

MANAGEMENT OF POD BUGS IN COWPEA (*Vigna unguiculata L.*) THROUGH ECO-FRIENDLY INSECTICIDES

ABSTRACT

Investigation on management of pod bugs in cowpea (*Vigna unguiculata L.*) through eco-friendly insecticides was carried out during *kharif* 2018 at dry land farm, S.V. Agricultural College, Tirupati. The results revealed that NSKE @ 5 per cent was found to be the most effective in reducing pod bugs population with highest mean per cent reduction over the control, lowest per cent pod damage (39.57 %), seed damage (27.33%), highest hundred grain weight (12.0gm) and the highest grain yield (933 kg ha⁻¹) followed by spinosad @ 0.2 ml/l and neem oil @ 0.5 per cent. It would be better to suggest NSKE @ 5 per cent for the better management of pod bugs in cowpea.

Key words: *Pod bugs, Population, Management and Cowpea*

INTRODUCTION

Cowpea (*Vigna unguiculata L.*) is one of the most important pulse crops, native to central Africa, belongs to family Fabaceae. Cowpea is called as vegetable meat due to high amount of protein in grain with better biological value on dry weight basis. In recent years pod bugs are a real threat to quality grain production in cowpea. Among the Pod bugs, *Riptortus pedestris* (Fabricius) (Heteroptera: Coreidae), and *Clavigralla gibbosa* Spinola (Hemiptera: Coreidae) are the most destructive of leguminous crops, desap tender shoots and pods of cowpea leads to the damage to pods and seeds up-to 60 to 70 percent(Krishna *etal* 2005) . Damaged seeds further do not germinate and are not acceptable for human consumption (Shanower *et al.*, 1999).

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 eco- friendly insecticides against pod bugs in cowpea ecosystem.

MATERIAL AND METHODS

Field trial was conducted with popular cowpea variety (TPTC-29) during *kharif* 2017-18 at Dryland farm, S.V. Agricultural College, Tirupati to evaluate the efficacy of eco – friendly insecticides against pod bugs. The experiment was laid out in a randomized block design with eight treatments including untreated control and replicated thrice. The size of the individual plot was 5 m x 4 m with spacing of 45 cm between the rows and 10 cm between the plants. All the recommended

The pods harvested from five randomly selected plants in each treatment were dehusked and the obtained seeds were segregated into healthy and damaged seeds. Seeds which were shrivelled, shrunken and malformed were considered as damaged seeds. The per cent seed damage was estimated based on number of seeds damaged by pod bugs in a pod by using the formula.

$$\text{Per cent seed damage} = \frac{\text{Number of damaged seeds}}{\text{Total no. of seeds per pod}} \times 100$$

Weight of 100 grains collected randomly from each treatment was recorded. The data on grain yield was recorded from the net plot of each treatment separately and converted to per hectare for statistical analysis. The documented data was transformed into necessary transformation and subjected to ANOVA and DMRT analysis for evaluating the relative efficacy of different treatments over the control.

RESULTS AND DISCUSSION

Riptortus pedestris

First spray:

The pre-treatment count at one day before spraying showed that, the mean number of nymphs and adults per plant of *R. pedestris* on cowpea in all the experimental plots ranged from 5.67 to 8.00 bugs per plant which was more or less uniform.

