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Efficacy of Bio Pesticides against Castor Semilooper *Achaea janata* (Lepidoptera: Erebidae)

K. Divija[1*], M. Anuradha[2], O. Shaila[3] and V. Divya Rani[3]
[1]Department of Entomology, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad (Telangana), India.
[2]Pricipal, APT, Palem, Telangana, (Telangana), India.
[3]RARS, Palem, Telangana (Telangana), India.

(Corresponding author: K. Divija)*
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ABSTRACT: Field studies were conducted to evaluate the efficacy of four microbials, two botanicals and one chemical insecticide along with untreated control against castor semilooper in castor hybrid, PCH-111 during *Rabi*, 2021 at RARS, Palem in RBD replicated thrice. Profenophos 50EC @ 1ml L^{-1} was found best by showing highest reduction over control of semilooper larvae in both first (82.78%) and second spray (80.68%). Among biopesticides, mortality of the semilooper larvae was high in Btk treated plots as the per cent reduction over control was highest in both first (71.30%) and second spray (69.64%) followed by *B. bassiana* (63.10% after first spray and 64.12% after second spray). After 10 days of second spray the defoliation by the larvae was observed to be less than 10% in all the treated plots compared to 33.33% in untreated plot. Larval parasitization by *S. maculipennis* was very high in larvae from azadirachtin (56.67%, 53.33%) and pongamia oil (53.33%, 50.00%) compared to chemical insecticide (16.67%, 13.33%) treated plots in both first and second spray respectively. Because of the high cost of manufacture, low storage stability, susceptibility to environmental conditions, efficacy issues and other factors, the use of bio pesticides is currently limited compared to synthetic chemical pesticides. Some of these issues can be addressed by altering the formulation, which has proven to be effective in boosting and maintaining the activity of various botanicals and microbials. Bio-pesticides clearly have a vital role to play in the development of future integrated pest management strategies.

Keywords: Castor, *Achaea janata*, Defoliation, biopesticides, Profenophos, *Snellenius maculipennis*, Parasitization.

INTRODUCTION

Castor (*Ricinus communis*) is a non-edible oilseed crop of Euphorbiaceae family. The crop is predominantly grown in rainfed areas. India is the world's leading producer and exporter of castor beans. According to the government's third advance estimates, total castor production in India is 17.74 lakh tonnes in 2020-21.According to the 4^{th} advance estimates of the Telangana State Government, castor productivity is 355 kg ha^{-1}. (www.agri.telangana.gov.in). Excessive damage produced by lepidopteran pests, such as the castor semilooper, *Achaea janata* (Noctuidae: Lepidoptera), tobacco caterpillar, *Spodoptera litura* (Noctuidae: Lepidoptera), and capsule borer, *Conogethes punctiferalis* (Noctuidae: Lepidoptera) is one of the major constraints that limits the castor productivity. Semilooper and tobacco caterpillar are active during the vegetative stage and causes over 50% defoliation. Estimates of seed yield loss range from 35 to 50 percent, depending on the crop's growth stage and the insect attack. Natural enemies in the castor ecosystem include the parasitoids, *Trichogramma chilonis*, *Microplitis maculipennis* Szepligeti and insect predators such as spiders, and insectivorous birds. One of the methods for controlling the pests is conservation of these natural enemies. Until now, the most common method of controlling these pests is to employ synthetic insecticides. Although they have proven to be effective at reducing pest populations, they have detrimental consequences for the ecosystem and the crops themselves. *Snellenius (Microplitis) maculipennis*, a semilooper larval parasitoid that parasitizes more than 75% of larvae in the field, is greatly affected by the synthetic insecticides (Basappa and Lingappa 2005). Biopesticides have been proved to be a viable alternative to chemical pesticides. Microbial and botanical insecticides may offer an environmentally beneficial approach to control these insect pests while preserving natural enemies (Vanlaldiki *et al.,* 2013; Dhingra *et al.,* 2012; Lakshminarayana, 2010).

As a result, research has been carried out with the goal of identifying the most effective biopesticides for controlling defoliators in the castor crop while remaining compatible with natural enemies, as well as determining the economics of various treatments.

