

Influence of Different Groundnut - Cowpea Intercropping Ratios on Sucking Pests and their Natural Enemies

K Swaroopa, C Sandhya Rani, Ch Chiranjeevi and V Prasanna Kumari
Acharya N.G. Ranga Agricultural University, Guntur, A.P.

ABSTRACT

Among different ratios of groundnut + cowpea intercropping systems, the highest mean population of thrips and leaf hoppers were recorded in groundnut and cowpea sole crops (4.29 and 4.08 thrips/ plant & 5.58 and 10.64 jassids/ plant, respectively) followed by groundnut and cowpea crops in 3:1 ratio of groundnut + cowpea intercropping systems (3.50 and 3.69 thrips/ plant & 4.98 and 8.18 jassids/ plant, respectively) and comparatively lowest population was recorded in both groundnut cowpea crops at 7:1 ratio of groundnut + cowpea intercropping system (2.90 and 3.10 thrips/ plant; 4.09 & 7.83 leaf hoppers/ plant, respectively). A similar trend was followed in case of aphid population where highest population recorded in cowpea sole crop (23.20 aphids/ plant on leaves and 34.01 aphids/ plant on shoots, respectively) followed by groundnut and cowpea crops at 3:1 ratio of intercropping systems (5.94, 18.61 aphids/ plant on leaves and 10.91, 25.29 aphids/ plant on shoots, respectively) and lowest population was recorded in groundnut and cowpea crops at 7:1 (3.66, 14.22 aphids/ plant on leaves and 10.25, 18.71 aphids/ plant on shoots, respectively) ratio. The highest mean population of Coccinellids and spiders in groundnut and cowpea crops were observed in 3:1 (1.64, 1.65 coccinellids/ plant and 1.48, 1.83 spiders/ plant, respectively) and 7:1 ratios (1.20, 1.62 coccinellids/ plant and 1.34 and 1.38 spiders/ plant, respectively) of groundnut + cowpea intercropping systems among all intercropping ratios. The highest net returns and maximum B: C ratios were obtained in 7:1 ratio of groundnut + cowpea intercropping system.

Key words: Cowpea, Groundnut, Intercropping.

Groundnut (*Arachis hypogaea* L.), also known as peanut, is a legume that ranks 6th among the oilseed crops and 13th among the food crops of the world. It is one of the most important oilseed crops in India, covering nearly half of the area under oilseeds. It provides high quality edible oil (48-50%) and easily digestible protein (26-28%). It is cultivated as *kharif* and *rabi* crop in India in an area of 4.76 M ha with a production of 6.77 Mt and productivity of 1552 kg ha⁻¹. Andhra Pradesh is one of the leading states with 0.87 M.ha. under groundnut cultivation producing 0.49 Mt with a productivity of 564 kg ha⁻¹ (Ministry of Agriculture and Farmers Welfare, Government of India, 2014-15). The insect pests of groundnut inflict serious losses both directly as defoliators, sap suckers, root feeders etc. and indirectly as vectors to dreaded viral diseases of the crop (Stalker and Campbell, 1983). Chemical control is being recommended with success but the awareness of deleterious effects of chemicals led to the thinking about alternatives to chemicals. Non-chemical methods in agriculture have well established in history for their role in insect pest management. Of these, Intercropping is the most important component gaining importance due to realization of inherent advantages it confers in sustaining crop production in an eco-friendly environment. Intercropping can effect the microclimate of the agro ecosystem and ultimately produce an unfavorable environment for pests. Considering the above facts, the present study was

undertaken to study the influence of different groundnut + cowpea intercropping ratios on the incidence of sucking pests and their natural enemies.

MATERIAL AND METHODS

A field experiment was conducted during *kharif* season of 2016 at the Agricultural College Farm, Acharya N G Ranga Agricultural University, Bapatla with the groundnut variety K6 and a local variety of cowpea following Randomized Complete Block Design (RCBD) having plot size of 7.2 m x 3 m with four replications. The main crop and intercrops were sown at different ratios of 3:1, 7:1 and 11:1 along with sole crops of groundnut + cowpea. A spacing of 30 cm X 10 cm was maintained in case of both groundnut and cowpea, sown with plant-to-plant distance of 10 cm having same row-to-row distance of 30 cm. No plant protection measures were taken throughout the season. The observations on the population of thrips, leaf hoppers and aphids were taken from top, middle and bottom portions of leaves, in case of aphids the count taken from 2 cm shoot portion from the top. The naturally occurring predators were recorded as number per plant. All sucking pests and natural enemies recorded from randomly selected ten plants in different intercropping systems right from 10 days after germination up to harvesting. Various species of coccinellid predators were considered as a group, and their presence was recorded in all the cropping systems.