At one day after spraying (DAS), the highest per cent reduction over control was recorded in NSKE @ 5 per cent (59.72%) followed by spinosad @ 0.2 ml/L (48.52%), neem oil @ 0.5 per cent (40.28%), *Metarhizium anisopliae* @ 1.0 g/l (30.16%), novaluron @ 1.0 ml/l (29.44%), emamectin benzoate @ 0.2g/l (21.56%) and *Beauveria bassiana* @ 1.0 g/l (20.44%) (Table 1) At three DAS the highest per cent reduction over control was recorded in NSKE @ 5 per cent (75.20%) followed by spinosad 45SC @ 0.2 ml/l (56.67%), neem oil @ 0.5 per cent (50.00%), *Metarhizium anisopliae* @ 1.0 g/l (45.62%), *novaluron* @ 1.0ml/l (38.61%), *Beauveria bassiana* @ 1.0 g/l (35.56 %) and *emamectin benzoate* @ 0.2 g/l (25.26%) (Table 1). At five DAS, The highest per cent reduction over control was recorded in NSKE @ 5 per cent (65.4%) followed by spinosad @ 0.2 ml/l (55.17 %), neem oil @ 0.5 per cent (46.75%), *Metarhizium anisopliae* @ 1.0 g/l (39.03 %), novaluron @ 1.0 ml/l (30.83%), *Beauveria bassiana* @ 1.0 g/l (29.31%) and emamectin benzoate @ 0.2 g/l (21.52 %) (Table 1). At seven DAS, The highest per cent reduction over control was recorded in NSKE @ 5 per cent (79.50%) followed by spinosad @ 0.2 ml/l (67.78%), neem oil @ 0.5% (54.67%), *Metarhizium anisopliae* @ 1.0 g/l (44.00%), *Beauveria bassiana* @ 1.0 g/l (35.11%), novaluron @ 1.0 ml/l (30.33%) and emamectin benzoate @ 0.2 g/l (23.52%) (Table .1).

When the overall efficacy of first spray against *R. pedestris* was considered, NSKE @ 5 per cent was found to be the best treatment by recording the highest mean per cent reduction over control (69.97%) followed by spinosad @ 0.2 ml/l (57.03%) and neem oil @ 0.5 per cent (47.92 %). The next treatments in the descending order of efficacy were *Metarhizium anisopliae* @ 1.0 g/l (39.70%), novaluron @ 1.0 ml/l (32.31%) *Beauveria bassiana* @ 1.0 g/l (30.11%) and emamectin benzoate @ 0.2 g/l (22.97%) (Table 1).

Second spray

The pre treatment count at one day before spraying showed that the mean number of nymphs and adults per plant of *R. pedestris* on cowpea in all the experimental plots ranged from 8.67 to 10.00 bugs per plant which was more or less uniform.

At one DAS the highest per cent reduction over control was recorded in NSKE @ 5 per cent (61.31%), followed by spinosad @ 0.2ml/L (48.15%), neem oil @ 0.5 per cent (40.65%), *Metarhizium anisopliae* @ 1.0 g/l (32.50%), *Beauveria bassiana* @ 1.0 g/l (26.15%), novaluron @ 1.0 ml/l (24.00%) and emamectin benzoate @ 0.2 g/l (18.10%) (Table 1). At three 3DAS, 5DAS and at 7 DAS almost all same line of trend in mean per cent reduction over control was observed. The order of effectiveness of these treatments was NSKE @ 5 per cent > spinosad @ 0.2 ml/l > neem oil @ 0.5 per cent > *Metarhizium anisopliae* @ 1.0 g/l > novaluron @ 1.0 ml/l > *Beauveria bassiana* @ 1.0 g/l > emamectin benzoate @ 0.2 g/l (Table 1).

When the overall efficacy of second spray against *R. pedestris* was considered, NSKE @ 5 per cent was found to be the best treatment by recording the highest mean per cent reduction over control (64.17%) followed by spinosad @ 0.2 ml/l (54.54 %) and neem oil @ 0.5 per cent (47.29%). The next treatments in the descending order of efficacy were *Metarhizium anisopliae* @1.0 g/l (36.91%), novaluron @1.0 ml/l (29.17%) *Beauveria bassiana* @ 1.0 g/l (29.63%) and emamectin benzoate @ 0.2 g/l (21.86%) (Table 1)



Nymph

Adult

Fig.2. *Riptortus pedestris*

Clavigralla gibbosa

First spray:

The pre-treatment count at one day before spraying showed that the mean number of bugs/plant (*Clavigralla gibbosa*) on cowpea in all the experimental plots ranged from 7.67 to 10.50 bugs per plant which was more or less uniform.