MATERIAL AND METHODS

Field studies were conducted to evaluate the efficacy of biopesticides and a chemical pesticide against *A. janata* in castor hybrid PCH-111 during *Rabi*, 2021 at the research farm of RARS, Palem, PJTSAU, Telanagana. Experiment was laid out in Randomized Block Design (RBD) with eight treatments replicated thrice. Plot size of each treatment is 5m × 7m (35m^2) with a spacing of 120cm × 45cm. All the agronomic practices were followed as per the recommendations. Bioefficacy of biopesticides, *Beauveria bassiana* (2 × 10^8 CFU g^{-1}) @ 5g l^{-1}, *Metarhizium anisopliae* (2×10^8 CFU g^{-1})@5g l^{-1} *Bacillus thuringiensis.var.kursatki*@1g l^{-1} *Metarhizium rileyi* (1.5 × 10^{13} spores ml^{-1})@5g l^{-1}, Azadirachtin (1500ppm)@5ml l^{-1}, Pongamia oil @ 2 ml l^{-1} was tested against *A. janata* in comparison with profenophos 50EC @ 1ml l^{-1} and untreated control. The treatments were imposed twice with an interval of 10 days during first and third week of December after observing a defoliation of greater than 25%. Observations were recorded on larval population/plant from five randomly selected plants from each replication in each treatment at one day before and 5, 7 and 10 days after spraying. The mean larvae/plant and per cent reduction over control was worked out. The defoliation per cent was recorded as per cent leaf area infested/plant. The per cent parasitization of semilooper larvae by *S. maculipennis* was also recorded. Results were analyzed by following appropriate statistical methods (RBD) and subjected to ANOVA in simple RBD analysis as per the procedures suggested by Gomez and Gomez (1984). Data on larval population was transformed using √(x+0.5) and percentages were transformed using arcsine transformations by using OPSTAT, Central Agricultural University, Hisar.

RESULTS AND DISCUSSIONS

The mean semilooper larval population in the plots before and at different intervals after first spray are presented in Table 1. The pre treatment count of the larvae for first spray ranged from 2.33 to 2.87 larvae/plant. A significantly lower infestation of semilooper (0.33 larvae/plant) was recorded in profenophos treated plot after 10 days of first spray. This is in concurrence with the previous reports (Rajabaskar and Regupathy 2013). Higher toxicity of profenophos is due to its ability to inactivate acetylcholine esterase and affecting the pest's nervous system. Among the biopesticides, the significantly similar Btk and *B. bassiana* treated plots were found to have a population of 0.67 and 0.80 larvae/plant after 10 days of first spray followed by *M. rileyi* (1.00 larvae/plant) and *M. anisopliae* which are on par with each other. The significant effect of entomopathogenic fungi in reducing the larval population superior to botanicals is in line with the work of Vanlaldiki *et al*. (2013).

Table 1: Effect of bio pesticides against castor semilooper during first spray.

Sr. No.	Treatments	Dosage	Mean larval population of *A.janata* per plant after first spray					
			Pre count	5DAS	7DAS	10DAS	Mean	PRC
1.	*B. bassiana* (2×10^8 CFU g^{-1})	5gl^{-1}	2.47(1.57)	1.60(1.26)^{de}	0.93(0.96)^{de}	0.80(0.89)^{de}	1.11	63.10
2.	*M. anisopliae* (2×10^8 CFU g^{-1})	5gl^{-1}	2.33(1.53)	1.80(1.34)^{bcd}	1.27(1.12)^{c}	1.13(1.06)^{c}	1.40	50.80
3.	Btk	1gl^{-1}	2.87(1.69)	1.53(1.24)^{e}	0.80(0.89)^{e}	0.67(0.82)^{e}	1.00	71.30
4.	*M. rileyi* (1.5×10^{13} spores ml^{-1})	5gl^{-1}	2.4(1.55)	1.73(1.32)^{cde}	1.13(1.06)^{cd}	1.00(1.00)^{cd}	1.29	55.72
5.	Azadirachtin (1500ppm)	5ml l^{-1}	2.33(1.53)	2.00(1.41)^{bc}	1.60(1.26)^{b}	1.47(1.21)^{b}	1.69	40.96
6.	Pongamia oil	2ml l^{-1}	2.27(1.48)	2.07(1.44)^{b}	1.73(1.32)^{b}	1.67(1.29)^{b}	1.82	34.40
7.	Profenophos	1ml l^{-1}	2.80(1.67)	1.00(0.99)^{f}	0.46(0.68)^{f}	0.33(0.57)^{f}	0.60	82.78
8.	Control		2.60(1.61)	3.07(1.75)^{a}	3.20(1.79)^{a}	3.27(1.81)^{a}	3.18	
	SE(m±)		0.018	0.025	0.024	0.029		
	CV (%)		2.319	4.213	5.115	6.796		
	CD (P=0.05)		NS	0.099	0.102	0.129		

