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EFFECT OF INSECTICIDES ON THE POPULATION OF NATURAL ENEMIES IN OKRA

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ABSTRACT
Okra [Abelmoschus esculentus L. (Moench)] also known as lady's finger is an important vegetable crop valued for its immature, tender and green fruits in India. India is a major vegetable producing and consuming country and vegetables form an important dietary component. The roots and stems of okra are used for cleaning the cane juice from which gum or brown sugar is prepared (Chauhan, 1972). Okra provides an important source of vitamins, calcium, potassium and other mineral matters which are often lacking in the diet of developing countries (Anon., 1990). Since okra is an important vegetable crop in human dietary, it is necessary to minimize the number of pesticide sprays in order to reduce the pesticide load in environment and as well as it is important to conserve the natural enemies. Some of the natural enemies coccinellids, lacewings, predatory bugs and wasps were present in the okra ecosystem (Abdalla A. Sattiet al., 2012). A study was conducted at Main Agricultural Research Station (MARS), University of Agricultural Sciences, Raichur, during 2014-15 rabi-summer season to study the effect of insecticides (used to control the major sucking pest, leafhopper) on natural enemies of okra (coccinellid and Chrysoperla). Six chemical treatments viz., Dinotefuran 20 SG, Flonicamid 50 WG, Fipronil 5 SC, Thiamethoxam 25 WDG, Acetamiprid 20 SP, and Acephate 75 SP along with a untreated control were field evaluated. Among the chemical treatments acetamiprid 20 SP found to be safer insecticides to natural enemies. While the molecules namely, thiamethoxam 25 WDG at 25 g a. i. per hectare were moderately safer to natural enemies while acephate 75 SP at 375 g a. i. per hectare was highly toxic which need to be avoided its usage in okra ecosystem.

KEYWORDS: *Okra,* Coccinellid, Chrysoperla.

INTRODUCTION
Okra [*Abelmoschus esculentus* L. (Moench)] also known as bhendi an important vegetable crop valued for its immature, tender and green fruits in India. Bhendi is a warm season vegetable crop and requires a long warm growing season. In India it is grown is summer months and during the rainy season. It is grown over an area of 5.33 lakh hectares with production of 6.34 metric tonnes and productivity of 110 lakh metric tonnes per year in India, where as in Karnataka it is cultivated over an area of 8,600 hectare with a production of 75.10 thousand tonnes per year (Anon., 2014). Sucking pests and fruit borers are the major bottleneck in successful production of okra. Although, insecticides application is the sole measure of control practiced in many areas, which have led to several problems like presence of residues, elimination of natural enemies, development of resistance and environmental disharmony. The crop sustains different insect fauna which serve to attract numerous predators (Bilal and Satti, 2012). To overcome these problems, identification of new molecules is the need of the hour so as to fit them in IPM practices. Natural enemies co-exist with the pests in a crop ecosystem. Heavy use of insecticides with high toxicity can control the pest effectively but it may have adverse effect on natural enemies' population. Hence, the effects of different insecticides on population of natural enemies were studied and results of present findings were discussed here under.

MATERIALS & METHODS
Experimental details
The field trial was laid out in experimental plot at Main Agricultural Research Station (MARS), University of Agricultural Sciences, Raichur, during 2014-15 *rabi* summer season to study the effect of insecticides (used to control the major sucking pest, leafhopper) on the population of natural enemies of okra (coccinellid and *Chrysoperla*). Arka Anamika variety of okra seeds were sown in the field with a spacing of 60×30 cm between rows and plants, respectively with a plot size of 4.2×6.0 m in a Randomized Block Design (RBD) consisting of seven treatments and replicated thrice. The crops were raised following all recommended agronomic practices except plant protection measures (Table 1). Ten plants were selected randomly in each treatment and the population of coccinellid (adults and grubs) and *Chrysoperla* (eggs and grubs) per plant were recorded a day before and ten days after each spray.

TABLE 1: Treatment details used for field study

Sl. No	Treatments	Dosage (g a.i /ha)
1	Dinotefuran 20 SG	20
2	Flonicamid 50 WG	75
3	Fipronil 5 SC	25
4	Thiamethoxam 25 WDG	25
5	Acetamiprid 20 SP	20
6	Acephate 75 SP	375
7	Untreated control	-

RESULTS & DISCUSSION

Effect of different treatments on the population of coccinellid adults and grubs in okra

A day before spraying coccinellid adults population found to be uniform in distribution in all the treatments (Table 2).

