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Bio-efficacy of Biopesticides against Sucking Pests in Green Gram Grown during *Kharif*

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ABSTRACT

Investigations were carried out at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during Kharif, 2015 for bio-efficacy of various biopesticides on the incidence of sucking pests viz., aphids (Aphis craccivora Koch), jassids (Empoasca kerri Pruthi), whiteflies (Bemisia tabaci Gennadius), thrips (Thrips palmi Karny) and flower thrips (Megalurothrips usitatus Bagnall) in green gram. Among the various biopesticides evaluated for their field efficacy against sucking pests, tobacco decoction (2 %) extracted either with hot or cold water found more effective followed by Beauveria bassiana(0.1%, 1 x 10^{10} CFU/ g). Azadirachtin recorded the highest thrips population and failed to protect the crop as it was at par with control.The effectiveness of these treatments also reflected on green gram yield. Higher Incremental Cost Benefit Ratio (ICBR) was also obtained in these treatments.

Key words: *Biopesticides, Sucking pests, Tobacco decoction hot or cold, B. bassiana, Neem oil, NSKE, L. lecanii, Azadirachtin.*

INTRODUCTION

Pulse crops have a unique position in sustainable crop production as they provide highly nutritive food and keep the soil alive as well as productive and also in the agricultural economy of India being the major source of protein in Indian dietary. The General Assembly of the United Nations has recognised pulses as an essential source of protein and a part of improving nutrition globally and declared 2016 as "The International Year of Pulses"[3]. India is the world's largest producer (18.5 million tonnes), largest importer (3.5 million tonnes) and largest consumer (22.0 million tonnes) of pulses[4].

The sucking pests like aphids, *Aphis craccivora* Koch; jassids, *Empoasca kerri* Pruthi; white flies, *Bemisia tabaci* Gennadius, thrips, *Thrips palmi* Karny and flower thrips, *Megalurothrips usitatus* Bagnall are known to cause significant damage to green gram crop. Whitefly, a potential vector of mung bean yellow mosaic virus (MYMV), can cause losses ranging from 30 – 70 per cent[20] and 80 to 100 per cent in green gram and black gram[14]. Thrips caused at least 40 per cent yield loss in green gram[19].

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The annual yield loss due to the insect pests has been estimated to the tune of 30 per cent in green gram[18] and in urd bean and green gram[9]. There is a need to investigate the tools for the sucking pests of green gram to develop an effective management strategy. In sustainable farming, biopesticides often considered to be important components of Integrated Pest Management (IPM) programmes and have received much practical attention as substitutes to synthetic chemicals. Henceforth, the field experiment was conducted to evaluate some unknown biopesticides to manage the sucking pests in green gram.

MATERIALS AND METHODS

In order to evaluate the efficacy of various biopesticides *viz.*,Azadirachtin 0.15 EC @ 0.0006%, Neem oil @ 0.5%, NSKE @ 5%, *Beauveria bassiana*(1 x 10^{10} CFU/ g) @ 0.1%, *Lecanicillium lecanii*(1 x 10^{10} CFU/ g) @ 0.1%, Tobacco decoction (Hot water extraction) @ 2%, Tobacco decoction (Cold water extraction) @ 2% and Control (water spray) against sucking pests in green gram. The experiment was laid out in a Randomized Block Design with three replications having gross and net plot area 2.7 m × 3.0 m and 1.8 m × 2.7 m, respectively during *Kharif* season of 2015 at College Agronomy Farm, B. A. College of Agriculture, AAU, Anand. Green gram cultivar, Meha was grown with spacing 45 cm × 15 cm under recommended agronomical practices.

Method of application

First spray application of respective biopesticides was given on the initiation of the pests and subsequently one another spray was given after 25 days using manually operated knapsack sprayer having duromist nozzle with slight runoff stage. To prepare neem seed kernel extract, the required quantity of kernels was weighed (250 g) on electric balance and grinded on electric grinder. The powder was kept in muslin cloth bag and soaked into 2 litres of water for overnight and thereafter, the bag was squeezed repeatedly until the out flowing fluid turns light brownish in colour. Finally volume (5 litres) was prepared by adding water. To prepare tobacco decoction (Hot water), 100 g tobacco leaf dust was soaked in 5 litres of water and kept for overnight. Next day, it was boiled at 60-70°C temperature for one hour and maintained five litre volume by adding additional water. In this stock solution, 100 g washing powder was added and mixed well. To make tobacco decoction (cold water), same procedure was followed except the boiling. Spray solution was prepared fresh a day before spray application and diluted with water (1:4) just before spraying. Likewise, the required biopesticides were collected from Department of Entomology and were sprayed.

