

Original Research Article

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Effect of Intercropping on Sucking Insect Pests and Natural Enemies of Cotton

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ABSTRACT

The main aim of the study was to reduce the maximum use of pesticides, these pesticides increases pest resurgence, environmental pollution and toxic residue in food. Efforts were being made to encourage those pest management practices which are ecofriendly. Pooled mean of both the years during 2016 and 2017 revealed that minimum population of leafhopper nymphs was recorded in cotton intercropped with *bajra* as border crop (2.47 nymphs/leaf) and maximum population was recorded in sole cotton (3.54 nymphs/leaf). Minimum population of thrips adults was recorded in cotton intercropped with *bajra* as border crop (2.24 adults/leaf) and maximum population in sole cotton (3.88 adults/leaf), and minimum population of whitefly adults was recorded in cotton intercropped with sorghum as border crop (2.52 adults/leaf) and maximum population in sole cotton (3.97 adults/leaf). In both the years 2016 and 2017, highest population of spiders and *Chrysoperla* spp. was recorded in cotton-sesame intercropping and lowest in sole cotton, and highest coccinellid beetles in cotton-pigeonpea intercropping system and lowest in sole cotton.

Keywords

Intercropping,
Insect pests, Cotton

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Introduction

Cultivating cotton as a sole crop is usually found to be risky and less remunerative. Intercropping in cotton is of significance because of higher profit and stabilized yield advantage, especially under adverse weather conditions. Some intercrops may act as barrier crops, some intercrops deter or others may attract insect pests of cotton and some intercrops attract natural enemies of insect pests. Natural enemies are organisms that kill, decrease the reproductive potential of, or otherwise reduce the numbers of another

organism. Natural enemies that limit pests are key components of integrated pest management programs. Important natural enemies of insect pests include predators, parasitoids, and pathogens. A large number of natural enemies are associated with insect pests of cotton crop and these natural enemies are more in diverse crops as compared to sole crop. Sharma *et al.*, (2009) revealed interplant maize/cowpea acted as source of predator due to diverse microhabitats, greater availability of food sources such as prey, nectar and pollen, all of which encouraged colonization and buildup of natural enemies, compared with

cotton monoculture having lesser biodiversity. Effect of different intercrops like blackgram, soyabean, cowpea, setaria, pigeonpea, sorghum and maize was studied in cotton ecosystem. It was reported that these intercrops helped in the reduction of bollworm complex through the enhancement of predators like coccinellids and *Chrysoperla*. Highest population of *Chrysoperla* and coccinellids were observed in sorghum and maize (Rajput and Daware, 2002). There is increasing awareness about the ill effects of pesticide, particularly in terms of pest resurgence, environmental pollution and toxic residue in food. Hence, efforts are being made to encourage those pest management practices which are ecofriendly. Keeping this in view, the study was undertaken with this objective.

Materials and Methods

The population of leafhopper nymphs, adults of thrips and whitefly were recorded from three leaves, each one from top, middle and bottom canopies on six randomly selected plants per plot and observation were recorded at 10 days interval starting from 10 days after sowing. The observations recorded on sucking insect pests were later averaged to per leaf basis. The population of natural enemies was recorded after 15 days interval on six cotton plants selected randomly from each plot by beat bucket sampling method starting from first of July.

Results and Discussion

During 2016 the mean showed that minimum leafhopper nymphs population was recorded in cotton intercropped with *bajra* as border crop (2.86 nymphs/leaf) which was at par with cotton intercropped with sorghum as border crop (2.90 nymphs/leaf) and cotton-pigeonpea 1:1 (3.16 nymphs/leaf). Maximum population of leafhopper nymphs was recorded in sole cotton (3.97 nymphs/leaf) (Table 1). Among