At one DAS The highest per cent reduction over control was recorded in NSKE @ 5 per cent (53.33%) followed by spinosad @ 0.2 ml/l (43.39%), neem oil @ 0.5 per cent (38.43%), novaluron @ 1.0 ml/l (30.83%), *Metarhizium anisopliae* @ 1.0 g/l (29.44%), emamectin benzoate @ 0.2 g/l (21.56%) and *Beauveria bassiana* 1.0 g/l (20.44%) (Table 2). At three 3DAS, 5DAS and at 7 DAS almost all same line of trend in mean per cent reduction over control was observed. The order of effectiveness of these treatments was NSKE @ 5 per cent > spinosad @ 0.2 ml/l > neem oil @ 0.5 per cent > *Metarhizium anisopliae* @ 1.0 g/l > novaluron @ 1.0 ml/l > *Beauveria bassiana* @ 1.0 g/l > emamectin benzoate @ 0.2 g/l (Table 2).

When the overall efficacy of first spray against *C. gibbosa* was considered, NSKE @ 5 per cent was found to be the best treatment by recording the highest mean per cent reduction over control (69.79 %) followed by spinosad @ 0.2 ml/l (60.85%) and neem oil @ 0.5 per cent (51.85%). The next treatments in the descending order of efficacy were *Metarhizium anisopliae* @ 1.0 g/l (41.39%), novaluron @ 1.0 ml/l (40.21%) *Beauveria bassiana* @ 1.0 g/l (34.72%) and emamectin benzoate @ 0.2 g/l (24.19%) (Table 2).

Second spray:

The pre treatment count at one day before spraying showed that the experimental plots ranged from 8.00 to 10.7 bugs per plant which was more or less uniform.

At one DAS the highest per cent reduction over control was recorded in NSKE @ 5 per cent (54.23 %), followed by spinosad @ 0.2ml/L (44.81 %), neem oil @ 0.5 per cent (35.83%), *Metarhizium anisopliae* @ 1.0 g/l (33.97%), novaluron @ 1.0 ml/l (24.00%) *Beauveria bassiana* @ 1.0 g/l (26.15%), and emamectin benzoate @ 0.2 g/l (18.10%) (Table 2). At three 3DAS, 5DAS and at 7 DAS almost all same line of trend in mean per cent reduction over control was observed. The order of effectiveness of these treatments was NSKE @ 5 per cent > spinosad @ 0.2 ml/L > neem oil @ 0.5 per cent > *Metarhizium anisopliae* @ 1.0 g/l > novaluron @ 1.0 ml/l > *Beauveria bassiana* @ 1.0 g/l (26.00%) > emamectin benzoate @ 0.2 g/L (18.67%) (Table 2).

When the overall efficacy of second spray against *C. gibbosa* was considered, NSKE @ 5 per cent was found to be the best treatment by recording the highest mean per cent reduction over control (67.38%) followed by spinosad @ 0.2 ml/l (57.27%) and neem oil @ 0.5 per cent (47.92%). The next treatments in the descending order of efficacy were *Metarhizium anisopliae* @ 1.0 g/l (41.24%), novaluron @ 1.0 ml/l (37.68%), *Beauveria bassiana* @ 1.0 g/l (27.20%) and emamectin benzoate @ 0.2 g/l (21.85%) (Table 2). The present findings are conformity with Srinivas (2010) reported that the highest per cent reduction (66.1 %) in population bugs over control was observed in NSKE 5% this may be due to affect egg laying and egg hatching influencing the production

percentage of young one. The ovipositional deterrence might be mainly due to the strong odour of the products and ovicidal activity due to interference with the embryonic development within the egg (Venugopala Rao *et al.*, 2005).



Nymph

Adult

Fig 3. *Clavigralla gibbosa*

Yield parameters:

Pod damage:

The per cent pod damage inflicted by pod bugs on cowpea in experimental plots during *kharif* 2018 ranged from 39.57 to 83.33 per cent. The least per cent pod damage was recorded due to NSKE @ 5 per cent (39.57%) followed by spinosad @ 0.2 ml/l (47.49%), neem oil @ 0.5 per cent (49.14%), *Metarhizium anisopliae* @ 1.0 g/l (50.45%), novaluron @ 1.0 ml/l (51.00%), *Beauveria bassiana* @ 1.0 g/l (53.45%) and emamectin benzoate @ 0.2 g/l (58.73%). The untreated control recorded the highest per cent pod damage (83.33%) (Table 3).

