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Efficacy of Biopesticides against Pod Bug, *Clavigralla gibbosa* Spinola (Heteroptera; Coreidae) in Pigeonpea

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ABSTRACT

Background: Pigeonpea is the major pulse crop of India. In reproductive stage pigeonpea is exposed to biotic pests causing damage to flowers, pods and grains. Pod bugs, *Clavigralla gibbosa* Spinola are one of the major biotic constraints in reducing productivity of pigeonpea. Nymphs and adults suck the sap from pods and cause loss of seed yield. Chemical residues will remain in the grains affecting health of the consumer. Eco-friendly molecules are best alternatives to manage pod bugs.

Methods: Efficacy test of biopesticides *viz*., *Lecanicillium lecanii*, *Beauveria bassiana*, *Metarhizium anisopliae,* NSKE 5%, Neemazol 1% and Sasyarakshak against *C. gibbosa* was conducted in pigeonpea during *Kharif* 2017-18 and 2018-19 at Agricultural Research Station, Kalaburagi, Karnataka, India under field conditions with seven treatments including control in three replications. Two sprays were taken at tender pod stage and population was recorded. Pod damage and grain damage was assessed at harvest.

Result: NSKE 5% was superior in reducing pod bug population, pod damage and grain damage followed by *L. lecanii* and neemazol 1%. *M. anisopliae* was found to be ineffective in reducing the population, pod damage and grain damage. The average grain yield of 1229.10 kg/ha was highest in NSKE 5% followed by *L. lecanii* (1223.48 kg/ha) and neemazol 1% (1199.53 kg/ha). The B:C was 2.45 in NSKE 5% and 2.43 in *L. lecanii* were higher than other treatments. Therefore, these two biopesticides can be used for effective management of pod bug in pigeonpea.

Key words: Biopesticides, *Clavigralla gibbosa*, Pigeonpea, Pod bug.

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is a food legume crop cultivated in semi-arid tropical and sub-tropical areas (Shanower *et al*., 1999). World's total 90% of pigeonpea production is from India, but the yields of crop has remained stagnant over the past few decades due to its vulnerability to several biotic and abiotic stresses (Basandrai *et al.,* 2011). Among biotic factors more than 300 species insect pests known to attack pigeonpea (Prasad and Singh, 2004) but insects which occur in reproductive stage cause maximum yield losses (Rangaiah and Sehgal, 1984) *viz.,* gram pod borer, *Helicoverpa armigera* (Hubner), pod fly, *Melanagromyza obtusa* (Malloch) and spotted pod borer, *Maruca vitrata* (Geyer) cause severe damage. However, in recent past major changes were noticed in pest status on this crop. Leaf webber, *Grapholita critica* (Meyr.) and sucking pests such as, pod bugs, *Clavigralla gibbosa* Spinola, *Reptortus dentipes* Fabricius, *Anoplocnemis curvipis* (Fabricius) and *Nezara virudula* (Linnaeus) and green leafhopper, *Empoasca kerri* (Pruthi) are appearing in large numbers and reaching to the pest status causing significant economic loss (Rachappa *et al*., 2018).

The pod bug can cause the pod damage of 21% to 26% and grain damage of 1.96% to 16.97% in pigeonpea (Ganguly *et al.,* 2016). In recent years pod bugs are a real threat to quality grain production in pigeonpea. Both nymphs and adults suck sap from pods and make shrivelled leading to reduction in the quality of grains. The chemical insecticides have found to be effective in controlling the pod pest complex. However, indiscriminate use of chemicals lead to the problems like pest outbreak, development of insecticide resistance by pests, elimination of natural enemies and risk to human and animal health besides environmental pollution. So, now it is high time to think of those strategies which are eco-friendly and environmentally safe to manage the pests efficiently. Keeping this in view present study was undertaken to evaluate the efficacy of biopesticides against pod bug, *C. gibbosa* in pigeonpea ecosystem.