the intercrops, minimum population of leafhopper nymphs recorded in cotton intercropped with *bajra* as border crop (2.86 nymphs/leaf) followed by cotton intercropped with sorghum as border crop (2.90 nymphs/leaf), cotton-pigeonpea 1:1 (3.16 nymphs/leaf), cotton-pigeonpea 2:1 (3.20 nymphs/leaf), cotton-sesame 1:1 (3.31 nymphs/leaf), cotton-sesame 2:1 (3.34 nymphs/leaf), cotton-pigeonpea 3:1 (3.41 nymphs/leaf) and highest in cotton-sesame 3:1 (3.42 nymphs/leaf). During 2017, mean population showed that minimum population of leafhopper nymphs was recorded in cotton intercropped with *bajra* as border crop (2.09 nymphs/leaf) which was at par with cotton intercropped with sorghum as border crop (2.09 nymphs/leaf). Maximum population of leafhopper nymphs was recorded in sole cotton (3.11 nymphs/leaf) and it was significantly different from all other treatments. Among the intercrops, minimum population of leafhopper nymphs recorded in cotton intercropped with *bajra* as border crop (2.09 nymphs/leaf) and cotton intercropped with sorghum as border crop (2.09 nymphs/leaf) followed by cotton-pigeonpea 1:1 (2.49 nymphs/leaf), cotton-pigeonpea 2:1 (2.58 nymphs/leaf), cotton-sesame 2:1 (2.61 nymphs/leaf), cotton-pigeonpea 3:1 (2.62 nymphs/leaf), cotton-sesame 1:1 (2.62 nymphs/leaf) and highest in cotton-sesame 3:1 (2.78 nymphs/leaf).

Pooled mean of both the years during 2016 and 2017 revealed that minimum population of leafhopper nymphs was recorded in cotton intercropped with *bajra* as border crop (2.47 nymphs/leaf) which was at par with cotton intercropped with sorghum as border crop (2.49 nymphs/leaf). Maximum population was recorded in sole cotton (3.54 nymphs/leaf). Among the intercrops, lowest population of leafhopper was recorded in cotton intercropped with *bajra* as border crop (2.47 nymphs/leaf) followed by cotton intercropped

with sorghum as border crop (2.49 nymphs/leaf), cotton-pigeonpea 1:1 (2.85 nymphs/leaf), cotton-pigeonpea 2:1 (2.87 nymphs/leaf), cotton-sesame 1:1 (2.96 nymphs/leaf), cotton-sesame 2:1 (2.97 nymphs/leaf), cotton-pigeonpea 3:1 (3.02 nymphs/leaf) and highest in cotton-sesame 3:1 (3.10 nymphs/leaf). The results are in agreement with Saminathan *et al.*, (2002) and Kavitha *et al.*, (2003) who reported that cotton-sorghum intercropping had minimum population of leafhopper and maximum population was found in sole cotton. Similarly, sorghum crop has been reported to act as a bio-reservoir for development of spider colony by Duffield (1995). The spider populations could have considerably suppressed the population of leafhopper due to their dense webbing and higher predating activity. Jambhunkar *et al.*, (1998), Godhani (2006), Surulivelu, (2006) and Balakrishnan *et al.*, (2010) also reported that intercropped cotton with pigeonpea suppressed the incidence of sucking pests over sole crop. The pigeonpea might have provided unfavourable microclimate and further, the allelochemicals might have deterred the sucking pests.

During 2016, mean revealed that minimum population of thrips adults was recorded in cotton intercropped with *bajra* as border crop (2.10 adults/leaf) which was at par with cotton intercropped with sorghum as border crop (2.25 adults/leaf). Maximum population of thrips adults was recorded in sole cotton (3.59 adults/leaf) which was at par with cotton-sesame 2:1 (3.24 adults/leaf) and cotton-sesame 3:1 (3.22 adults/leaf) (Table 2).