Method of recording observations

For recording the observations, five plants were selected randomly and tagged in each net plot. The population of aphids, jassids, whiteflies and thrips was counted from three (upper, middle and lower leaves) from the same selected plants. The population of flower thrips per five flowers was counted from the same selected plants in each sector. The observations on sucking pests as well as natural enemies population were recorded prior to one day of first spray as well as after 3, 5 and 10 days after each spray.

Yield

Yield was recorded after threshing and separating of green gram seeds. Seed yield from each plot was weighed separately and converted into quintals per hectare for further statistical analysis.

$$\text{Per cent increase over control} = \frac{\text{Yield of treatment} - \text{Yield of control}}{\text{Yield of treatment}} \times 100$$

The per cent increase over control was also calculated by following formula:

Economics

The economics of the biocides were worked out. In order to know the economics of different treatments evaluated against sucking pests infesting green gram, Insecticidal Cost Benefit Ratio (ICBR) was worked out. For the purpose, total cost of biopesticides treatment per hectare was calculated for each treatment based on the prevailing market price. The net gain (yield) over control was calculated by subtracting the yield obtained in control treatment from the yield obtained in each biopesticides treatment. Then, the realization was worked out for each treatment based on increased yield (q/ha) over control. The net profit (Rs./ha) for each treatment was computed by deducting the cost of biopesticides treatment from the value of realization over control. The ICBR *i.e.* net gain in rupees per rupee cost of biopesticides treatment was calculated by dividing net profit with the cost of treatment. This gives value of gross ICBR. To calculate the value of net ICBR (NICBR) *i.e.* additional profit gained per rupee cost of treatment, 1 rupee was subtracted from ICBR obtained in each treatment.

RESULTS AND DISCUSSION

Application of biopesticides

First spray application of respective biopesticides was given on the initiation of the sucking pests and subsequently one another spray was given after 25 days.

Efficacy of various biopesticides on aphids, *A. craccivora*

The data on aphids population recorded periodically was also pooled and depicted in Table 1 (Column 2). The data clearly indicated that all the biopesticidal treatments significantly better than control. Among the various biopesticides, tobacco decoction, hot water was found significantly superior than rest of the treatments and recorded the lowest (2.32 aphids/ 3 leaves)population of aphids. Although, it was at par with tobacco decoction cold water extraction (2.49) and *B. bassiana*(2.56). Neem oil, NSKE and *L. Lecanii* recorded 3.87, 3.99 and 4.08 aphids per 3 leaves, respectively and were at par with each other. Among the biopesticides, azadirachtin (6.05) recorded the highest aphids population and found to be less effective. However, all the biopesticides were significantly more effective as compared to control (9.17).

Table 1: Efficacy of biopesticides against different sucking pests in green gram in *Kharif* Pooled over periods and sprays)

Treatments	No. of sucking pests/ 3 leaves				No. of flower thrips/ 5 flowers
	Aphids	Jassids	Whiteflies	Thrips	
1	2	3	4	5	6
Azadirachtin 0.15 EC @ 0.0006 %	2.56 c (6.05)	1.96 c (3.34)	2.12 c (3.99)	3.48 d (11.61)	2.34 c (4.98)
Neem oil @ 0.5 %	2.09 b (3.87)	1.56 b (1.93)	1.69 b (2.36)	2.20 b (4.34)	1.86 b (2.96)
NSKE @ 5 %	2.12 b (3.99)	1.58 b (2.00)	1.72 b (2.46)	2.22 b (4.43)	1.88 b (3.03)
Beauveriabassiana (1×10^{10} CFU/ g) @ 0.1%	1.75 a (2.56)	1.53 b (1.84)	1.31 a (1.22)	1.75 a (2.56)	1.46 a (1.63)
Lecanicilliumlecanii (1×10^{10} CFU/ g) @ 0.1%	2.14 b (4.08)	1.94 c (3.26)	1.75 b (2.56)	2.68 c (6.68)	1.90 b (3.11)
Tobacco decoction (Hot water extraction) @ 2 %	1.68 a (2.32)	1.17 a (0.87)	1.26 a (1.09)	1.70 a (2.39)	1.38 a (1.40)
Tobacco decoction (Cold water extraction) @ 2 %	1.73 a (2.49)	1.20 a (0.94)	1.28 a (1.14)	1.73 a (2.49)	1.41 a (1.49)
Control (water spray)	3.11 d (9.17)	2.49 d (5.70)	2.53 d (5.90)	3.74 e (13.49)	2.59 c (6.21)
F-Test (T)	Sig	Sig	Sig	Sig	Sig
S.Em.± Treatment (T)	0.08	0.04	0.09	0.06	0.09
Period (P)	0.03	0.02	0.01	0.03	0.02
T x P	0.08	0.05	0.03	0.08	0.06
C. D. at 5% Treatment (T)	0.24	0.11	0.27	0.17	0.27
Period (P)	0.08	NS	0.03	0.08	0.06
T x P	NS	NS	NS	NS	NS
C.V.%	11.02	9.34	15.85	9.90	14.48