All the spiders, irrespective of the family to which they belonged, were recorded together as one unit. The final pooled mean data was analyzed and presented.

RESULTS AND DISCUSSION

The thrips incidence recorded from 36th SW (0.00 and 1.18 thrips/plant) to 44th SW (4.29 and 2.17 thrips/plant) but the peak incidence of thrips (5.75 and 6.25 thrips/plant) was noticed during 39th and 40th SW in groundnut and cowpea sole crops, respectively. The data on thrips population varied among the different groundnut + cowpea intercropping ratios. In 3:1 ratio the thrips population ranged from 0.05 to 4.50 and 0.05 to 5.00 thrips/plant; 7:1 ratio recorded 0.05 to 4.25 thrips/plant and 0.05 to 4.25 thrips/plant, whereas 11:1 ratio recorded 3.25 to 4.50 and 3.75 to 5.00 thrips/plant in groundnut and cowpea intercrops respectively. The mean thrips population ranged from 2.90 and 3.10 thrips/plant (7:1 ratio) to 4.29 and 4.08 thrips/plant (sole crops) in groundnut and cowpea crops respectively (Table 1).

Among all intercropping ratios the 7:1 ratio has recorded lesser mean population of thrips which was on par with 11:1 (3.34; 3.59 thrips/plant) followed by 3:1 ratio (3.50; 3.69 thrips/plant) and showed significant difference with the sole crops of groundnut and cowpea (4.29 and 4.08 thrips/plant, respectively) (Table 5).

The above findings are in conformity with Lakshmi (2012) who reported that groundnut + cowpea intercropping (6:1) showed significantly lesser mean population of thrips (3.73 thrips/plant) when compared to the groundnut sole crop (4.41 thrips/plant). Contrasting results were obtained with the Girija *et al.* (2015) who reported that the groundnut + cowpea intercropping (3:1) supported higher thrips population after the groundnut sole crop.

The leaf hopper incidence ranged from 35th SW (0.23 and 0.15 leaf hopper/plant) to 44th SW (2.25 and 10.50 leaf hopper/plant) but the peak incidence of leaf hoppers (9.00 and 19.50 leaf hoppers/plant) was noticed during 40th and 42th SW in groundnut and cowpea sole crops respectively. The data on leaf hopper population varied among the different groundnut + cowpea intercropping ratios. In 3:1 ratio the leaf hopper population ranged from 0.23 to 10.32 and 0.40 to 19.50 leaf hoppers/plant; 7:1 ratio recorded 0.10 to 9.13 leaf hoppers / plant and 0.10 to 17.75 leaf hoppers /plant, whereas 11:1 ratio recorded 1.13 to 7.53 and 0.10 to 15.75 leaf hoppers /plant in groundnut and cowpea intercrops respectively. Lowest leaf hopper mean population was recorded in groundnut at 7:1 (4.09 leaf hopper/plant) groundnut + cowpea intercropping ratio which was on par with 11:1 (4.50 leaf hoppers/plant) followed by 3:1 (4.98 leaf hopper/plant) groundnut + cowpea intercropping ratio (Table 2).

The highest leaf hopper mean population in cowpea at 11:1 (6.75 leaf hoppers/plant) and it was on par with 7:1 (7.83 leaf hoppers/plant) and 3:1 (8.18 leaf hoppers/plant) ratios of intercropping system when compared to the cowpea sole crop (10.64 leaf hoppers/plant). The reduced leaf hopper population was noticed in all the intercropping ratios when compared to the sole crops. These findings are in conformity with Lakshmi (2012) reported the groundnut + cowpea intercropping (6:1) recorded significantly lesser mean per cent damage of leaf hopper (9.84%) when compared to the groundnut sole crop (10.61%). According to Girija *et al.* (2015) the groundnut + cowpea intercropping (3:1) supported highest leaf hopper population (0.60 leaf hoppers/plant) which was on par with the sole groundnut crop (0.73 leaf hoppers/plant) (Table 5).