Seed damage:

The per cent seed damage inflicted by pod bugs on cowpea in experimental plots during *kharif* 2018 ranged from 27.33 to 63.28 per cent. The lowest per cent seed damage was recorded in NSKE @ 5 percent (27.33 %), followed by spinosad @ 0.2ml/l (29.81 %), neem oil @ 0.5 per cent (37.56%), *Metarhizium anisopliae* @ 1.0g/l (37.89 %), novaluron @ 1.0 ml/l (44.65%), *Beauveria bassiana* @ 1.0 g/l (48.77 %) and emamectin benzoate @ 0.2 g/l (48.93 %). The untreated control recorded the highest per cent seed damage (63.28%) (Table 3). The present findings similar with Nara

100 grain weight:

The present study revealed that, all the treatments recorded higher 100 grain weight, compared to untreated control. The treatment NSKE @ 5 per cent recorded the maximum 100 grain weight 12 g, followed by spinosad @ 0.2 ml/l (11.00g), neem oil @ 0.5 per cent (8.60g), *Metarhizium anisopliae* @ 1.0g/l (7.60 g), novaluron @ 1.0 ml/l (7.40 g), *Beauveria bassiana* @ 1.0 g/l (7.10g), emamectin benzoate @ 0.2 g/l (7.06 g) and untreated control (7.00 g) (Table 3).

Grain yield:

The data revealed that all the treatments had higher grain yield, compared to untreated check. The treatment NSKE @ 5 per cent recorded the maximum yield of 933.33 kg ha⁻¹, followed by spinosad @ 0.2 ml/l (850 kg ha⁻¹), neem oil @ 0.5 per cent (736.66 kg ha⁻¹), *Metarhizium anisopliae* @ 1.0 g/l (680kg ha⁻¹), novaluron @ 1.0 ml/l (670 kg ha⁻¹), *Beauveria bassiana* @ 1.0 g/l (590 kg ha⁻¹) and emamectin benzoate @ 0.2 g/l (546.6 kg ha⁻¹) while untreated check recorded yield of 523.3 kg ha⁻¹ (Table 3).

Similar results were reported by Singh and Nath (2011) who reported that eco- friendly bio pesticides viz., (NSKE 5%, *Bt* and nimbecidine) had significant influence on the reduction of grain weight loss by pod bugs. The average grain weight loss was minimum in the plots treated with two sprays of NSKE @ 5 per cent as compared with untreated control, which exhibited the maximum grain weight loss during both the years. And also agreement with 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)

In present finding after the NSKE next best treatment is spinosad 45 SC @ 0.2ml/L in terms of pest population in 1, 3, 5, 7 days after spraying and also per cent pod damage, per cent seed damage, 100 grain weight and yield. The present findings conformity with Dahal *et al.* (2020) reported that the highest per cent reduction (53.3%) of pod bugs over the control was observed in spinosad treated plot. The present findings similar with (Narasimha murthy and keval 2013) reported that plot treated with spinosad 45% SC showed minimum (8.30%) pod damage and 2.36% grain damage by pod bug and higher grain yield 1625 kg/ha.

SUMMARY AND CONCLUSION

The results of the field experiment on evaluation of certain eco-friendly insecticides against pod bugs on cowpea revealed that, all the insecticide treatments tested were effective in management of pod bugs than the untreated control. At seven days after the second spray, the highest per cent reduction of pod bugs over the control was recorded with NSKE @ 5 per cent followed by spinosad @ 0.2 ml/l, neem oil @ 0.5 per cent, *Metarhizium anisopliae* @ 1.0 g/l, novaluron @ 1.0 ml/l, *Beauveria bassiana* @ 1.0 g/l and emamectin benzoate @ 0.2g/l. The lowest per cent pod and seed damage inflicted by pod bugs on cowpea was recorded in the treatment NSKE @ 5 per cent followed by spinosad @ 0.2 ml/l, neem oil @ 0.5 per cent, *Metarhizium anisopliae* @ 1.0 g/l, novaluron @ 1.0 ml/l, *Beauveria bassiana* @ 1.0 g/l and emamectin benzoate