Among the intercrops, minimum population of thrips adults recorded in cotton intercropped with *bajra* as border crop (2.10 adults/leaf) followed by cotton intercropped with sorghum as border crop (2.25 adults/leaf), cotton-pigeonpea 1:1 (2.76 adults/leaf), cotton-sesame 1:1 (2.92 adults/leaf), cotton-

pigeonpea 2:1 (2.93 adults/leaf), cotton-pigeonpea 3:1 (3.02 adults/leaf), cotton-sesame 3:1 (3.22 adults/leaf) and highest population of thrips was recorded in cotton-sesame 2:1 (3.24 adults/leaf). During 2017, mean revealed that minimum population of thrips adults was recorded in cotton intercropped with sorghum as border crop (2.35 adults/leaf) which was at par with cotton intercropped with *bajra* as border crop (2.39 adults/leaf). Maximum population of thrips adults was recorded in sole cotton (4.16 adults/leaf) which was significantly different from all other treatments. Among the intercrops, minimum population of thrips recorded in cotton intercropped with sorghum as border crop (2.35 adults/leaf) followed by cotton intercropped with *bajra* as border crop (2.39 adults/leaf), cotton-pigeonpea 1:1 (3.15 adults/leaf), cotton-pigeonpea 2:1 (3.23 adults/leaf), cotton-pigeonpea 3:1 (3.31 adults/leaf), cotton-sesame 1:1 (3.38 adults/leaf), cotton-sesame 2:1 (3.53 adults/leaf) and highest population in cotton-sesame 3:1 (3.64 adults/leaf).

Pooled mean of both the years during 2016 and 2017, revealed that minimum population of thrips adults was recorded in cotton intercropped with *bajra* as border crop (2.24 adults/leaf) which was at par with cotton intercropped with sorghum as border crop (2.30 adults/leaf). Maximum population of thrips adults was recorded in sole cotton (3.88 adults/leaf). Among the intercrops, lowest population of thrips adults was recorded in cotton intercropped with *bajra* as border crop (2.24 adults/leaf) followed by cotton intercropped with sorghum as border crop (2.30 nymphs/leaf), cotton-pigeonpea 1:1 (2.96 adults/leaf), cotton-pigeonpea 2:1 (3.08 adults/leaf), cotton-sesame 1:1 (3.15 adults/leaf), cotton-pigeonpea 3:1 (3.17 adults/leaf), cotton-sesame 2:1 (3.39 adults/leaf), and highest population in cotton-sesame 3:1 (3.43 adults/leaf). The results are

in accordance with Rafee (2010) who reported that intercropping of cotton with sorghum resulted in low infestation of thrips (1.82 thrips/leaf) followed by cotton-cowpea (1.83 thrips/leaf), cotton-sesame (1.93 thrips/leaf) and highest in sole cotton (2.20 thrips/leaf). Godhani (2006) and Kadam *et al.*, (2014) also concluded that lower incidence of thrips was found in cotton intercropped with sesame over sole cotton. The reduction in pests incidence in intercropped cotton may be due to low resources concentration or due to abundance of natural enemies. Similar finding was reported by Balasubramanyam *et al.*, (1998) who reported that intercropping system had low infestation of sucking pests such as whiteflies, leafhoppers, aphids and thrips over sole cotton.

During 2016, mean revealed that minimum population of whitefly adults was recorded in cotton intercropped with sorghum as border crop (2.54 adults/leaf) which was at par with cotton intercropped with *bajra* as border crop (2.58 adults/leaf) (Table 3). Maximum population of whitefly adults was recorded in sole cotton (4.03 adults/leaf) which was at par with cotton-sesame 3:1 (3.75 adults/leaf).

Among the intercrops, minimum population of whitefly adults recorded in cotton intercropped with sorghum as border crop (2.54 adults/leaf) followed by cotton intercropped with *bajra* as border crop (2.58 adults/leaf), cotton-pigeonpea 1:1 (2.90 adults/leaf), cotton-sesame 1:1 (3.16 adults/leaf), cotton-pigeonpea 2:1 (3.36 adults/leaf), cotton-pigeonpea 3:1 (3.46 adults/leaf), cotton-sesame 2:1 (3.60 adults/leaf) and highest population of whitefly was in cotton-sesame 3:1 (3.75 adults/leaf).