The aphid incidence on leaves recorded from 36th SW (0.00 and 2.80 aphids/plant) to 44th SW (8.50 and 13.00 aphids/plant) but the peak incidence of aphids (7.00 and 40.25 aphids/plant) was noticed during 41st SW and 42nd SW in both groundnut and cowpea sole crops respectively.

The data on aphid population varied among the different groundnut + cowpea intercropping ratios. In 3:1 ratio, the aphid population ranged from 1.50 to 12.25 and 9.50 to 29.25 aphids/plant; 7:1 ratio recorded 1.50 to 6.50 aphids/ plant and 9.00 to 17.75 aphids / plant, whereas 11:1 ratio recorded 1.25 to 10.87 and 0.23 to 18.00 aphids/plant in groundnut+ cowpea intercrops respectively (Table 3).

The aphid incidence on shoots recorded from 36th SW (0.00 and 19.50 aphids/plant) to 44th SW (0.00 and 29.50 aphids/plant) but the peak incidence of aphids (12.50 and 58.00 aphids/plant) was noticed during 41st and 40th SW in groundnut and cowpea sole crops respectively.

The data on aphid population varied among the different groundnut + cowpea intercropping ratios. In 3:1 ratio the aphid population ranged from 2.20 to 13.25 and 9.75 to 46.50 aphids/plant; 7:1 ratio recorded 2.50 to 14.17 and 5.50 to 30.25 aphids /plant, whereas 11:1 ratio recorded 3.08 to 14.00 and 6.25 to 25.00 aphids/plant in groundnut + cowpea intercrops respectively (Table 4).

The highest mean population of aphids in groundnut was recorded in 3:1 (5.94; 10.91 aphids/plant on leaves and shoots, respectively) which was on par with the 7:1 (3.66; 10.25 aphids/plant on leaves and shoots, respectively) followed by 11:1 (2.05; 9.47 aphids/plant on leaves and shoots, respectively) groundnut + cowpea intercropping ratios and followed by groundnut sole crop (1.49; 8.16 aphids/plant on leaves and shoots, respectively).

In case of cowpea the highest mean population of aphids was observed in cowpea sole crop (23.20;

34.01 aphids/ plant on leaves and shoots, respectively) which was on par with the 3:1 (18.61; 25.29 aphids/ plant on leaves and shoots, respectively) and showing significant difference with the 7:1 (14.22; 18.71 aphids/ plant on leaves and shoots, respectively) followed by 11:1 (12.89 ; 18.47 aphids/ plant on leaves and shoots respectively) groundnut+ cowpea intercropping ratios. This is because the aphids were the severe pests for the cowpea it was reduced when intercropped with the crop which is not infested severely by that pest (Table 5)

The present findings are in agreement with those of Kennedy *et al.* (1990) who reported that the groundnut intercropped with cowpea at 3:1 ratio has not significantly reduced the aphid population when compared to the sole crop.

The coccinellid presence recorded from 35th SW (0.00 and 0.03 coccinellids/plant) to 44th SW (0.15 and 4.15 coccinellids/plant) but the peak population of coccinellids (0.28 and 4.15 coccinellids/plant) was noticed during 41st and 44th SW in groundnut and cowpea sole crops respectively. The data on coccinellid population varied among the different groundnut + cowpea intercropping ratios. In 3:1 ratio the coccinellids population ranged from 0.03 to 3.28 and 0.33 to 3.50 coccinellids/plant; 7:1 ratio recorded 0.03 to 2.35 coccinellids/plant and 0.13 to 2.50 coccinellids/plant, whereas 11:1 ratio recorded 0.05 to 0.53 and 0.10 to 1.50 coccinellids/plant in groundnut and cowpea intercrops respectively. The highest mean coccinellids population ranged from 1.64 and 1.65 (3:1 ratio) to 0.09 and 2.34 (sole crops) in groundnut and cowpea crops, respectively (Table 6).