Figures in parentheses are√ (X+0.5) transformed values; CD= Critical difference; NS= Non- significant; PRC= Per cent reduction over control

The results from the pooled mean data after spray revealed that among the biopesticides, Btk and *B. bassiana* were superior by causing 71.30% and 63.10% reduction over control respectively followed by *M. rileyi* (55.72%) and *M. anisopliae* (50.80%). Higher larval mortality of *A. janata* recorded in Bt treated plots is in correspondence with the work of Kulshrestha *et al*. (1965) who reported 79.9% field mortality of *A. janata* larvae due to Bt. The botanicals, azadirachtin and pongamia oil caused 40.96% and 34.40% reduction over control respectively. The larvae from the plots treated with azadirachtin showed reduced feeding behavior. This is in agreement with the earlier work of Nath and Singh (2011); Roy and Saraf (2006) done on *S. litura*. The same trend of efficacy as in first spray was observed in the second spray presented in Table 2. The profenophos completely reduced the population of the semilooper larvae after 10 days of second spray. In biopesticides, the highest per cent reduction over control for second spray was caused by Btk (69.64%), *B.bassiana* (64.12%) followed by *M. rileyi* (56.76%) whereas least was due to pongamia oil (33.76%) (Fig. 1). The least efficacy of pongamia oil in the research is in accordance to the research work of Duraimuragan *et al*. (2015) whereas, Deshmukh and Borle (1976) mentioned that karanja oil has some limits for use at the farmer's level due to its aqueous nature.

Table 2: Effect of bio pesticides against castor semilooper during second spray.

Sr. No.	Treatments	Dosage	Mean larval population of *A. janata* per plant after second spray					
			Pre count	5DAS	7DAS	10DAS	Mean	PRC
1.	*B. bassiana* (2×10^8 CFU g^{-1})	$5gl^{-1}$	0.80(0.89)^{de}	0.47(0.98)^{de}	0.27(0.87)^{ef}	0.20(0.84)^{ef}	0.31	64.12
2.	*M. anisopliae* (2×10^8 CFU g^{-1})	$5gl^{-1}$	1.13(1.06)^{c}	0.80(1.22)^{c}	0.60(1.05)^{d}	0.53(1.02)^{d}	0.64	47.56
3.	Btk	$1gl^{-1}$	0.67(0.82)^{e}	0.33(0.91)^{e}	0.20(0.84)^{f}	0.13(0.79)^{f}	0.22	69.64
4.	*M. rileyi* (1.5×10^{13} spores ml^{-1})	$5gl^{-1}$	1.00(1.00)^{cd}	0.67(1.08)^{d}	0.40(0.95)^{e}	0.33(0.91)^{e}	0.47	56.76
5.	Azadirachtin (1500ppm)	5ml l^{-1}	1.47(1.21)^{b}	1.13(1.28)^{bc}	0.87(1.17)^{c}	0.60(1.14)^{c}	0.87	45.72
6.	Pongamia oil	2ml l^{-1}	1.67(1.29)^{b}	1.40(1.38)^{b}	1.13(1.28)^{b}	1.07(1.25)^{b}	1.20	33.76
7.	Profenophos	1ml l^{-1}	0.33(0.57)^{f}	0.13(0.79)^{f}	0.07(0.75)^{g}	0.00(0.71)^{g}	0.07	80.68
8.	Control		3.27(1.81)^{a}	3.53(2.01)^{a}	3.60(2.02)^{a}	3.53(2.01)^{a}	3.55	
	SE(m$\pm$)		0.029	1.135	1.198	0.901		
	CV (%)		6.796	5.23	3.950	4.54		
	CD (P=0.05)		0.129	0.11	0.077	0.086		

Figures in parentheses are$\sqrt{(X+0.5)}$ transformed values; CD= Critical difference; NS= Non- significant; PRC= Per cent reduction over control