@ 0.2g/l. The highest grain yield and 100 grain weight were recorded in the treatment NSKE @ 5 per cent followed by spinosad @ 0.2 ml/l, neem oil @ 0.5 per cent, *Metarrhizium anisopliae* @ 1.0 g/l, novaluron @ 1.0 ml/l, *Beauveria bassiana* @ 1.0 g/l and emamectin benzoate @ 0.2 g/l.

The treatment NSKE @ 5 per cent recorded significantly low pod and seed damage by pod bugs and significantly higher grain yield and 100 grain weight than the other treatments, indicating the superiority of NSKE @ 5 per cent in managing the pod bugs in cowpea.

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UNDER PEER REVIEW

Table 1. Efficacy of botanical, microbial and synthetic insecticides against *Riptortus pedestris* on cowpea during kharif 2018- first and second spray

S.No.	Treatment	Pre spray count (Mean*)	Per cent reduction over control - 1 st spray				Mean % Reduction	Pre spray count (Mean*)	Percent reduction over control -2 nd spray				Mean % Reduction
			1 DAS	3DAS	5DAS	7DAS			1 DAS	3DAS	5DAS	7DAS	
1	NSKE 5%	7.00	59.72 ^a (50.66)	75.00 ^a (60.00)	65.4 ^a (54.23)	79.50 ^a (63.22)	69.97	8.67	61.31 ^a (51.64)	55.71 ^a (48.29)	64.64 ^a (53.57)	75.00 ^a (60.07)	64.17
2	Neem oil 0.5%	7.33	40.28 ^{cd} (39.34)	50.00 ^{ab} (45.00)	46.75 ^{ac} (43.10)	54.67 ^c (47.69)	47.92	8.33	40.65 ^{bc} (39.60)	40.65 ^c (39.60)	52.67 ^b (46.53)	55.19 ^{bc} (47.99)	47.29
3	<i>Beauveria bassiana</i> 1.0 g/l	5.67	20.44 ^a (26.71)	35.56 ^{bc} (36.59)	29.31 ^{cd} (32.62)	35.11 ^{cd} (36.30)	30.11	10.00	26.51 ^{de} (30.81)	26.00 ^d (30.65)	30.67 ^{cd} (33.62)	35.33 ^d (36.43)	29.63
4	<i>Metarhizium anisopliae</i> 1.0 g/l	6.67	30.16 ^{cd} (33.30)	45.62 ^{ab} (42.47)	39.03 ^{bd} (38.58)	44.00 ^{de} (41.54)	39.70	7.67	32.50 ^{bc} (34.68)	33.67 ^c (35.46)	36.67 ^c (37.26)	44.81 ^{bc} (42.01)	36.91
5	Novaluron 1.0 ml/l	8.00	29.44 ^{cd} (32.83)	38.61 ^{bc} (38.39)	30.83 ^{bd} (33.44)	30.33 ^{ef} (33.34)	32.31	9.33	24.00 ^{cd} (28.90)	26.00 ^d (30.57)	25.00 ^{cd} (29.94)	41.67 ^{bc} (40.19)	29.17
6	Spinosad 0.2 ml/l	6.67	48.52 ^{ab} (44.14)	56.67 ^b (48.85)	55.17 ^{ab} (48.00)	67.78 ^b (55.42)	57.03	8.67	48.15 ^b (43.94)	47.00 ^b (43.28)	58.00 ^{ab} (49.63)	65.00 ^{ab} (53.79)	54.54
7	Emamectin benzoate 0.2 g/l	8.00	21.56 ^d (27.26)	25.26 ^d (30.15)	21.52 ^d (27.30)	23.52 ^f (28.92)	22.97	9.67	18.10 ^e (25.11)	18.67 ^f (25.57)	21.33 ^d (27.47)	29.33 ^d (32.74)	21.86
8	Untreated check	8.00	-	-	-	-	-	10.00	-	-	-	-	-
	SE(m)		2.51	2.30	0.83	0.82			2.30	1.35	0.94	0.82	
	CD at 5%		7.76	7.08	2.57	2.54			7.08	4.23	2.90	2.54	

* Mean no. of nymphs and adults on five randomly selected plant. DAS- Days after spraying.