Among groundnut- cowpea intercropping ratios; the 3:1 and 7:1 ratios were on par with each other (1.64 and 1.20 coccinellids/plant, respectively). The 11:1 ratio recorded less mean population of coccinellids in both groundnut and cowpea crops which recorded 0.20 and 0.42 coccinellids/plant, respectively (Table 5)

The occurrence of spiders incidence recorded from 35th SW (0.20 and 1.00 spiders/plant) to 44th SW (0.75 and 3.50 spiders/plant) but the peak population of spiders (1.00 and 4.25 spiders/plant) was noticed during 41st and 42nd SW in groundnut and cowpea sole crops respectively. The data on spider population varied among the different groundnut + cowpea intercropping ratios. In 3:1 ratio the spiders population ranged from 0.33 to 2.50 and 0.55 to 3.25 spiders/plant; 7:1 ratio recorded 0.20 to 2.50 spiders/ plant and 0.33 to 2.75 spiders/plant, whereas 11:1 ratio recorded 0.10 to 1.25 and 0.20 to 2.80 spiders/plant in groundnut+ cowpea intercrops respectively (Table 7). The mean spider population ranged from 1.48 and 1.83 (3:1 ratio) to

0.62 and 2.04 (sole crops) in groundnut and cowpea crops, respectively.

The highest mean population in case of groundnut was recorded in 3:1 (1.48 spiders/plant) and 7:1 (1.34 spiders/plant) ratio of intercropping system which were on par with each other. There is a significant difference among all intercropping ratios in case of groundnut and significantly lesser mean population was recorded in 11:1 (0.73 and 1.18 spiders/plant) ratio both in groundnut and cowpea crops, respectively (Table 5).

Duffield and Reddy (1997) reported increased activity of coccinellids and spiders in leguminous intercrops. Surulivelu (2004) reported that cowpea is a short duration pulse crop which attracts aphids, thus increasing occurrence of coccinellids and multiplication of coccinellids and other predators in groundnut. Singh *et al.* (1991) studied influence of intercropping on natural enemy complex in groundnut and reported that the population of spiders was higher in intercropping system than that of the sole crop. Manjula and Lakshmi (2014) reported that coccinellid population was comparatively high in groundnut + cowpea system (2.44/plant) and groundnut + red gram (1.85/plant), where no plant protection was taken up. This might be attributed to the fact that aphids prefer cowpea for feeding which would have attracted the grubs and adults of coccinellids towards the crop.

Yield and Economics

As all treatments cultivated under unprotected conditions, the plot yields were collected and extrapolated in kg ha⁻¹ in both groundnut and cowpea crops. Pertaining to groundnut, the yield data varied among the treatments and ranged from 1481 (3:1 ratio) to 1879 kg ha⁻¹ (7:1 ratio). The highest yield was recorded in 7:1 ratio followed by groundnut sole crop. In cowpea the yield data varied among the treatments and ranged from 146 (11:1 ratio) to 2199 kg ha⁻¹ (sole crop). The highest B: C ratio (1: 3.10) and net returns (Rs 63988 ha⁻¹) was found with 7:1 ratio followed by 3:1 (1: 2.64; Rs 52174 ha⁻¹) ratio of groundnut + cowpea intercropping. The low input cost in case of intercropping showed less impact on cost of cultivation and thus resulted in the higher B: C ratio in case of those intercropping ratios (Table 8).

The present findings are in accordance those of with Singh *et al.* (1991) who reported that groundnut + redgram system recorded higher economic returns than all other treatments. Sekhar *et al.* (1995) noticed that additional income was obtained with groundnut + pigeonpea system. Lakshmi (2012) reported that the yield of groundnut was more in 3:1 ratio groundnut+ cowpea intercropping where the net returns were less because of low price for cowpea.

Table 1: Influence of different groundnut + cowpea intercropping ratios on the incidence of thrips during *kharij*, 2016-17