Ten days after the first spray acetamiprid 20 SP at 20 g *a. i.* per hectare record the highest population of coccinellid adults among the insecticidal treatments followed by thiamethoxam 25 WG at 25 *a. i.* per hectare and were statistically at par with each other and differed significantly from other insecticidal treatments

The lowest populations of coccinellid adults were recorded in acephate 75 SP at 375 g *a. i.* per hectare followed by dinotefuran 20 SG at 20 g *a. i.* per hectare and flonicamid 50 WG at 75 g *a. i.* per hectare and fipronil 5 SC at 25 g *a. i.* per hectare were statistically at par with each other. Similar trend of adult coccinellids population was observed in ten days after second, third and fourth sprays.

It was found from the present study that at first, second, third and fourth spray acetamiprid 20 SP at 20 g *a. i.* per hectare recorded highest coccinellid grubs population followed by thiamethoxam 25 WDG at 25 g *a. i.* per hectare which was found relatively safer to the coccinellid grubs. Dinotefuran 20 SG at 20 g *a. i.* per hectare and fipronil 5 SC at 25 g *a. i.* per hectare recorded relatively less number of coccinellid grubs and found to be moderately toxic. Whereas, acephate 75 SP at 375 g *a. i.* per hectare recorded relatively less number of grubs and the similar results were also found in ten days after second, third and fourth spray.

Effect of different treatments on the population of *Chrysoperla* eggs and grubs in okra

The results from present investigation also revealed that acetamiprid 20 SP at 20 g *a. i.* per hectare recorded maximum *Chrysoperla* eggs followed by thiamethoxam 25 WDG at 25 g *a. i.* per hectare which was also found statistically superior to dinotefuran 20 SG at 20 g *a. i.* per hectare, fipronil 5 SC at 25 g *a. i.* per hectare. Whereas, lowest number of *Chrysoperla* eggs were recorded in acephate 75 SP at 375 g *a. i.* per hectare second spray (Table 3). Similar results were also noticed in ten days after third and fourth sprays. Even though insecticides used in the present study have not been reported to have any ovicidal action but there is a decrease in the number of eggs in different treatments which may be due to deterrent effect towards the adults for oviposition and this needs confirmation.

No *Chrysoperla* grubs were noticed a day before and ten days after first spray. However, ten days after second spray highest population of *Chrysoperla* grubs were recorded in acetamiprid 20 SP at 20 g *a. i.* per hectare treatment and found to be statistically superior and safer to the grubs followed by thiamethoxam 25 WDG at 25 g *a. i.* per hectare, flonicamid 50 WG at 75 g *a. i.* per hectare and fipronil 5 SC 25 g *a. i.* hectare and dinotefuran 20 SG at 20 g *a. i.* per hectare.

The lowest population of *Chrysoperla* grubs recorded in acephate 75 SP at 375 g *a. i.* per hectare.

Similar results were also found in ten days after third and fourth spray.Present study revealed that acetamiprid 20 SP at 20 g *a. i.* per hectare found to be relatively safer insecticide to natural enemies (coccinellids and *Chrysoperla*) followed by thiamethoxam 25 WG at 25 g *a. i.* per hectare. These findings are in confirmation with the findings of Ghosal *et al.* (2013) who reported that neonicotinoids v*iz.*, thiamethoxam 25 WG at 50 g *a. i.* per hectare and acetamiprid 20 SP at 40 g *a. i.* per hectare have no adverse effect on natural enemies in okra, Bharpoda *et al.* (2014) and Ahmed *et al.* (2014) in cotton.

Similarly the finding of Gaikwad *et al.* (2014) with thiamethoxam at 0.005 per cent was in agreement with the present findings revealing its safeness to lady bird beetle in safflower ecosystem. However, they differed with acetamiprid at 0.004 per cent as toxic to coccinellids which may be due to change in crop and dosage of the insecticide used.

