protectants, respectively and soap powder (0.1%) to the NSKE as a emulsifier.

Observations were recorded a day before and five, seven and ten days after treatment (DAT). The number of larvae per plant was counted from five tagged plants in each plot. Total number of fruits and damaged fruits harvested at each picking from each plot was counted and converted to per cent basis. Similarly, Marketable fruit yield was recorded from net plot excluding the border rows at each picking and finally was computed to quintals per ha to workout incremented benefit cost ratio (IBC) and additional net profit.Number of larvae per plant was converted to $\sqrt{x+0.5}$ values and all per cent data were subjected to arc sine transformation before analysis. Treatment means were compared by using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The population density prior to treatment imposition was varied from 2.14 to 2.35 larvae per plant and was non-significant between treatments to disclose uniformity in the pest density. All the bioagents either alone or in combination with NSKE including control did not differ significantly from each other at 5 days after treatment (DAT). However, endosulfan reduced the larval population to 1.45 from 2.30 larvae per plant to stand out as

Table 1. Effect of integration of bioagents and NSKE in the management of tomato fruit borer, *Helicoverpa armigera*

Treatment		No. of larvae / plant				Reduction (%) over pre treatment (10DAT)
		Pre - Treatment	5 DAT	7 DAT	10 DAT	
T_1	*Ha*NPV (250 LE/ha)+ NSKE (5%)	2.26^a	2.19^b	1.63^b	1.57^{bc}	30.53^{bc}
T_2	*M. a.*(1.8 x 10^{11} conidia/ha) + NSKE (5%)	2.29^a	2.09^b	1.80^{cde}	1.72^{bcd}	24.89^{cd}
T_3	*N. r.* (2.0 x 10^{11} conidia/ha) + NSKE (5%)	2.38^a	2.12^b	1.52^b	1.49^b	37.66^b
T_4	*B. b.*(1.0 x 10^{11} conidia/ha) + NSKE (5%)	2.28^a	2.16^b	1.75^{bcd}	1.63^{bcd}	28.50^c
T_5	Nematode* (1.15 million IJ's/ha) +NSKE (5%)	2.26^a	2.12^b	1.89^{cde}	1.81^{cde}	18.83^{def}
T_6	*Ha*NPV (250 LE/ha)	2.29^a	2.23^b	1.89^{cde}	1.87^{de}	18.34^{def}
T_7	*M. a* (1.8x10^{11} conidia/ha)	2.26^a	2.20^b	2.09^{ef}	2.06^{fg}	8.85^g
T_8	*N. r.* (2.0x10^{11} conidia/ha)	2.22^a	2.20^b	1.90^{cdef}	1.75^{cde}	21.17^{de}
T_9	*B. b.* (1.0x10^{11} conidia/ha)	2.35^a	2.20^b	2.00^{def}	2.01^{ef}	13.79^{fg}
T_{10}	Nematode* (1.15 million IJ's/ha)	2.14^a	2.06^b	2.20^f	2.26^{fg}	-5.69^h
T_{11}	NSKE (5%)	2.23^a	2.06^b	1.76^{bcd}	1.87^{de}	16.14^{ef}
T_{12}	Endosulfan 35 EC (1250 ml/ha) (Standard check)	2.30^a	1.45^a	0.93^a	0.94^a	58.95^a
T_{13}	Untreated Control	2.30^a	2.33^b	2.17^f	2.43^g	-5.65^h
	C.D. (5%)	**NS**	**0.16**	**0.09**	**0.10**	**4.69**
	S.Em.±	**0.04**	**0.05**	**0.03**	**0.03**	**1.57**