Treatments	Thrips (No. of insects / plant*)																			
	17 DAG (36 SW)		24 DAG (37 SW)		31 DAG (38 SW)		38 DAG (39 SW)		45 DAG (40 SW)		53 DAG (41 SW)		60 DAG (42 SW)		68 DAG (43 SW)		76 DAG (44 SW)			
	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP		
Groundnut + Cowpea (3:1)	0.05 (1.02)	0.05 (1.02)	3.75 (1.97)	2.75 (1.92)	3.75 (2.15)	4.25 (2.28)	3.87 (2.17)	3.25 (2.05)	4.25 (2.20)	4.13 (2.25)	4.50 (2.27)	5.00 (2.43)	2.50 (2.31)	4.75 (2.38)	2.45 (1.86)	3.00 (1.97)	3.50 (1.85)	2.45 (1.85)	3.50 (1.87)	3.69 (1.92)
Groundnut + Cowpea (7:1)	0.05 (1.02)	0.05 (1.02)	2.75 (1.85)	2.55 (1.88)	3.75 (1.93)	2.88 (1.96)	3.75 (2.17)	4.25 (2.28)	4.25 (2.27)	4.25 (2.28)	2.10 (2.28)	4.50 (2.33)	2.18 (1.75)	2.12 (1.76)	2.00 (1.77)	2.30 (1.81)	2.90 (1.72)	2.00 (1.72)	2.90 (1.70)	3.10 (1.76)
Groundnut + Cowpea (11:1)	0.00 (1.00)	0.00 (1.00)	3.25 (2.10)	3.75 (2.15)	2.00 (2.04)	3.50 (2.11)	3.75 (1.73)	2.25 (1.79)	4.50 (2.15)	4.00 (2.22)	4.00 (2.33)	5.00 (2.44)	3.25 (2.23)	4.00 (2.23)	2.50 (2.03)	3.50 (2.10)	3.34 (1.84)	2.75 (1.92)	3.34 (1.82)	3.59 (1.89)
Groundnut sole crop	0.00 (1.00)	0.00 (1.00)	4.25 (2.08)	0.00 (1.00)	4.75 (2.27)	0.00 (1.00)	5.75 (2.35)	0.00 (1.00)	5.50 (2.58)	0.00 (1.00)	4.00 (2.54)	0.00 (1.00)	3.50 (2.23)	0.00 (1.00)	3.25 (2.07)	0.00 (1.00)	4.29 (2.03)	0.00 (1.00)	4.29 (2.07)	0.00 (1.00)
Cowpea sole crop	0.00 (1.00)	1.18 (1.44)	0.00 (1.00)	3.63 (2.06)	0.00 (1.00)	3.63 (2.13)	0.00 (1.00)	4.75 (2.39)	0.00 (1.00)	6.25 (2.67)	0.00 (1.00)	5.45 (2.53)	0.00 (1.00)	3.75 (2.38)	0.00 (1.00)	3.25 (2.04)	0.00 (1.00)	2.17 (1.76)	0.00 (1.00)	4.08 (2.01)
SEM±	0.07	0.07	0.17	0.15	0.15	0.14	0.14	0.15	0.13	0.13	0.11	0.10	0.14	0.12	0.17	0.11	0.14	0.12	0.07	0.07
CD(0.05)	0.22	0.22	0.54	0.45	0.47	0.45	0.44	0.46	0.42	0.41	0.35	0.31	0.46	0.39	0.43	0.34	0.46	0.39	0.22	0.23
CV%	13.10	13.10	15.44	13.25	14.62	13.71	13.41	13.75	11.81	11.19	9.72	8.83	13.97	11.77	15.59	9.65	16.22	13.60	7.56	7.39

GN: Groundnut CP: Cowpea DAG: Days after Germination SW: Standard week

Figures in parentheses indicate square root transformed $\sqrt{x + 1}$ values.

* Average of 10 plants

Table 2: Influence of different groundnut + cowpea intercropping ratios on the incidence of *Empoasca kerri* during *kharif*, 2016-17