Notes: Figures in parentheses are retransformed values; those outside are $\sqrt{X+0.5}$transformed values. Treatment mean with letter(s) in common are not significant by DNMRT at 5 % level of significance within a column; Non-Significant; S: Significant

Higher effectiveness of neem oil and lower effectiveness of *V. Lecanii* against aphids was reported in cowpea[11]. Higher effectiveness of *B. bassiana was* observed in laboratory bioassay[17] and in urdbean[16] against aphids. Tobacco decoction extracted either hot or cold water extraction was most effective to manage the population of aphids in safflower[15].

Efficacy of various biopesticides on jassids, *E. Kerri*

The periodical data recorded after first and second sprays were also pooled and presented in Table 1 (Column 3). The chronological order of various biopesticides based on number of jassids per 3 leaves (given in bracket) was: tobacco decoction hot water extract (0.87) > tobacco decoction cold water extract (0.94) >*B. bassiana*(1.84) >neem oil (1.93) > NSKE (2.00) >*L. lecanii*(3.26) >azadirachtin (3.34) > control (5.70). Among the tested biopesticides, tobacco decoction extracted either hot water or cold water found significantly superior and recorded lower population of jassids. *B. bassiana,* neem oil and NSKE were found to be mediocre in their effectiveness against pest. Whereas, *L. Lecanii* and azadirachtin were proved to be less effective as they recorded significantly higher population of jassids in green gram.

The highest per cent reduction of jassids in brinjal was reported by the application of tobacco decoction and NSKE[2]. Neem oil was more effective to manage the population of jassids in cowpea[11]. Higher effectiveness of neem oil and NSKE against jassids was mentioned[7] in cotton earlier. Effectiveness of NSKE was reported against jassids infesting soybean crop[8].

Efficacy of various biopesticides on whiteflies, *B. tabaci*

The data on whiteflies population recorded periodically was also pooled and presented in Table 1 (Column 4). All the biopesticidal treatments were significantly differed from the control. Among the various biopesticides, tobacco decoction both hot water (1.09 whiteflies/ 3 leaves) or cold water extraction (1.14) as well as *B. bassiana* (1.22) recorded significantly lower population and proved their higher effectiveness against this pest. Further, they all were at par with each other. Neem oil, NSKE and *L. lecanii* recorded 2.36 to 2.56 whiteflies per 3 leaves and also found comparatively effective. Among the tested biopesticides, azadirachtin (3.99) recorded significantly the highest population and found to be least effective against whiteflies in green gram. However, it was better than control (5.90).

While shifting the literatures, *B. bassiana* in cotton was found highly effective whereas neem products *viz.,* neem oil and NSKE proved to be mediocre in their effectiveness against whiteflies[7]. Neem oil and NSKE in sesame were mediocre in their effectiveness[1]. Higher efficacy of *B. bassiana* against whiteflies was observed in black gram[18]. The effectiveness of NSKE was proved to be mediocre in controlling whiteflies in green gram[13], in black gram[12]and in moth bean[5]. As such, the present findings are in conformity with the past literatures.

Efficacy of various biopesticides on thrips, *T. palmi*

The periodical data recorded after first and second sprays were also pooled and presented in Table 1 (Column 5). The chronological order of various biopesticides based on number of thrips per 3 leaves (given in bracket) was: tobacco decoction hot water extract (2.39) > tobacco decoction cold water extract (2.49) >*B. bassiana* (2.56) >neem oil (4.34) > NSKE (4.43) >*L. Lecanii* (6.68) >azadirachtin (11.61) > control (13.49). Among the tested biopesticides, tobacco decoction extracted either hot water or cold water as well as *B. bassiana* found significantly superior and recorded lower population of thrips. Neem oil and NSKE were proved to be mediocre in their effectiveness against this pest. *L. Lecanii* was found comparatively less effective against thrips infesting green gram. Azadirachtin proved to be least effective and failed to protect the crop as it was at par with population of control.