In the present study it also found that flonicamid 50 WG at 75 g *a. i.* per hectare, fipronil 5 SC at 20 g *a. i.* per hectare and dinotefuran 20 SG at 20 g *a. i.* per hectare recorded less number of natural enemies and found to be moderately toxic. These findings were in confirmation with Sreenivas *et al.* (2015) who reported that dinotefuran 20 SG at 30 g *a. i.* per hectare was not toxic to coccinellids and *Chrysoperla* in *Bt* cotton.In the present study it is also found that acephate 75 SP was found to be highly toxic insecticide to natural enemies by recording lowest population. Similar results were also reported by Bharpoda*et al.* (2014) and Honnappagouda (2010) in okra who revealed that acephate 75 SP as toxic to natural enemies (Coccinellids and *Chrysoperla*).

TABLE 2: Effect of different treatments on the population of coccinellids adults and grubs in okra

Sl. no.	Treatment	Dosage (g a. i/ha)	Mean population of Coccinellids/plant									
			Adults/plant					Grubs/plant				
			1DBS	10 DAIS	10 DAIIS	10 DAIIIS	10 DAIVS	1DBS	10 DAIS	10 DAIIS	10 DAIIIS	10 DAIVS
1	Dinotefuran 20 SG	20	1.42	0.23 (0.85)^{cd}	0.30 (0.89)^{c}	0.23 (0.85)^{e}	0.3 (0.89)^{bc}	1.48	0.21 (0.84)^{cd}	0.26 (0.87)^{de}	0.29 (0.89)^{bc}	0.28 (0.88)^{cd}
2	Flonicamid 50 WG	75	1.12	0.25 (0.87)^{c}	0.31 (0.90)^{c}	0.32 (0.91)^{d}	0.35 (0.92)^{b}	1.35	0.29 (0.89)^{c}	0.30 (0.89)^{bcd}	0.23 (0.85)^{c}	0.30 (0.89)^{cd}
3	Fipronil 5 SC	25	1.26	0.21 (0.84)^{cd}	0.28 (0.88)^{c}	0.28 (0.88)^{de}	0.31 (0.90)^{b}	1.35	0.28 (0.88)^{cd}	0.28 (0.88)^{cd}	0.25 (0.87)^{c}	0.31 (0.90)^{bc}
4	Thiamethoxam 25 WDG	25	1.28	0.52 (1.01)^{b}	0.54 (1.02)^{b}	0.46 (0.98)^{c}	0.51 (1.00)^{b}	1.12	0.47 (0.98)^{b}	0.38 (0.94)^{c}	0.35 (0.92)^{b}	0.50 (1.00)^{b}
5	Acetamiprid 20 SP	20	1.23	0.63 (1.06)^{b}	0.64 (1.07)^{b}	0.56 (1.03)^{b}	0.62 (1.06)^{ab}	1.28	0.48 (0.99)^{b}	0.4 (0.95)^{b}	0.31 (0.90)^{bc}	0.53 (1.01)^{b}
6	Acephate 75 SP	375	1.40	0.10 (0.77)^{d}	0.12 (0.79)^{d}	0.11 (0.78)^{f}	0.00 (0.71)^{c}	1.16	0.08 (0.76)^{d}	0.18 (0.82)^{e}	0.14 (0.80)^{d}	0.10 (0.77)^{e}
7	Untreated control	-	1.50	1.23 (1.32)^{a}	1.03 (1.24)^{a}	1.15 (1.28)^{a}	1.03 (1.24)^{a}	1.61	1.07 (1.25)^{a}	1.11 (1.27)^{a}	1.22 (1.31)^{a}	1.10 (1.26)^{a}
S. Em±			0.48	0.02	0.03	0.01	0.06	0.77	0.02	0.02	0.01	0.03
CD (P = 0.05)			NS	0.07	0.08	0.04	0.18	NS	0.06	0.06	0.04	0.09

DA I, II, III, IV S- Days after first, second, third, fourth spraying

DBS-Day before spraying

Figures in the parentheses are $\sqrt{x+0.5}$ transformed values

Means followed by same letter (s) in a column not significantly different by DMRT (P = 0.05).