Treatments	<i>E. kerri</i> (No. of insects/ plant*)																							
	10 DAG (35 th SW)		17 DAG (36 th SW)		24 DAG (37 th SW)		31 DAG (38 th SW)		38 DAG (39 th SW)		45 DAG (40 th SW)		53 DAG (41 st SW)		60 DAG (42 nd SW)		68 DAG (43 rd SW)		76 DAG (44 th SW)					
	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP		
Groundnut+ Cowpea (3:1)	0.23 (1.10)	0.40 (1.17)	1.28 (1.48)	1.03 (1.40)	2.80 (1.92)	3.75 (2.15)	4.20 (2.27)	4.25 (2.28)	4.47 (2.32)	6.40 (2.71)	7.25 (2.70)	8.75 (3.09)	10.10 (3.23)	15.25 (4.00)	10.32 (3.20)	19.50 (4.49)	5.83 (2.37)	13.50 (3.69)	3.28 (1.94)	9.00 (3.11)				
Groundnut+ Cowpea (7:1)	0.10 (1.02)	0.10 (1.02)	1.15 (1.45)	0.78 (1.32)	2.18 (1.77)	3.12 (2.03)	2.48 (1.84)	5.40 (2.52)	3.55 (2.12)	5.05 (2.43)	5.85 (2.48)	8.50 (3.07)	8.00 (2.91)	13.00 (4.18)	9.13 (3.05)	17.75 (4.31)	5.10 (2.30)	13.50 (3.78)	3.38 (1.88)	7.35 (2.69)				
Groundnut+ Cowpea (11:1)	1.13 (1.42)	0.10 (1.02)	2.43 (1.81)	0.35 (1.16)	3.88 (2.19)	3.12 (1.99)	5.95 (2.51)	5.65 (2.48)	6.98 (2.66)	5.72 (2.58)	7.53 (2.74)	11.25 (3.49)	6.80 (2.74)	14.50 (3.93)	4.48 (2.31)	15.75 (4.08)	3.60 (2.08)	10.25 (3.27)	2.25 (1.80)	0.87 (1.36)				
Groundnut sole crop	0.23 (1.10)	0.00 (1.00)	2.50 (1.82)	0.00 (1.00)	3.75 (2.16)	0.00 (1.00)	7.60 (2.90)	0.00 (1.00)	8.90 (3.07)	0.00 (1.00)	9.00 (3.11)	0.00 (1.00)	7.68 (2.81)	0.00 (1.00)	5.08 (2.40)	0.00 (1.00)	3.50 (2.10)	0.00 (1.00)	2.25 (1.78)	0.00 (1.00)				
Cowpea sole crop	0.00 (1.00)	0.15 (1.07)	0.00 (1.00)	2.50 (1.86)	0.00 (1.00)	7.25 (2.81)	0.00 (1.00)	8.75 (3.09)	0.00 (1.00)	11.50 (3.51)	0.00 (1.00)	14.25 (3.89)	0.00 (1.00)	15.75 (4.08)	0.00 (1.00)	19.50 (4.52)	0.00 (1.00)	16.25 (4.11)	0.00 (1.00)	10.50 (3.35)				
SEM±	0.08	0.04	0.15	0.12	0.12	0.21	0.05	0.25	0.17	0.15	0.15	0.23	0.13	0.30	0.25	0.21	0.15	0.33	0.13	0.34				
CD (0.05)	0.26	0.12	0.48	0.39	0.28	0.54	0.13	0.68	0.52	0.48	0.42	0.72	0.40	0.94	0.60	0.67	0.48	0.82	0.40	0.65				
CV%	14.61	7.76	10.25	16.75	14.21	15.88	8.00	16.56	9.58	10.74	9.52	13.87	10.60	15.81	16.00	10.86	10.74	16.53	10.67	15.85				

GN: Groundnut

CP: Cowpea

DAG: Days after Germination

SW: Standard week

Figures in parentheses indicate square root transformed $\sqrt{x+1}$ values.

*Average of 10 plants

Table 3: Influence of different groundnut + cowpea intercropping ratios on the incidence of *Aphis craccivora* on leaves during *kharif*, 2016-17