Lower defoliation (4.00%) was recorded in profenophos treated plot after 10 days of first spray. In the bio pesticides, Btk and *B. bassiana* treated plots a defoliation of 5.34% and 7.00% was recorded after 10 days of first spray followed by *M. rileyi* (9.67%) and *M. anisopliae* (10.67%) which are on par with each other. The superiority of *B. bassiana* among the entomopathogens tested reported in the present study also mentioned in the work of Purwar and Sachan (2005). The results from the pooled mean data after first spray revealed that among the bio pesticides, Btk and *B. bassiana* by causing 74.89% and 66.52% reduction over control respectively in defoliation are considered to be superior followed by *M. rileyi* (59.08%) and *M. anisopliae* (54.43%). The botanicals, azadirachtin and pongamia oil caused 46.06% and 39.55% reduction over control in defoliation respectively (Table 3, Fig. 1). The efficacy of the treatments in reducing the defoliation in second spray presented in Table 4 was found to be similar to the first spray. The per cent reduction over control of defoliation in the second spray was higher by profenophos (81.28%) followed by Btk (72.16%), *B. bassiana* (68.32%) and *M. rileyi* (60.64%) whereas least was caused by pongamia oil (36.64%) (Table 4, Fig. 2). The level of toxicity of the bio pesticides has decreased with time indicated by the higher efficacy of the pesticides upto 5 days after spraying and gradual decrease from 7 days to 10 days after treatment application in our present study. This is similar to the findings of Vimala Devi *et al*. (1996) where it was mentioned that the maximum mortality of the larvae was observed at 5 days of treatment.

The effect of treatments on the larval parasitization by *S. maculipennis* was observed in the two sprays mentioned in Table 5. It revealed that all the botanicals and microbials were safer to the parasitoid compared to the profenophos. Next to the untreated plots, the larval parasitization was very high in larvae collected from azadirachtin in both first (56.67%) and second spray (53.33%) followed by pongamia oil and *M. anisopliae.* The parasitization of larvae from chemical insecticide treated plot is 16.67% during first spray and 13.33% during second spray. This indicated the harmful and negative effect of the chemical insecticides and the safety of the bio pesticides towards the natural enemies. This safety of bio pesticides to semilooper larval parasitoid, *S. maculipennis* over profenophos under field conditions are in consistent with the findings of Basappa and Lingappa (2005). The significant similarity existed between all the microbials and the botanicals were on par with each other.

Table 3: Effect of biopesticides on defoliation caused by castor semilooper during first spray.

Sr. No.	Treatments	Dosage	Per cent defoliation of *A. janata* per plant after first spray					
			Pre count	5DAS	7DAS	10DAS	Mean	PRC
1.	*B. bassiana* (2×10^8 CFU g^{-1})	5gl^{-1}	28.33(32.16)	15.67(23.32)^d	8.33(16.77)^d	7.00 (15.32)^e	10.33	66.52
2.	*M. anisopliae* (2×10^8 CFU g^{-1})	5gl^{-1}	28.00(31.94)	18.00(25.09)^c	12.33(20.55)^c	10.67(19.06)^d	13.67	54.43
3.	Btk	1gl^{-1}	30.67(33.62)	13.00(21.13)^e	6.67(14.95)^{de}	5.34(13.34)^f	8.34	74.89
4.	*M. rileyi* (1.5×10^{13} spores ml^{-1})	5gl^{-1}	29.33(32.79)	17.33(24.59)^{cd}	11.33(19.67)^c	9.67(18.11)^d	12.78	59.08
5.	Azadirachtin (1500ppm)	5ml l^{-1}	30.00(33.19)	21.00 (27.27)^b	16.33(23.84)^b	14.67(22.52)^c	17.33	46.06
6.	Pongamia oil	2ml l^{-1}	28.67(32.37)	21.76 (27.74)^b	17.67(24.84)^b	16.67(24.09)^b	18.70	39.55
7.	Profenophos	1ml l^{-1}	31.33(34.03)	12.33 (18.75)^f	6.00(13.29)^e	4.00(11.54)^g	7.44	77.68
8.	Control		29.00(32.58)	30.00(33.21)^a	31.33(34.03)^f	32.00(34.44)^a	31.11	
	SE(m$\pm$)		0.508	0.508	0.601	0.480		
	CV (%)			3.503	4.964	4.197		
	CD (P=0.05)		NS	1.542	1.825	1.455		

Figures in parentheses are angular transformed values; CD= Critical difference; NS= Non- significant; PRC= Per cent reduction over control

Table 4: Effect of bio pesticides on defoliation caused by castor semilooper during second spray.