During 2017, revealed that minimum population of whitefly adults was recorded in cotton intercropped with sorghum as border crop (2.61 adults/leaf) which was at par with

cotton intercropped with *bajra* as border crop (2.72 adults/leaf) and cotton-pigeonpea 1:1 (3.04 adults/leaf). Maximum population was recorded in sole cotton (4.01 adults/leaf) which was at par with cotton-sesame 3:1 (3.80 adults/leaf). Among the intercrops, minimum population of whitefly adults recorded in cotton intercropped with sorghum as border crop (2.61 adults/leaf) followed by cotton intercropped with *bajra* as border crop (2.72 adults/leaf), cotton-pigeonpea 1:1 (3.04 adults/leaf), cotton-pigeonpea 2:1 (3.30 adults/leaf), cotton-pigeonpea 3:1 (3.46 adults/leaf) and cotton-sesame 1:1 (3.46 adults/leaf), cotton-sesame 2:1 (3.63 adults/leaf) and highest in cotton-sesame 3:1 (3.80 adults/leaf).

Pooled mean of both the years during 2016 and 2017 revealed that minimum population of whitefly adults was recorded in cotton intercropped with sorghum as border crop (2.52 adults/leaf) which was at par with cotton intercropped with *bajra* as border crop (2.61 adults/leaf). Maximum population of whitefly adults was recorded in sole cotton (3.97 adults/leaf) which at par with cotton-sesame 3:1 (3.66 adults/leaf). Among the intercrops, lowest population of whitefly adults was recorded in cotton intercropped with sorghum as border crop (2.52 adults/leaf) followed by cotton intercropped with *bajra* as border crop (2.61 adults/leaf), cotton-pigeonpea 1:1 (2.93 adults/leaf), cotton-sesame 1:1 (3.26 adults/leaf), cotton-pigeonpea 2:1 (3.29 adults/leaf), cotton-pigeonpea 3:1 (3.44 adults/leaf), cotton-sesame 2:1 (3.61 adults/leaf), and highest in cotton-sesame 3:1 (3.66 adults/leaf). The results are in agreement with Jambhunkar *et al.*, (1998) who reported that intercropping cotton with legumes reduced the incidence of whitefly. This might be due to the reason that when tall growing plants are intercropped in cotton, these might reduce the whitefly dispersal and avoid them to land on the cotton crop.

Materials and Methods

Dates of sowing	14 th May and 11 th May during 2016 and 2017 for cotton, and 2 th June and 4 th June during 2016 and 2017 for intercrops in the experimental area of Department of Entomology, CCS Haryana Agricultural University, Hisar.
Design	Randomized Block Design
No. of replication	Three
No. of treatments	Nine
Row to row distance	67.5 × 30 cm
Intercrops	(1) Cotton+Sesame (1:1) (2) Cotton+Sesame (2:1) (3) Cotton+Sesame (3:1) (4) Cotton+Pigeonpea (1:1) (5) Cotton+Pigeonpea (2:1) (6) Cotton+Pigeonpea (3:1) (7) A row of Sorghum around cotton plot (8) A row of bajra around cotton plot
Varieties:- Desi cotton Sesame Pigeonpea Sorghum Bajra	HD-432 HT-1 Paras HC-171 HHB-67i

Table.1 Effect of intercropping on population of leafhopper nymphs in cotton

Treatments	Mean number of leafhopper nymphs per leaf		
	2016	2017	Pooled mean
Cotton+Sesame 1:1	3.31 (2.01)	2.62 (1.83)	2.96 (1.93)
Cotton+Sesame 2:1	3.34 (2.01)	2.61 (1.82)	2.97 (1.93)
Cotton+Sesame 3:1	3.42 (2.04)	2.78 (1.87)	3.10 (1.96)
Cotton+Pigeonpea 1:1	3.16 (1.96)	2.49 (1.79)	2.85 (1.89)
Cotton+Pigeonpea 2:1	3.20 (1.98)	2.58 (1.81)	2.87 (1.90)
Cotton+Pigeonpea 3:1	3.41 (2.03)	2.62 (1.83)	3.02 (1.94)
Cotton+ <i>Bajra</i> (border crop)	2.86 (1.90)	2.09 (1.70)	2.47 (1.81)
Cotton+Sorghum (border crop)	2.90 (1.91)	2.09 (1.70)	2.49 (1.81)
Sole Cotton	3.97 (2.25)	3.11 (1.95)	3.54 (2.06)
SE± (m)	(0.02)	(0.02)	(0.02)
CD at 5%	(0.06)	(0.06)	(0.05)