Treatments	<i>A. craccivora</i> (No. of aphids/ plant*)																							
	17 DAG		24 DAG		31 DAG		38 DAG		45 DAG		53 DAG		60 DAG		68 DAG		76 DAG							
	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP						
Groundnut+ Cowpea (3:1)	0.00 (0.00)	9.50 (3.23)	1.50 (1.56)	15.00 (3.95)	4.75 (2.36)	17.25 (4.22)	3.25 (2.03)	19.5 (4.52)	8.00 (2.99)	20.25 (4.57)	9.00 (3.15)	23.75 (4.86)	12.25 (3.30)	29.25 (5.42)	6.00 (2.61)	20.25 (4.58)	4.75 (2.38)	12.75 (3.61)						
Groundnut+ Cowpea (7:1)	0.00 (0.00)	9.00 (3.13)	1.50 (1.57)	13.50 (3.79)	3.25 (2.02)	13.00 (3.71)	2.75 (1.92)	16.25 (4.12)	4.00 (2.14)	17.75 (4.24)	5.25 (2.44)	15.50 (3.97)	6.50 (2.68)	14.25 (3.78)	2.50 (2.24)	14.00 (3.83)	1.50 (1.56)	14.75 (3.95)						
Groundnut+ Cowpea (11:1)	0.00 (0.00)	0.23 (1.10)	1.25 (1.41)	11.75 (3.49)	2.75 (1.86)	12.00 (3.60)	1.25 (1.43)	13.50 (3.75)	2.00 (1.72)	13.25 (3.74)	7.25 (1.76)	17.50 (4.27)	10.87 (1.93)	18.00 (4.31)	2.75 (1.89)	15.00 (3.99)	1.25 (1.43)	14.75 (3.96)						
Groundnut sole crop	0.00 (0.00)	0.00 (1.00)	0.08 (1.03)	0.00 (1.00)	1.58 (1.51)	0.00 (1.00)	2.53 (1.81)	0.00 (1.00)	4.18 (2.12)	0.00 (1.00)	5.65 (2.44)	0.00 (1.00)	7.00 (2.71)	0.00 (1.00)	4.75 (2.34)	0.00 (1.00)	2.80 (1.89)	0.00 (1.00)						
Cowpea sole crop	0.00 (0.00)	8.50 (3.07)	0.00 (1.00)	20.00 (4.40)	0.00 (1.00)	20.50 (4.46)	0.00 (1.00)	23.75 (4.89)	0.00 (1.00)	34.50 (5.89)	0.00 (1.00)	40.25 (6.41)	0.00 (1.00)	26.25 (4.97)	0.00 (1.00)	22.00 (4.72)	0.00 (1.00)	13.00 (3.75)						
SEM±	0.00	0.14	0.17	0.22	0.16	0.25	0.16	0.30	0.17	0.33	0.17	0.38	0.34	0.34	0.23	0.30	0.16	0.24						
CD (0.05)	0.00	0.43	0.54	0.45	0.45	0.50	0.50	0.92	0.54	1.03	0.55	1.20	1.08	1.08	0.61	0.93	0.50	0.76						
CV%	0.00	12.12	11.30	10.21	12.52	15.11	14.80	15.20	11.45	16.20	12.00	15.51	13.91	16.00	16.12	15.65	14.79	14.35						

GN: Groundnut CP: Cowpea DAG: Days after Germination SW: Standard week

Figures in parentheses indicate square root transformed $\sqrt{x + 1}$ values.

* Average of 10 plants

Table 4: Influence of different groundnut + cowpea intercropping ratios on incidence of *Aphis craccivora* on shoots during *kharij*, 2016-17

Treatments	<i>A. craccivora</i> (No. of aphids/ plant*)																	
	17 DAG (36 th SW)		24 DAG (37 th SW)		31 DAG (38 th SW)		38 DAG (39 th SW)		45 DAG (40 th SW)		53 DAG (41 st SW)		60 DAG (42 nd SW)		68 DAG (43 rd SW)		76 DAG (44 th SW)	
	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP
Groundnut + Cowpea (3:1)	0.00 (0.00)	9.75 (3.27)	3.28 (1.12)	10.78 (3.16)	4.57 (1.18)	14.25 (3.90)	9.25 (1.18)	30.50 (5.56)	11.12 (1.28)	46.50 (6.80)	13.25 (1.34)	32.50 (5.74)	5.00 (1.56)	25.25 (5.12)	2.20 (1.10)	28.10 (5.39)	0.00 (1.00)	30.00 (5.56)
Groundnut + Cowpea (7:1)	0.00 (0.00)	5.50 (2.50)	3.18 (1.24)	5.68 (2.49)	4.28 (1.26)	14.00 (3.87)	6.15 (1.29)	15.75 (4.08)	11.82 (1.27)	21.5 (4.73)	14.17 (1.08)	24.00 (4.98)	4.00 (1.42)	23.50 (4.94)	2.50 (1.11)	28.25 (5.40)	0.00 (1.00)	30.25 (5.57)
Groundnut + Cowpea (11:1)	0.00 (0.00)	6.25 (2.67)	3.08 (1.32)	8.18 (2.88)	5.58 (1.41)	15.50 (4.06)	7.23 (1.29)	17.00 (4.24)	12.25 (1.31)	22.25 (4.81)	14.00 (1.26)	24.00 (4.99)	4.25 (1.46)	24.12 (5.00)	3.20 (1.12)	24.00 (4.99)	0.00 (1.00)	25.00 (5.08)
Groundnut sole crop	0.00 (0.00)	0.00 (1.00)	3.00 (1.40)	0.00 (1.00)	3.30 (1.44)	0.00 (1.00)	5.65 (2.36)	0.00 (1.00)	10.47 (3.36)	0.00 (1.00)	12.50 (3.62)	0.00 (1.00)	4.00 (1.42)	0.00 (1.00)	2.50 (1.11)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
Cowpea sole crop	0.00 (0.00)	19.50 (4.48)	0.00 (1.00)	21.50 (4.68)	0.00 (1.00)	24.40 (4.97)	0.00 (1.00)	26.87 (5.25)	0.00 (1.00)	58.00 (7.66)	0.00 (1.00)	56.00 (7.54)	0.00 (1.00)	40.25 (6.36)	0.00 (1.00)	30.10 (5.54)	0.00 (1.00)	29.50 (5.47)
SEM±	0.00	0.05	0.04	0.25	0.04	0.24	0.03	0.32	0.04	0.34	0.08	0.25	0.34	0.33	0.35	0.17	0.28	0.20
CD (0.05)	0.00	0.13	0.14	0.77	0.14	0.76	0.11	1.00	0.13	1.07	0.27	0.77	1.07	1.01	1.10	0.54	0.62	0.62
CV%	0.00	7.20	7.33	9.20	7.37	13.17	5.70	15.16	6.61	12.75	13.35	9.32	16.88	13.30	12.45	7.13	9.26	8.00