Figures in parentheses are angular transformed values. The values followed by same letter did not differ significantly as per DMRT

Table2. Efficacy of botanical, microbial and synthetic insecticides against *Clavigralla gibbosa* on cowpea during *kharif* 2018- first and Second spray

S.No.	Treatment	Pre spray count (Mean*)	Per cent reduction over control -1 st spray				Mean % Reduction	Pre spray count (Mean*)	Percent reduction over control - 2 nd spray				Mean % Reducti on
			1 DAS	3DAS	5DAS	7DAS			1 DAS	3DAS	5DAS	7DAS	
1	NSKE 5%	8.67	53.33 ^a (46.92)	73.33 ^a (58.93)	75.83 ^a (61.27)	76.67 ^a (61.14)	69.79	8.00	54.23 ^a (47.43)	66.87 ^a (54.89)	69.97 ^a (56.99)	78.44 ^a (62.74)	67.38
2	Neem oil 0.5%	8.67	38.43 ^{bc} (38.28)	50.00 ^c (45.00)	57.41 ^{ab} (49.31)	61.57 ^{ab} (51.72)	51.85	9.33	35.83 ^c (36.73)	50.00 ^b (45.00)	49.17 ^{ab} (44.51)	56.67 ^{ab} (48.85)	47.92
3	<i>Beauveria bassiana</i> 1.0 g/l	9.67	27.41 ^c (31.31)	31.11 ^e (33.90)	44.81 ^{cd} (42.01)	35.56 ^{cd} (36.59)	34.72	9.00	19.17 ^{de} (25.76)	29.07 ^d (32.45)	33.61 ^d (35.41)	26.93 ^e (31.22)	27.20
4	<i>Metarhizium anisopliae</i> 1.0 g/l	10.33	29.44 ^b (32.83)	39.33 ^d (38.23)	51.67 ^{cd} (45.91)	46.11 ^{bc} (42.75)	41.39	8.67	33.97 ^d (35.60)	39.10 ^c (38.64)	42.43 ^{ad} (40.65)	49.47 ^b (44.69)	41.24
5	Novaluron 1.0 ml/l	8.67	30.83 ^b (33.66)	38.33 ^d (38.25)	50.00 ^{cd} (45.00)	41.67 ^{bc} (40.17)	40.21	9.67	31.11 ^{de} (33.90)	37.01 ^c (37.42)	37.78 ^{bc} (37.91)	44.81 ^{bc} (42.01)	37.68
6	Spinosad 0.2 ml/l	7.67	43.39 ^{ab} (41.20)	65.08 ^b (53.84)	65.08 ^{ab} (53.84)	69.84 ^b (56.70)	60.85	9.00	44.81 ^b (42.01)	59.35 ^{ab} (50.40)	58.52 ^{ab} (49.99)	66.39 ^a (54.59)	57.27
7	Emamectin benzoate 0.2 g/l	8.33	16.20 ^d (23.39)	24.07 ^e (29.38)	32.41 ^a (34.55)	24.07 ^e (29.38)	24.19	10.67	12.78 ^e (20.59)	21.83 ^d (27.82)	27.78 ^d (31.68)	25.00 ^e (29.93)	21.85
8	Untreated check	10.50	-	-	-	-	-	10.70	-	-	-	-	-
	SE(m)		1.49	1.12	2.25	1.95			1.65	2.06	1.54	2.33	
	CD at 5%		4.61	3.46	6.85	6.03			5.11	6.36	4.75	7.18	

*Mean no. of nymphs and adults on five randomly selected plant. DAS- Days after spraying.