Figures in parentheses are square root transformed values

Table.2 Effect of intercropping on population of thrips adults in cotton

Treatments	Mean number of thrips adults per leaf		
	2016	2017	Pooled mean
Cotton+Sesame 1:1	2.92 (1.89)	3.38 (2.00)	3.15 (1.95)
Cotton+Sesame 2:1	3.24 (1.97)	3.53 (2.04)	3.39 (2.02)
Cotton+Sesame 3:1	3.22 (1.96)	3.64 (2.07)	3.43 (2.03)
Cotton+Pigeonpea 1:1	2.76 (1.84)	3.15 (1.95)	2.96 (1.90)
Cotton+Pigeonpea 2:1	2.93 (1.89)	3.23 (1.97)	3.08 (1.94)
Cotton+Pigeonpea 3:1	3.02 (1.90)	3.31 (1.98)	3.17 (1.95)
Cotton+ <i>Bajra</i> (border crop)	2.10 (1.69)	2.39 (1.77)	2.24 (1.73)
Cotton+Sorghum (border crop)	2.25(1.73)	2.35(1.75)	2.30(1.75)
Sole Cotton	3.59 (2.03)	4.16 (2.19)	3.88 (2.12)
SE± (m)	(0.03)	(0.02)	(0.02)
CD at 5%	(0.09)	(0.06)	(0.06)

Figures in parentheses are square root transformed values

Table.3 Effect of intercropping on population of whitefly adults in cotton

Treatments	Mean number of whitefly adults per leaf		
	2016	2017	Pooled mean
Cotton+Sesame 1:1	3.16 (1.99)	3.46 (2.03)	3.26 (2.01)
Cotton+Sesame 2:1	3.60 (2.10)	3.63 (2.05)	3.61 (2.08)
Cotton+Sesame 3:1	3.75 (2.12)	3.80 (2.11)	3.66 (2.10)
Cotton+Pigeonpea 1:1	2.90 (1.92)	3.04 (1.93)	2.93 (1.93)
Cotton+Pigeonpea 2:1	3.36 (2.04)	3.30 (2.00)	3.29 (2.02)
Cotton+Pigeonpea 3:1	3.46 (2.05)	3.46 (2.03)	3.44 (2.04)
Cotton+ <i>Bajra</i> (border crop)	2.58 (1.85)	2.72 (1.87)	2.61 (1.85)
Cotton+Sorghum (border crop)	2.54 (1.84)	2.61 (1.84)	2.52 (1.83)
Sole Cotton	4.03 (2.18)	4.01 (2.15)	3.97 (2.16)
SE± (m)	(0.03)	(0.03)	(0.03)
CD at 5%	(0.07)	(0.09)	(0.07)

Figures in parentheses are square root transformed values

Table.4 Effect of intercropping on natural enemies population in cotton during 2016