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MATERIALS AND METHODS

To test the efficacy of biopesticides against pod bugs in pigeonpea, field experiments were carried out at Agricultural Research Station, Kalaburagi during *kharif* 2017-18 and 2018-19. The experiments consisted of seven treatments including control *viz., Lecanicillium lecanii* @ 2g/l, *Beauveria bassiana* @ 2g/l, *Metarhizium anisopliae* @ 2g/l*,* NSKE 5%, Neemazol 1% @ 2ml/l and Sasyarakshak @ 10ml/l with three replications in a randomized block design having plot size of 8 m x 8.1 m and spacing of row to row (90 cm) and plant to plant (20 cm). The biopesticides, *L. lecanii B. bassiana* and *M. anisopliae* were supplied by University of Agricultural Sciences, Dharwad, Neemazol by Gr Organic Farms, Ludhiana, Sasyarakshak by BRICS, Karnataka and NSKE 5% was prepared in ARS, Kalaburagi. All the package of practices (Anonymous 2017) was followed to rise the crop except for insect pests. The *Helicoverpa armigera* was managed through manual collection and repeated spraying of *Ha*NPV (Cherry *et al.,* 2000).

In each treatment two sprays were given first application at tender pod stage followed by second spray after 15 days. Observations on bugs population was recorded one day before and 10 days after each spray. Both pod and grain damage by pod bug was assessed from five randomly selected plants from each plot at harvest. Pod damage was assessed by selecting all the pods of five plants and for grain damage hundred pods were selected randomly among the pods of five. The per cent pod damage, per cent grain damage and grain yield per plot were recorded. The grain yield (kg ha^{-1}) was computed and experimental data was subjected to statistical analysis using two-way ANOVA.

RESULTS AND DISCUSSION

Pod bug (*C. gibbosa*) population was non-significant ranging from 3.20 to 3.60 bugs per plant at one day before first spray in all the treatments including control during *Kharif* 2017-18 indicating uniform incidence of pest in the experimental plot. At ten days after treatment, the population was significant ranging from 1.33 to 3.20 bugs per plant. The treatments like NSKE 5% (1.33 bug/plant), *L. lecanii* (1.40 bug/plant) and neemazol 1% (1.47 bug/plant) have registered lower bug population and were at par with each other. The next best treatments were sasyarakshak (1.73 bug/plant), *B. bassiana* (2.13 bugs/plant) and *M. anisopliae* (2.27 bugs/ plant). Maximum population reduction of pod bug over control was observed in NSKE 5% (58.44%) followed by *L. lecanii* (56.25%) and neemazol 1% (54.06%) and least reduction was in treatment *M. anisopliae* (29.06%) (Table 1). In second spray, at one day before spray, observation on the mean population of pod bug ranged from 2.93 to 3.40 per plant (Table 1). Ten days after treatment, the bug population ranged from 1.13 to 3.47 bugs per plant. The NSKE 5% and *L. lecanii* recorded lowest population of 1.13 bugs per plant and it was statistically on par with neemazol 1% (1.27 bug/plant) and highest in *M. anisopliae* (2.13 bugs/ plant) among treated plot. The highest reduction of pod bug population over control was observed in NSKE 5% and *L. lecanii* of 67.44% followed by neemazol 1% (63.40%) and least reduction in *M. anisopliae* (38.62%) (Table 1).

In *Kharif* 2018-19, at one day before first spray, the pod bug population was uniform ranging from 2.67 to 2.95 bugs/ plant. Ten days after spray, NSKE 5% recorded lowest population 1.05 bug/plant and it was statistically at par with *L. lecanii* (1.13 bug/plant). Highest population was in *B. bassiana* treated plot (1.92 bug/plant) followed by *M. anisopliae* (1.87 bug/plant). Maximum population reduction was observed in NSKE 5% (65.57%) followed by *L. lecanii* (62.95%) whereas lowest in *B. bassiana* (37.05%). During second spray, population ranged from 2.36 to 3.58 bugs/ plant at one day before spray. Ten days after spray, NSKE 5% recorded lowest population of 0.95 bug/plant and it was statistically on par with *L. lecanii* (0.97 bug/plant) and Neemazol (1.05 bug/plant). Maximum population in *M. anisopliae* (2.20 bugs/plant) treated plot. The NSKE 5% recorded maximum reduction of bugs (76.13%) followed by *L. lecanii* (75.63%) and *M. anisopliae* (44.72%) was lowest (Table 2).