Sr. No.	Treatments	Dosage	Per cent defoliation of *A.janata* per plant after second spray					
			Pre count	5DAS	7DAS	10DAS	Mean	PRC
1.	*B. bassiana* (2×10^8 CFU g^{-1})	5gl^{-1}	7.00(15.32)^e	3.67(11.02)^{de}	2.00(7.95)^{de}	1.33(6.54)^e	2.33	68.32
2.	*M. anisopliae* (2×10^8 CFU g^{-1})	5gl^{-1}	10.67(19.06)^d	7.00(15.34)^c	4.67(12.46)^c	3.67(11.02)^d	5.11	53.92
3.	Btk	1gl^{-1}	5.34(13.34)^f	2.67(9.36)^{ef}	1.33(6.54)^e	0.67(3.92)^e	1.56	72.16
4.	*M. rileyi* (1.5×10^{13} spores ml^{-1})	5gl^{-1}	9.67(18.11)^d	5.67(13.76)^{cd}	3.67(11.02)^{cd}	2.67(9.36)^d	4.00	60.64
5.	Azadirachtin (1500ppm)	5ml l^{-1}	14.67(22.52)^c	10.67(19.06)^b	7.67(16.07)^b	6.67(14.89)^c	8.34	45.28
6.	Pongamia oil	2ml l^{-1}	16.67(24.09)^b	13.33(21.41)^b	10.33(18.72)^b	9.33(17.75)^b	11.00	36.64
7.	Profenophos	1ml l^{-1}	4.00(11.54)^g	1.67(6.13)^f	0.67(2.90)^f	0.00(0.29)^f	0.78	81.28
8.	Control		32.00(34.44)^a	33.67(35.46)^a	33.67(35.46)^a	33.00(35.06)^a	33.45	
	SE(m$\pm$)		0.480	1.456	1.372	1.052		
	CV (%)		4.197	11.639	14.580	12.319		
	CD (P=0.05)		1.455	3.352	3.546	2.665		

Figures in parentheses are angular transformed values; CD= Critical difference; NS= Non- significant; PRC= Per cent reduction over control

Parasitized larva

Semilooper affected by the Bt

Table 5: Effect of bio rational pesticides on parasitization by *S. maculipennis.*

Sr. No.	Treatments	Dosage	Per cent parasitization by *S. maculipennis*	
			First spray	Second spray
1.	*B. bassiana* (2×10^{8} CFU g^{-1})	$5gl^{-1}$	40.00 (39.15)^{d}	40.00 (39.23)^{de}
2.	*M. anisopliae* (2×10^{8} CFU g^{-1})	$5gl^{-1}$	46.67 (43.08)^{bcd}	46.67 (43.08)^{bcd}
3.	Btk	$1gl^{-1}$	40.00 (39.23)^{d}	36.67 (37.22)^{e}
4.	*M. rileyi* (1.5×10^{13} spores ml^{-1})	$5gl^{-1}$	43.33 (41.15)^{cd}	43.33 (41.15)^{cde}
5.	Azadirachtin (1500ppm)	5ml l^{-1}	56.67 (48.85)^{ab}	53.33 (46.92)^{ab}
6.	Pongamia oil	2ml l^{-1}	53.33 (46.92)^{bc}	50.00 (45.00)^{bc}
7.	Profenophos	1ml l^{-1}	16.67 (23.86)^{e}	13.33 (21.14)^{f}
8.	Control		66.67 (54.78)^{a}	60.00 (50.77)^{a}
	SE(m$\pm$)		2.077	1.813
	CV (%)		8.543	7.745
	CD (P=0.05)		6.303	5.503