Treatments	Spiders/plant	Coccinellids/plant	<i>Chrysperla</i> adults /plant
Cotton+Sesame 1:1	1.83 (1.65)	1.16 (1.44)	0.59 (1.25)
Cotton+Sesame 2:1	1.68 (1.60)	1.01 (1.39)	0.54 (1.23)
Cotton+Sesame 3:1	1.32 (1.49)	0.98 (1.39)	0.49 (1.21)
Cotton+Pigeonpea 1:1	1.50 (1.55)	1.41 (1.52)	0.38 (1.17)
Cotton+Pigeonpea 2:1	1.31 (1.49)	1.37 (1.51)	0.33 (1.15)
Cotton+Pigeonpea 3:1	1.13 (1.44)	1.31 (1.49)	0.32 (1.14)
Cotton+ <i>Bajra</i> (border crop)	0.95 (1.38)	0.80 (1.32)	0.37 (1.16)
Cotton+Sorghum (border crop)	0.90 (1.37)	0.75 (1.30)	0.44 (1.18)
Sole Cotton	0.88 (1.36)	0.74 (1.30)	0.28 (1.12)
SE± (m)	(0.05)	(0.04)	(0.04)
CD at 5%	(0.14)	(0.10)	(0.02)

Figures in parentheses are square root transformed values

Table.5 Effect of intercropping on natural enemies population in cotton during 2017

Treatments	Spiders/plant	Coccinellids/plant	<i>Chrysperla</i> adults /plant
Cotton+Sesame 1:1	2.30 (1.80)	1.23 (1.47)	0.33 (1.13)
Cotton+Sesame 2:1	2.13 (1.76)	1.02 (1.40)	0.24 (1.12)
Cotton+Sesame 3:1	1.67 (1.62)	0.97 (1.38)	0.23 (1.10)
Cotton+Pigeonpea 1:1	1.90 (1.69)	1.44 (1.53)	0.21 (1.09)
Cotton+Pigeonpea 2:1	1.67 (1.62)	1.36 (1.50)	0.20 (1.09)
Cotton+Pigeonpea 3:1	1.50 (1.57)	1.31 (1.50)	0.16 (1.07)
Cotton+ <i>Bajra</i> (border crop)	1.68 (1.63)	0.80 (1.33)	0.17 (1.08)
Cotton+Sorghum (border crop)	1.58 (1.60)	0.77 (1.32)	0.17 (1.08)
Sole Cotton	1.40 (1.54)	0.75 (1.31)	0.14 (1.06)
SE± (m)	(0.05)	(0.03)	(0.02)
CD at 5%	(0.15)	(0.11)	(0.01)

Figures in parentheses are square root transformed values

Tall growing nature of *bajra* and sorghum might have reduced the activity of whitefly, which always prefers to travel on the top level. Similarly, Patel (2001) reported that cotton intercropping with sesame had low incidence of sucking pests as compared to sole cotton. Rafee (2010) also concluded that cotton-sorghum intercropping resulted in low infestation of whitefly (0.19 adults/leaf) followed by cotton-cowpea (0.20 adults/leaf), cotton-sesame (0.21 adults/leaf), and highest in sole cotton (0.30 adults/leaf).

The data on table 4 revealed that maximum population of spiders was recorded in cotton-sesame 1:1 (1.83 spiders/plant) which was at par with cotton-pigeonpea 1:1 (1.50 spiders/plant) and cotton-sesame 2:1 (1.68 spiders/plant). Minimum population of spiders was recorded in sole cotton (0.88 spiders/plant) which was at par with cotton intercropped with sorghum as border crop (0.90 spiders/plant), cotton intercropped with *bajra* as border crop (0.95 spiders/plant), cotton-pigeonpea 3:1 (1.13 spiders/plant), cotton-pigeonpea 2:1 (1.31 spiders/plant) and cotton-sesame 3:1 (1.32 spiders/plant). The results of the present study are in agreement with those of Patel (2001) and Kadam *et al.*, (2014) who concluded that cotton intercropping with sesame enhanced arthropod

natural enemies of cotton pests *i.e.* spiders. Similarly, Venugopala *et al.*, (1995) and Mote *et al.*, (2001) reported that maximum spiders population were found in cotton intercropped with pigeonpea and lowest in sole cotton.