Table 1: Effect of biopesticides on the population of pod bugs in 2017-18.

Treatments	Pod bugs per plant					
	First spray			Second spray		
	1 DBS	10 DAS	Reduction over untreated check (%)	1 DBS	10 DAS	Reduction over untreated check (%)
T1:- *Lecanicilium lecanii* @ 2g/l	3.47(1.99) ^{a}	1.40(1.38)^{ab}	56.25	3.07(1.89)^{ab}	1.13(1.28)^{a}	67.44
T2:- *Beauveria bassiana* @ 2g/l	3.47(1.99) ^{a}	2.13(1.62)^{d}	33.44	3.33(1.96)^{bc}	2.07(1.60)^{c}	40.35
T3:- *Metarhizium anisopliae* @ 2g/l	3.27(1.94) ^{a}	2.27(1.66)^{d}	29.06	3.40(1.97)^{c}	2.13(1.62)^{c}	38.62
T4:- NSKE 5%	3.60(2.02) ^{a}	1.33(1.35)^{a}	58.44	2.93(1.85)^{a}	1.13(1.28)^{a}	67.44
T5:- Neemazol 1% @ 2ml/l	3.60(2.02) ^{a}	1.47(1.40)^{abc}	54.06	3.20(1.92)^{abc}	1.27(1.32)^{a}	63.40
T6:- Sasyarakshak @ 10ml/l	3.20(1.92) ^{a}	1.73(1.49)^{c}	45.94	3.07(1.89)^{ab}	1.53(1.43)^{b}	55.91
T7:- Control	3.47(1.99) ^{a}	3.20(1.92)^{e}	-	3.40(1.97)^{c}	3.47(1.99)^{d}	-
S.Em±	0.03	0.03		0.02	0.02	
CD at (p=0.05)	NS	0.09		0.07	0.08	

Values in parenthesis are $\sqrt{x+0.5}$ transformed.

Means followed by same alphabet in columns did not differ significantly (p=0.05) by DMRT.

Observation on pod damage and grain damage due to pod bug, *C. gibbosa* during 2017-18 showed that all the treatments were found to be significantly superior over control in reducing the pod damage (Table 3). The minimum pod damage and grain damage was recorded in plot treated with NSKE 5% (12.33% and 11.37%) and it was statistically at par with *L. lecanii* (13.00% and 12.47%), neemazol 1% (13.33% and 12.75%) and sasyarakshak (13.67% and 13.12%) respectively. Next best treatments are *B. bassiana* (16.33% and 14.42%) and *M. anisopliae* (17.00% and

Table 2: Effect of biopesticides on the population of pod bugs in 2018-19.

Treatments	Pod bugs per plant					
	First spray			Second spray		
	1 DBS	10 DAS	Reduction over untreated check (%)	1 DBS	10 DAS	Reduction over untreated check (%)
T1:- *Lecanicilium lecanii* @ 2g/l	2.90(1.84)[a]	1.13(1.28)[a]	62.95	2.51(1.73)[ab]	0.97(1.21)[ab]	75.63
T2:- *Beauveria bassiana* @ 2g/l	2.67(1.78)[a]	1.92(1.56)[d]	37.05	3.09(1.89)[de]	1.98(1.57)[d]	50.25
T3:- *Metarhizium anisopliae* @ 2g/l	2.86(1.83)[a]	1.87(1.54)[d]	38.69	3.15(1.91)[e]	2.20(1.64)[d]	44.72
T4:- NSKE 5%	2.71(1.79)[a]	1.05(1.24)[a]	65.57	2.36(1.69)[a]	0.95(1.20)[a]	76.13
T5:- Neemazol 1% @ 2ml/l	2.85(1.83)[a]	1.41(1.38)[b]	53.77	2.78(1.81)[c]	1.05(1.24)[ab]	73.62
T6:- Sasyarakshak @ 10ml/l	2.92(1.85)[a]	1.60(1.45)[bc]	47.54	2.81(1.82)[cd]	1.29(1.34)[c]	67.59
T7:- Control	2.95(1.86)[a]	3.05(1.88)[e]		3.58(2.02)[f]	3.98(2.12)[e]	
S.Em±	0.05	0.03		0.02	0.02	
CD at (p=0.05)	NS	0.09		0.07	0.08	