Figures in parentheses are angular transformed values CD= Critical difference

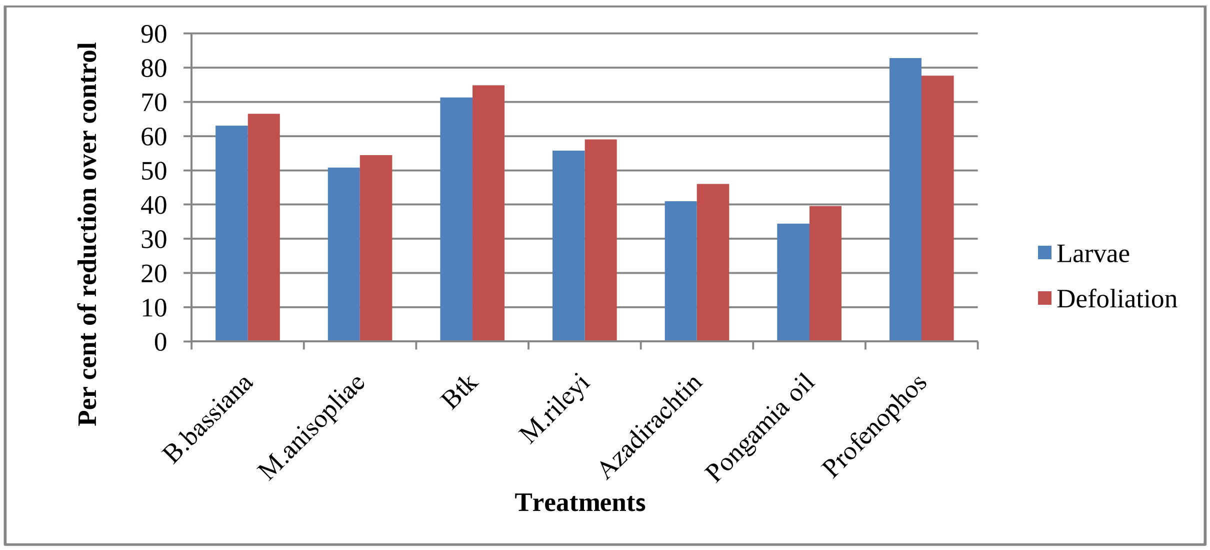

Fig. 1. Per cent reduction over control of larvae and defoliation by the treatments during first spray.

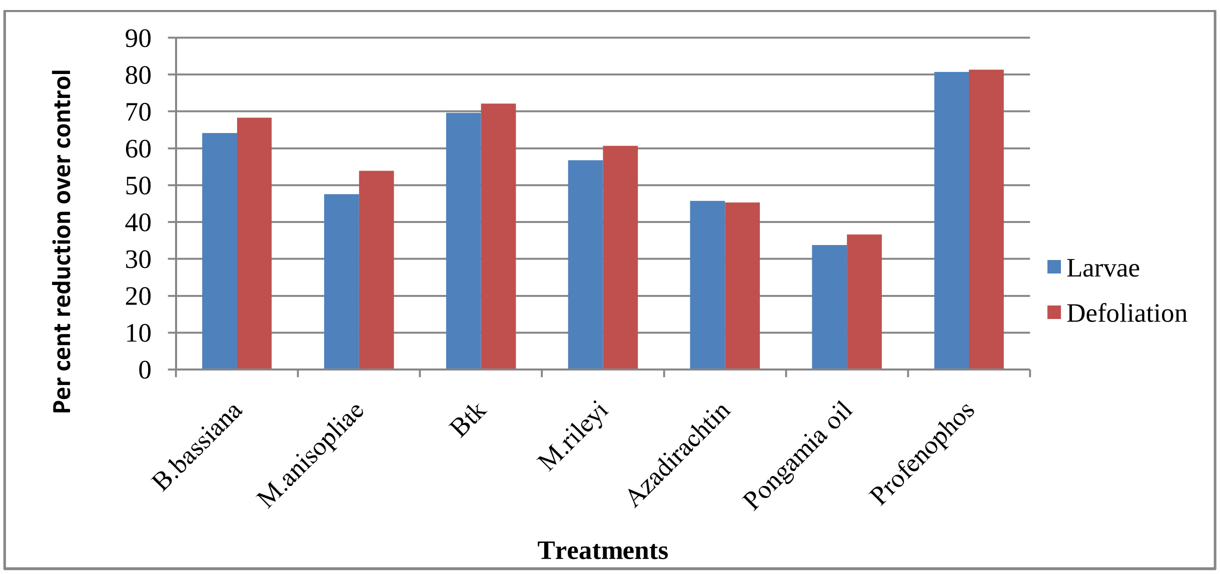

Fig. 2. Per cent reduction over control of larvae and defoliation by the treatments during 1st spray.

CONCLUSION

Spraying of profenophos was found to be most effective in controlling the castor pests. Among the microbials tested, Btk and *B. bassiana* are found effective from 5DAS and resulted in appreciable yield over untreated control and *M. anisopliae* was least effective as compared to other bio pesticides. In case of botanicals, azadirachtin was superior over pongamia oil against the *A. janata*. Botanicals were least effective to control the pest as compared to microbial pesticides. The results revealed that the bio pesticides has led to least reduction of parasitization by *S. maculipennis* contrary to the chemical insecticide, they are regarded as safer to the natural enemies. So, based on the efficacy and safety to natural enemies, microbials and azadirachtin can be recommended among which *Btk* is the best.

FUTURE SCOPE

Bio pesticides are environmentally sustainable compared to synthetic pesticides. As environmental safety of the pesticides is also essential in addition to the efficient pest control there is huge requirement for the usage of biopesticides in near future and so the research to study the efficacy of various bio pesticides is essential.

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Conflict of Interest. None.

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