DAT: Days after treatment; ***M.a.***: *Matarhizium anisopliae ;* ***N.r.***: *Nomuraea rileyi;* ***B.b***.:*Beauveria bassiana;*
***Ha*NPV**: *Helicoverpa armigera* Nuclear polyhedrosis virus; **IJs**: Infective Juviniles : **NSKE:** Neem Seed Kernel Extract
*** :** *Steinernema* sp. Means followed by same alphabet in a column do not differ significantly by DMRT

significantly superior over rest of the treatments (Table 1). With the advancement in time (7 and 10 DAT), entamopathogenic fungi and virus treatment either alone or in combination with NSKE noticed variation in their superiority. Population of fruit borer incidence did not differ at 7 DAT between *Nomurea rileyi* + NSKE (1.52 larvae / plant), *Ha*NPV + NSKE (1.63 larvae / plant), *B. bassiana* + NSKE (1.756 larvae / plant) and *M. anisopliae* + NSKE (1.80 larvae / plant) treatment combinations. In the trial, nematode (*Steinernema* sp.) + NSKE combination treatment was comparatively less effective than other treatment combinations but performed better over individual treatments in suppressing the larval population. At 10 days after treatment, all the bio-agents showed enhanced effect to record significantly less population compared to untreated control (Table 1). However, the larval population did not differ between bio-agents combined with NSKE treatments at the same time neither the combination treatments nor individual treatments were comparable to standard check. Nematode (*Steinernema* sp.) alone treatment (2.20 larvae/plant) failed to differ from untreated control (2.17 larvae /plant) and *M. anisopliae* (2.09 larvae/plant). However, latter treatment was as effective as nematode (*Steinernema* sp.) + NSKE (1.81 larvae /plant), *Ha*NPV (1.87 larvae/plant), *N. rileyi* (1.75 larvae /plant), *B. bassiana* (2.01 larvae /plant) and NSKE (1.87 larvae / plant) treatments. Similar observation was also made by Patil (2000) and he reported that foliar spray of *N. rileyi* at the rate of 2.0 x 10^{11} conidia / ha + NSKE (5%) was as effective as monocrotophos (0.05%) against *S. litura* in groundnut ecosystem. Likewise field effectiveness of combination of NPV + Nemark inundation to lower the larval load of noctuid pest like *H. armigera* in cotton as reported by Mastoli *et al.*, (1995). Similarly NPV + NSKE in chickpea (Patil, 1995), NPV at the rate of 250 LE / ha + NSKE (3%) in tomato (Gopal and Senguttuvan, 1997) have been reported against *H. armigera.*

Table 2. Effect of integration of bioagents and NSKE in the management of tomato fruit borer, *H. armigera* and its impact on yield and yield parameters

	Treatment Details	Fruit Damage (%)	Yield (q/ha)	Yield increased over control (%)	B:C ratio
T_1	*Ha*NPV (250 LE/ha)+ NSKE (5%)	7.78 ^{a}	200.66 ^{a}	7.19	95.20 ^{b}
T_2	*M. a*.(1.8 x 10^{11} conidia/ha)+ NSKE (5%)	12.75 ^{bc}	178.92 ^{cd}	8.64	73.83 ^{cd}
T_3	*N. r*. (2.0 x 10^{11} conidia/ha) + NSKE (5%)	6.83 ^{a}	204.83 ^{a}	11.58	99.20 ^{b}
T_4	*B. b*.(1.0 x 10^{11} conidia/ha) + NSKE (5%)	10.82 ^{b}	185.14 ^{bc}	9.34	79.87 ^{c}
T_5	Nematode* (1.15 million IJ's/ha)+NSKE (5%)	15.81 ^{de}	164.92 ^{de}	7.20	60.23 ^{de}
T_6	*Ha*NPV (250 LE/ha)	16.27 ^{de}	162.69 ^{def}	5.53	58.06 ^{ef}
T_7	*M. a* (1.8x10^{11} conidia/ha)	19.58 ^{f}	145.98 ^{f}	7.32	41.40 ^{g}
T_8	*N. r*. (2.0x10^{11} conidia/ha)	14.51 ^{cd}	166.37 ^{de}	10.79	61.03 ^{e}
T_9	*B. b*. (1.0x10^{11} conidia/ha)	18.59 ^{ef}	150.24 ^{ef}	8.05	45.96 ^{fg}
T_{10}	Nematode* (1.15 million IJ's/ha)	24.29 ^{g}	124.34 ^{g}	4.49	20.50 ^{h}
T_{11}	NSKE (5%)	17.00 ^{ef}	153.99 ^{ef}	9.53	49.40 ^{efg}
T_{12}	Endosulfan 35 EC (1250ml/ha) (Standard check)	5.78 ^{a}	218.15 ^{a}	16.80	112.09 ^{a}
T_{13}	Untreated Control	28.90 ^{h}	102.93 ^{h}	-	0.00 ^{h}
	C.D. (5%)	2.42	18.27		7.29
	S.Em±	0.82	6.1		2.44