Values in parenthesis are √x+0.5 transformed.

Means followed by same alphabet in columns did not differ significantly (p=0.05) by DMRT.

Table 3: Influence of biopesticides spray on pod damage and grain damage of pigeonpea due to pod bug (2017-18).

Treatments	Pod damage (%)	Pod damage reduction over control (%)	Grain damage (%)	Grain damage reduction over control (%)
T1:- *Lecanicilium lecanii* @ 2g/l	13.00(21.12)[a]	38.10	12.47(20.68)[ab]	35.90
T2:- *Beauveria bassiana* @ 2g/l	16.33(23.83)[b]	22.22	14.42(22.32)[cd]	25.86
T3:- *Metarhizium anisopliae* @ 2g/l	17.00(24.34)[b]	19.05	14.65(22.50)[d]	24.71
T4:- NSKE 5%	12.33(20.55)[a]	41.27	11.37(19.70)[a]	41.55
T5:- Neemazol 1% @ 2ml/l	13.33(21.40)[a]	36.51	12.75(20.91)[ab]	34.48
T6:- Sasyarakshak @ 10ml/l	13.67(21.69)[a]	34.92	13.12(21.22)[bc]	32.54
T7:- Control	21.00(27.26)[c]		19.45(26.17)[e]	
S.Em±	0.53		0.39	
CD at (p=0.05)	1.63		1.22	

Values in parenthesis are arcsine transformed.

Means followed by same alphabet in columns did not differ significantly (p=0.05) by DMRT.

Table 4: Influence of biopesticides spray on pod damage and grain damage of pigeonpea due to pod bug (2018-19).

Treatments	Pod damage (%)	Pod damage reduction over control (%)	Grain damage (%)	Grain damage reduction over control (%)
T1:- *Lecanicilium lecanii* @ 2g/l	10.16(18.59)[ab]	45.08	8.90(17.36)[ab]	47.34
T2:- *Beauveria bassiana* @ 2g/l	13.50(21.56)[c]	27.03	11.60(19.91)[c]	31.36
T3:- *Metarhizium anisopliae* @ 2g/l	14.25(22.18)[c]	22.97	12.15(20.40)[c]	28.11
T4:- NSKE 5%	9.10(17.56)[a]	50.81	8.59(17.04)[a]	49.17
T5:- Neemazol 1% @ 2ml/l	10.16(18.59)[ab]	45.08	11.12(19.48)[b]	30.47
T6:- Sasyarakshak @ 10ml/l	10.56(18.96)[b]	42.92	11.75(20.05)[c]	34.20
T7:- Control	18.50(25.47)[d]		16.90(24.27)[d]	
S.Em±	0.41		0.45	
CD at (p=0.05)	1.22		1.34	

Values in parenthesis are arcsine transformed.

Means followed by same alphabet in columns did not differ significantly (p=0.05) by DMRT.

Table 5: Grain yield and cost economics of pod bug management through biopesticides application.