Figures in parentheses are angular transformed values. The values followed by same letter did not differ significantly as per DMRT

Table 3. Pod damage, seed damage, 100 grain weight, yield of cowpea as influenced by insecticides during *Kharif* 2018

S.No.	Treatment	Dosage	Per cent pod damage	Per cent seed damage	100 grain weight (g)	Yield (kg/ha ⁻¹)
1	NSKE	5%	39.57 ^a (38.97)	27.33 ^a (31.36)	12.0	933.3 ^d
2	Neem oil	0.5%	49.14 ^{ab} (44.51)	37.56 ^{abc} (37.67)	8.60	736.6 ^{abc}
3	<i>Beauveria bassiana</i>	1.0 g/l	53.45 ^{ab} (47.05)	48.77 ^{bc} (44.15)	7.10	590.0 ^a
4	<i>Metarhizium anisopliae</i>	1.0 g/l	50.45 ^{ab} (45.29)	37.89 ^{abc} (37.94)	7.60	680.5 ^{ab}
5	Novaluron	1.0 ml/l	51.00 ^{ab} (45.58)	44.65 ^{abc} (41.87)	7.40	673.3 ^{ab}
6	Spinosad	0.2 ml/l	47.49 ^{ab} (43.55)	29.81 ^{ab} (33.06)	11.00	850.0 ^{cd}
7	Emamectin benzoate	0.2 g/l	58.73 ^b (50.24)	48.93 ^{bc} (44.38)	7.06	546.6 ^a
8	Untreated check	-	83.33 ^c (65.98)	63.28 ^c (52.80)	7.00	523.3 ^a
	SE(m)		3.47	0.98	0.59	188.7
	CD at 5%		10.52	2.82	1.81	61.6

REFERENCES:

- Abbott, W.S. 1925. A Method of computing the effectiveness of insecticides. *Journal of Economic Entomology*. 18: 265-267.
- Abudulai, M., Shepard, B. M and Mitchell, P. L. 2003. Antifeedant and toxic effects of a neem based formulation Neemix (R) against *Nezara viridula* (L.). *Journal of Entomological Science*. 38(3): 398-408.
- Dahala S., Gautamb B. S., Kandela, S., Samikshya S and Ojhaa, L,N. 2020. Management options against pod borer (*Maruca testulalis* geyer) and pod sucking bugs (*Riptortus dentipes*) of cowpea (*Vigna unguiculata* (L.) *Tropical Agro biodiversity* 24-30.

- Dutta, P., Reddy, S.G.E. and Borthakur, B.K. 2013. Effect of neem kernel aqueous extract (NKAE) in tea mosquito bug, *Helopeltis theivora* (Waterhouse, 1886) (Heteroptera: Muni s Entomology & Zoology. 8(1) : 213-218.
- kalyan, R.K., Saini, D.P., Meena, B.M., Abhishek, P., Pooja, N., Shilpa, V. and Sonika, J. (2017). Evaluation of new molecules against jassids and white flies of *Bt* cotton. *Journal of Entomological and Zoological Studies*. 5(3): 236-240.
- Narasimha, M and Keval, R. 2013. Field evaluation of some insecticides and bio-pesticide against tur pod bug, *Clavigralla gibbosa* (Spinola) in long duration pigeonpea. *African Journal of Agricultural Research*. 8(38): 4876-4881.
- Singh, R. S and Nath, P. 2011. Effect of biorational approaches on pigeonpea pod and grain damage by pod bug, *Clavigralla gibbosa*. *Annals of Plant Protection Sciences*. 19: 75-79.
- Venugopal Rao N., Uma Maheswari T., Manjula K., 2005. Botanical pesticides as tools of pest management. *Green Pesticides for Insect Pest Management*, Narosa Publishing House, Chennai. 320.
- Vinodhini and Malaikozhundan 2011. Efficacy of neem and pungam based botanical pesticides on sucking pests of cotton. *Indian Journal of Agricultural Research*: 45(4): 341-345.
- Srinivas (2010). Studies on bio ecology and management of pod sucking bug complex in arid legumes. m.sc.(ag).thesis. Acharya. N.G.Ranga Agricultural university. Lam. Guntur.