The data on table 4 revealed that maximum population of coccinellid beetles was observed in cotton-pigeonpea 1:1 (1.41 beetles/plant) which was at par with cotton-sesame 1:1 (1.16 beetles/plant), cotton-pigeonpea 3:1 (1.31 beetles/plant) and cotton-pigeonpea 2:1 (1.37 beetles/plant). Minimum population of coccinellid beetles was recorded in sole cotton (0.74 beetles/plant) which was at par with cotton intercropped with sorghum as border crop (0.75 beetles/plant), cotton intercropped with *bajra* as border crop (0.80 beetles/plant), cotton-sesame 3:1 (0.98 beetles/plant) and cotton-sesame 2:1 (1.01 beetles per plant). The results of present study are in agreement with those of Venugopal *et al.*, (1995) and Mote *et al.*, (2001) who reported that maximum coccinellids were found in pigeonpea and lowest in sole cotton. Lester and Furr (1972) and Kadam *et al.*, (2014) also reported that cotton-sesame inter-planting ecosystem favoured buildup of ladybird beetles over the sole cotton. Kavitha *et al.*, (2003) and Scholz and Parker (2004) reported that lady bird

beetles were one of the main predators in cotton adjacent to sorghum. These results are in conformity with those of Patel (2001) and Kadam *et al.*, (2014) who reported that maximum predators were found in cotton-sesame and minimum in sole cotton.

The data on table 4 revealed that maximum population of *Chrysoperla* spp. was recorded in cotton-sesame 1:1 (0.59 grubs and adults/plant) which was at par with cotton-sesame 2:1 (0.54 grubs and adults/plant). Minimum population of *Chrysoperla* spp. was recorded in sole cotton (0.28 grubs and adults/plant) which was at par with cotton-pigeonpea 3:1 (0.32 grubs and adults/plant). Similarly, Venugopal *et al.*, (1995) and Kranthi and Russell (2009) reported that maximum number of *Chrysoperla* spp. were found in pigeonpea and lowest in sole cotton. Rajput and Daware (2002) and Hegde *et al.*, (2004) also reported that cotton-sorghum intercropping enhanced the activity of *Chrysoperla* spp. over sole cotton.

The data on table 5 revealed that maximum population of spiders was recorded in cotton-sesame 1:1 (2.30 spiders/plant) which was at par with cotton-sesame 2:1 (2.13 spiders/plant) and cotton-pigeonpea 1:1 (1.90 spiders/plant). Minimum population of spiders was recorded in sole cotton (1.40 spiders/plant) which was at par with cotton intercropped with *bajra* as border crop (1.68 spiders/plant), cotton intercropped with sorghum as border crop (1.58 spiders/plant), cotton-sesame 3:1 (1.67 spiders/plant), cotton-pigeonpea 1:1 (1.90 spiders/plant), cotton-pigeonpea 2:1 (1.67 spiders/plant) and cotton-pigeonpea 3:1 (1.50 spiders/plant). The results of the present study are in agreement with those of Patel (2001) and Kadam *et al.*, (2014) who concluded that cotton intercropping with sesame enhanced arthropod natural enemies of cotton pests *i.e.* spiders.

The data on table 5 revealed that maximum population of coccinellid beetles was observed on cotton-pigeonpea 1:1 (1.44 beetles/plant) which was at par with cotton-sesame 1:1 (1.23 beetles/plant), cotton-pigeonpea 3:1 (1.31

beetles/plant) and cotton-pigeonpea 2:1 (1.36 beetles/plant). Minimum population of coccinellid beetles was recorded in sole cotton (0.75 beetles/plant) which was at par with cotton-sesame 3:1 (0.97 beetles/plant), cotton-sesame 2:1 (1.02 beetles/plant) cotton intercropped with *bajra* as border crop (0.80 beetles/plant) and cotton intercropped with sorghum as border crop (0.77 beetles/plant).

The data on table 5 revealed that maximum population of *Chrysoperla* spp. was recorded in cotton-sesame 1:1 (0.33 grubs and adults/plant) and it was at par with cotton-sesame 2:1 (0.24 grubs and adults/plant) and minimum population of *Chrysoperla* spp. was recorded in sole cotton (0.14 grubs and adults/plant) which was at par with cotton-pigeonpea 3:1 (0.16 grubs and adults/plant).

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