Treatments	Average grain yield (kg/ha)	Increase in yield over control (%)	Gross returns (Rs)	Sucking pest protection cost (Rs)	Crop production cost (Rs)	Total cost (Rs)	Net returns (Rs)	B:C Ratio
T1: L*ecanicilium lecanii* @ 2g/l	1223.48[ab]	22.64	69432	1300	27170	28470	40962	2.43
T2: *Beauveria bassiana* @ 2g/l	1095.27[de]	9.78	62156	1300	27170	28470	33686	2.18
T3: *Metarhizium anisopliae* @ 2g/l	1044.70[de]	4.71	59247	1300	27170	28470	30777	2.08
T4: NSKE 5%	1229.10[a]	23.19	69751	1200	27170	28370	41481	2.45
T5: Neemazol 1% @ 2ml/l	1199.53[bc]	20.23	68043	1600	27170	28770	39273	2.36
T6: Sasyarakshak @ 10ml/l	1126.42[cd]	12.90	63900	2500	27170	29670	34230	2.15
T7: Control	997.66[e]	-	56617	-	27170	27170	29447	1.92
S.Em±	37.57	-	-	-	-	-	-	-
CD at (p=0.05)	115.78	-	-	-	-	-	-	-

Means followed by same alphabet in columns did not differ significantly (p=0.05) by DMRT.

Market price of pigeonpea grains Rs. 5675 per quintal.

B:C ratio = Gross returns/Total cost.

14.65%). The reduction in pod damage and grain damage over control was highest in plot treated with NSKE 5% (41.27% and 41.55%) followed by *L. lecanii* (38.10% and 35.90%), neemazol 1% (36.51% and 34.48%) and sasyarakshak (34.92% and 32.54%) and lowest in *M. anisopliae* (19.05% and 24.71%) respectively (Table 3). In 2018-19 season also same trend was noticed (Table 4).

The average grain yield of 2017-18 and 2018-19 was maximum in NSKE 5% (1229.10 kg/ha) and it was at par with *L. lecanii* (1223.48 kg/ha). These were followed by neemazol 1% (1199.53 kg/ha), sasyarakshak (1126.42 kg/ha), *B. bassiana* (1095.27 kg/ha) and *M. anisopliae* (1044.70 kg/ha) and lowest was observed in control of 997.66 kg/ha (Table 5). The plot sprayed with NSKE 5% recorded 23.19 per cent increase in yield over control followed by *L. lecanii* (22.64%) and neemazol 1% (20.23) and least in *M. anisopliae* (4.71%).

The results on the cost and returns of pod bug management revealed that, the highest net profit of Rs. 41481 per ha with the application of NSKE 5% followed by *L. lecanii* (Rs. 40962 per ha) and neemazol 1% (Rs. 39273 per ha), respectively. The lower net profit was in *M. anisopliae* (Rs. 30777 per ha). The results on the benefit: cost ratio showed that a higher benefit: cost ratio in NSKE 5% (2.45) treated plot followed by *L. lecanii* (2.43) and lowest benefit: cost ratio of 2.08 recorded in *M. anisopliae*. (Table 5).

The efficacy of different biopesticides against tur pod bug in both sprays revealed that among treated plots highest population reduction was found in NSKE 5% followed by *L. lecanii* and neemazol 1% and lowest in *M. anisopliae*. Kalyan *et al.* (2017) also reported NSKE 5% has higher per cent reduction in population of sucking pests compare to entomopathogenic fungi in cotton. Similarly, Vinodhini and Malaikozhundan (2010) found neem seed kernel extract (5%) was most effective in reducing the population of sucking pests in cotton. Possession of antifeedant property against sucking pests by neem was proved earlier by Abudulai *et al*. (2003) and Dutta *et al.* (2013).

CONCLUSION

The pod damaging insect pests of pigeonpea next to pod borers and pod fly, pod sucking bugs are most important pest in India inflicting heavy loss to seed yield. Among the different biopesticides studied against pod bug, it was found that NSKE 5% and *L. lecanii* @ 2 g/l were effective in suppressing pod bug population and recorded higher grain yield with higher net profit and B: C ratio. Hence, these biopesticides may be rotated at least once or twice for effective management of pod bug in pigeonpea.

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