Higher effectiveness of neem oil and lower effectiveness of *L. lecanii* against thrips was reported in cowpea[11]. Azadirachtin did not

show any significant effect on thrips in cowpea[10].

Efficacy of various biopesticides on flower thrips, *M. usitatus*

The data on flower thrips population recorded periodically was also pooled and presented in Table 1 (Column 6). Among the biopesticidal treatments, tobacco decoction extracted either hot (1.40 thrips/ 5 flowers) or cold (1.49) water as well as *B. bassiana* (1.63) were found significantly better than the rest of the biopesticides under study. Neem products *viz.*,neem oil (2.96) and NSKE (3.03) were also found effective against flower thrips infesting green gram. Further, they were at par with each other. *L. Lecanii* (3.11) was found comparatively less effective. Among the tested biopesticides, azadirachtin (4.98) recorded significantly the highest population and failed to provide protection to the crop against flower thrips as it was at par with control (6.21).

Azadirachtin did not show any kinds of significant effect on thrips infesting cowpea[10].

Effect of various biopesticides on natural enemies population

Coccinellids (grubs and adults):

The data on coccinellids recorded periodically was also pooled and summarized in Table 2 (Column 2). The chronological order of various biopesticides in comparison to control based on population of coccinellids (grubs and adults) per plant (in bracket) was: control (1.87) >*B. bassiana* (1.69) >*L. lecanii* (1.57) >azadirachtin (1.40) >neem oil (1.35) > tobacco decoction cold water extract (1.30) > tobacco decoction hot water extract (1.24) >NSKE (1.19). There was no significant difference among the treatments so far the population of coccinellids is concerned. It indicated that none of the tested biopesticides imposed any significant adverse effect on the prevailing population of this predator.

***Chrysoperla* spp. (grubs):**

The population of *Chrysoperla* spp. (grubs) was observed at 10 DAS and presented in Table 2 (Column 3) clearly indicated that there was no significant difference among the treatments. From this results, it can be said that no any biopesticides under present study exerted any significant adverse effect on the population of this natural enemy.

Table 2: Impact of biopesticides on coccinellids, *Chrysoperla* spp. and seed yield of green gram

Treatments	No. of coccinellids (grubs + adults)/ plant	No. of *Chrysoperla* spp. grubs/ plant	Seed yield (q/ ha)	Increase over control (%)
1	2	3	4	5
Azadirachtin 0.15 EC @ 0.0006 %	1.38 (1.40)	1.44 (1.57)	6.98 d	18.19
Neem oil @ 0.5 %	1.36 (1.35)	1.42 (1.52)	8.64 abc	33.91
NSKE @ 5 %	1.30 (1.19)	1.39 (1.43)	8.03 bcd	28.89
Beauveria bassiana (1×10^{10} CFU/ g) @ 0.1%	1.48 (1.69)	1.50 (1.75)	8.95 ab	36.20
Lecanicillium lecanii (1×10^{10} CFU/ g) @ 0.1%	1.44 (1.57)	1.45 (1.60)	7.56 cd	24.47
Tobacco decoction (Hot water extraction) @ 2 %	1.32 (1.24)	1.38 (1.40)	9.72 a	41.30
Tobacco decoction (Cold water extraction) @ 2 %	1.34 (1.30)	1.37 (1.38)	9.26 ab	38.34
Control (water spray)	1.54 (1.87)	1.54 (1.87)	5.71 e	-
	F-Test (T)	NS	NS	Sig	-
S.Em.±	Treatment (T)	0.07	0.08	0.39	-
	Period (P)	0.01	-	-	-
	T x P	0.03	-	-	-
C. D. at 5%	Treatment (T)	NS	-	0.12	-
	Period (P)	0.04	-	-	-
	T x P	NS	-	-	-
	C.V.%	15.91	9.58	8.35	-

Notes: Figures in parentheses are retransformed values; those outside are $\sqrt{X+0.5}$transformed values. Treatment mean with letter(s) in common are not significant by DNMRT at 5 % level of significance within a column; Non-Significant; S: Significant

Higher population of coccinellids and more safeness in tomato plots treated with *B. bassiana* and *L. lecanii*[6]. Azadirachtin and *B. bassiana* were less harmful to coccinellids in black gram[22].