The data presented in Table 2 revealed that insecticide treatment excelled over rest of the treatments in both the years in reducing the larval population. *Nomuraea rileyi* + NSKE (37.66), *Ha*NPV + NSKE (30.53%) treatments were at par with each other in decreasing the larval population and were next best to standard check. On the contrary, no significant variation was observed between nematode (*Steinernema* sp.) and untreated plots. These results are in corroboration with reports of Rovesti and Dese (1999) who reported susceptibility of nematode (*Steinernema* sp.) when it was combined with neem based insecticides. On the contrary, Narayanan and Gopalkrishnan (1990) opined that *S. feltiae* (3x 10^3 IJ's/ml) in combination with reduced dosage of insecticide was equally effective in controlling *H. armigera* on tomato.

Spraying of *N. rileyi* (6.83 percent fruit damage or 76.37 percent decrease over UTC) and *Ha*NPV (7.78 percent fruit damage or 73.08% decrease over UTC) combined with NSKE were found significantly superior to all treatments either alone or combined with NSKE except endosulfan (5.78% fruit damage or 80 percent decrease over UTC) in reducing the fruit damage (Table 2). However, *M. anisopliae* + NSKE (12.72%) was comparable with and *B. bassiana* + NSKE (10.82%). Combination of *Ha*NPV + NSKE (208.47 q/ha) and *N. rileyi* + NSKE (214.40 q/ha) proved to be very effective treatments and on par with standard check, endosulfan (226.37 q/ha) in recording higher yield. *Nomuraea rileyi* alone treatment produced the tomato fruit yield as much as plots treated with NSKE, *Ha*NPV, nematode (*Steinernema* sp.) + NSKE, *M. anispliae* + NSKE. Per cent increase in yield over control was much in *N. rileyi* + NSKE (99.20%) and *Ha*NPV + NSKE (95.20%) treated plots were equally effective in increasing the yield over control. While in nematode (*Steinernema* sp.) treated plot, yield increase was 20.50 per cent over untreated control (Table 2). Field effectiveness of *N. rileyi* inundation reduced the larval load of *H. armigera* on tomato (Gopalkrishnan and Ashokan, 1994), Cotton, Pigeonpea (Kulkarni, 1999), Chickpea (Devaraj, 2000) and Potato (Hegde, 2001) are on record to highlight the utility of the fungus as an acceptable fungus in IPM of *H. armigera* in tomato as well as different crop ecosystems. The present results provide reinforcement to these reports. Similarly, efficacy of *Ha*NPV at the rate of 250 LE / ha against this pest was reported by Gopalkrishnan and Ashokan (1998). Treatment of *N. rileyi* (2.0 x 10^{11} conidia / ha) + NSKE (5%) and *Ha*NPV (250LE / ha) + NSKE (5%) resulted in an incremental yield of 101.90 and 97.73 q/ha over untreated control, respectively. The yield advantages were 82.21, 75.99, 63.44, 61.99, 59.76, 51.09 and 115.22 q/ha when *B. bassiana* + NSKE, *M. anisopliae* + NSKE, *N. rileyi*, nematode (*Steinernema* sp.) + NSKE, *Ha*NPV, NSKE and endosulfan treatments, respectively (Table 2). Maximum benefit for every additional unit investment was realized with *N. rileyi* + NSKE (Rs.11.58) and was next best to the endosulfan followed by *Ha*NPV + NSKE (Rs. 21033 / ha).

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