TABLE 3: Effect of different treatments on the population of *Chrysoperla* eggs and grubs in okra

Sl. no.	Treatment	Dosage (g a. i/ha)	Mean population of *Chrysoperla* /plant											
			Eggs/plant						Grubs/plant					
			1DBIS	10DAIS	1DBIIS	10DAIIS	10DAIIIS	10DAIVS	1DBIS	10DAIS	1DBIIS	10DAIIS	10DAIIIS	10DAIVS
1	Dinotefuran 20 SG	20	0.00 (0.71)	0.00 (0.71)	0.63 $(1.06)^{d}$	0.27 $(0.88)^{c}$	0.19 $(0.83)^{c}$	0.31 $(0.90)^{c}$	0.00 (0.71)	0.00 (0.71)	0.59 $(1.04)^{c}$	0.19 $(0.83)^{d}$	0.28 $(0.88)^{bc}$	0.28 $(0.88)^{c}$
2	Flonicamid 50 WG	75	0.00 (0.71)	0.00 (0.71)	0.59 $(1.04)^{d}$	0.23 $(0.85)^{c}$	0.21 $(0.84)^{c}$	0.28 $(0.88)^{c}$	0.00 (0.71)	0.00 (0.71)	0.60 $(1.05)^{c}$	0.23 $(0.85)^{cd}$	0.20 $(0.84)^{c}$	0.30 $(0.89)^{c}$
3	Fipronil 5 SC	25	0.00 (0.71)	0.00 (0.71)	0.62 $(1.06)^{d}$	0.26 $(0.87)^{c}$	0.15 $(0.81)^{c}$	0.34 $(0.92)^{c}$	0.00 (0.71)	0.00 (0.71)	0.58 $(1.04)^{c}$	0.20 $(0.84)^{cd}$	0.25 $(0.87)^{bc}$	0.31 $(0.90)^{c}$
4	Thiamethoxam 25 WDG	25	0.00 (0.71)	0.00 (0.71)	0.79 $(1.14)^{c}$	0.51 $(1.00)^{b}$	0.43 $(0.96)^{b}$	0.50 $(1.00)^{b}$	0.00 (0.71)	0.00 (0.71)	0.85 $(1.16)^{b}$	0.38 $(0.94)^{c}$	0.50 $(1.00)^{b}$	0.52 $(1.01)^{b}$
5	Acetamiprid 20 SP	20	0.00 (0.71)	0.00 (0.71)	0.87 $(1.17)^{b}$	0.65 $(1.07)^{b}$	0.52 $(1.01)^{b}$	0.60 $(1.05)^{b}$	0.00 (0.71)	0.00 (0.71)	0.92 $(1.19)^{b}$	0.60 $(1.05)^{b}$	0.50 $(1.00)^{b}$	0.66 $(1.08)^{b}$
6	Acephate 75 SP	375	0.00 (0.71)	0.00 (0.71)	0.15 $(0.81)^{e}$	0.00 $(0.71)^{d}$	0.00 $(0.71)^{d}$	0.00 $(0.71)^{d}$	0.00 (0.71)	0.00 (0.71)	0.13 $(0.79)^{d}$	0.10 $(0.77)^{d}$	0.00 $(0.71)^{d}$	0.00 $(0.71)^{d}$
7	Untreated control	-	0.00 (0.71)	0.00 (0.71)	1.30 $(1.34)^{a}$	1.11 $(1.27)^{a}$	0.87 $(1.17)^{a}$	1.21 $(1.31)^{a}$	0.00 (0.71)	0.00 (0.71)	1.34 $(1.36)^{a}$	1.03 $(1.24)^{a}$	0.94 $(1.20)^{a}$	1.04 $(1.24)^{a}$
S. Em±			0.00	0.00	0.01	0.04	0.03	0.03	0.00	0.00	0.01	0.03	0.05	0.05
CD (P = 0.05)			0.00	0.00	0.02	0.11	0.09	0.09	0.00	0.00	0.03	0.10	0.15	0.15

DA I, II, III, IV S- Days after first, second, third, fourth spraying

DBS-Day before spraying

Figures in the parentheses are $\sqrt{x+0.5}$ transformed values

Means followed by same letter (s) in a column not significantly different by DMRT (P = 0.05)

CONCLUSION

It can be concluded from the results of the study that, among the chemical treatments acetamiprid 20 SP was found to be safer insecticide to natural enemies. While the molecule thiamethoxam 25 WDG at 25 g a. i. per hectare was moderately safer to natural enemies while acephate 75 SP at 375 g a. i. per hectare was highly toxic which need to be avoided its usage in okra ecosystem.

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