Impact of various biopesticides on seed yield, per cent increase in yield over control and economics

The data on seed yield of green gram are presented in Table 2 (Column 4). Plots treated with different biopesticides yielded significantly higher seed yield (6.98 to 9.72 q/ ha) than control (5.71). The chronological order of various biopesticidal treatments in comparison to control based on seed yield (q/ ha) given in bracket was: tobacco decoction hot water (9.72)> tobacco decoction cold water (9.26) >*B. bassiana* (8.95) >neem oil (8.64) > NSKE (8.03) >*L. lecanii* (7.56) >azadirachtin (6.98) > control (5.71).

Significantly the highest seed yield was recorded from the plots treated with tobacco decoction hot water. However, it was at par with tobacco decoction cold water, *B. bassiana* and neem oil. NSKE, *L. lecanii* and azadirachtin yielded more or less equally as they were at par with each other. Although, the lowest seed yield was obtained from the control plots.

Higher yield in plots treated with *B. bassiana* in cucumber[21]. Higher yield from the sesame plots treated with neem oil[1]. The higher seed yield in black gram plots treated with NSKE[12].

Per cent increase in yield over control:

The per cent increase in yield over control in green gram seed yield was also worked out and presented in Table 2 (Column 5). The chronological order of various treatments based on per cent increase in yield over control given in bracket was: tobacco decoction hot water (41.30%)> tobacco decoction cold water (38.34%) >*B. bassiana* (36.20%) >neem oil (33.91%) > NSKE (28.89%) >*L. lecanii* (24.47%) >azadirachtin (18.19%). Maximum yield loss could be avoided with spray application of tobacco decoction extracted either by hot or cold water and *B. bassiana* followed by neem oil.

Economics:

The economics of various biopesticides (Table 3) revealed that the highest (24,060.00 Rs./ ha) realization was obtained from the treatmenttobacco decoction hot water extraction followed by tobacco decoction cold water extraction (21,300.00 Rs./ ha), *B. bassiana* (19,440.00 Rs./ ha) and neem oil (17,580.00 Rs./ ha). The highest Insecticidal Cost Benefit ratio (ICBR) was calculated from the plots treated with tobacco decoction hot water extraction (1:18.03). Tobacco decoction cold water extraction (1: 15.85), *B. bassiana* (1:12.75), *L. lecanii* (1:6.85) and neem oil (1:4.89) also recorded higher ICBR. NSKE (1:2.78) and azadirachtin (1: 1.95) recorded lower ICBR and found not much economical. The highest (17.03) Net Insecticidal Cost Benefit Ratio (NICBR) was calculated from the plots treated with tobacco decoction hot water extraction. Tobacco decoction cold water extraction (14.85) and *B. bassiana* (11.75) also recorded higher NICBR. NSKE (1.78) and azadirachtin (0.95) recorded lower NICBR and found not much economical.

Higher ICBR in sesame plots treated with neem oil[1].

Table 3: Economic of various biopesticides used for control of sucking pestsinfesting green gram

Biopesticides (%)	Conc. (%)	Total cost treatmen (Rs./ha)	Yield of seed (q/ha)	Net gain over control (q/ha)	Realization (Rs./ha)	Net Realization (Rs./ha)	ICBR	NICBR
1	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Azadirachtin 0.15 EC	0.0006	2584	6.98	1.27	7620	5036	1:1.95	0.95
Neem oil	0.5	2984	8.64	2.93	17580	14596	1:4.89	3.89
NSKE	5	3684	8.03	2.32	13920	10236	1:2.78	1.78
Beauveria bassiana (1×10^{10} CFU/ g)	0.1	1414	8.95	3.24	19440	18026	1:12.75	11.75
Lecanicillium lecanii (1×10^{10} CFU/ g)	0.1	1414	7.56	1.85	11100	9686	1:6.85	5.85
Tobacco decoction (Hot water extraction)	2	1264	9.72	4.01	24060	22796	1:18.03	17.03
Tobacco decoction (Cold water extraction)	2	1264	9.26	3.55	21300	20036	1:15.85	14.85
Control (water spray)	-	-	5.71	-	-	-	-	-

Market price of green gram grain : Rs. 60/ kg (Rs. 6000/ quintal)\
Labour charges : For spraying Rs. 296/labour/day
Two labour per hectare required for each spray, two sprays were given (500 litre spray solution is required for one spray for one hectare)

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