GN: Groundnut CP: Cowpea DAG: Days after Germination SW: Standard week

Figures in parentheses indicate square root transformed $\sqrt{x + 1}$ values.

*Average of 10 plants

Table 5: Influence of different ratios of groundnut+ cowpea intercropping on the mean population of sucking pests and natural enemies during *kharif*, 2016-17

Treatments	Mean population of sucking pests (No per plant)												Mean population of Natural enemies (No per plant)						Yield (kg ha ⁻¹)			
	Thrips			Leaf hopper			Aphids on leaves			Aphids on shoots			Coccinellids			Spiders			GN	CP		
	GN	CP		GN	CP		GN	CP		GN	CP		GN	CP		GN	CP					
Groundnut + Cowpea (3:1)	3.50 (1.87)	3.69 (1.92)	4.98 (2.21)	8.18 (3.15)	5.94 (2.43)	18.61 (4.54)	10.91 (3.30)	25.29 (5.02)	1.64 (1.31)	1.65 (1.28)	1.48 (1.22)	1.83 (1.35)	1.64 (1.31)	1.65 (1.28)	1.48 (1.22)	1.83 (1.35)	1.64 (1.31)	1.65 (1.28)	1.48 (1.22)	1.83 (1.35)	1481	512
Groundnut + Cowpea (7:1)	2.90 (1.70)	3.10 (1.76)	4.09 (2.01)	7.83 (2.74)	3.66 (1.91)	14.22 (3.51)	10.25 (3.21)	18.71 (4.32)	1.20 (1.28)	1.62 (1.27)	1.34 (1.15)	1.38 (1.16)	1.20 (1.28)	1.62 (1.27)	1.34 (1.15)	1.38 (1.16)	1.20 (1.28)	1.62 (1.27)	1.34 (1.15)	1.38 (1.16)	1879	292
Groundnut + Cowpea (11:1)	3.34 (1.82)	3.59 (1.89)	4.50 (2.15)	6.75 (2.60)	2.05 (1.40)	12.89 (3.58)	9.47 (3.08)	18.47 (4.29)	0.20 (0.44)	0.42 (0.64)	0.73 (0.85)	1.18 (1.08)	0.20 (0.44)	0.42 (0.64)	0.73 (0.85)	1.18 (1.08)	0.20 (0.44)	0.42 (0.64)	0.73 (0.85)	1.18 (1.08)	1687	146
Groundnut sole crop	4.29 (2.07)	0.00 (1.00)	5.58 (2.30)	0.00 (1.00)	1.49 (1.21)	0.00 (1.00)	8.16 (2.84)	0.00 (1.00)	0.09 (0.29)	0.00 (1.00)	0.62 (0.78)	0.00 (1.00)	0.09 (0.29)	0.00 (1.00)	0.62 (0.78)	0.00 (1.00)	0.09 (0.29)	0.00 (1.00)	0.62 (0.78)	0.00 (1.00)	1870	0.00
Cowpea sole crop	0.00 (1.00)	4.08 (2.01)	0.00 (1.00)	10.64 (3.26)	0.00 (1.00)	23.20 (4.77)	0.00 (1.00)	34.01 (5.17)	0.00 (1.00)	2.34 (1.62)	0.00 (1.00)	2.04 (1.42)	0.00 (1.00)	2.34 (1.62)	0.00 (1.00)	2.04 (1.42)	0.00 (1.00)	2.34 (1.62)	0.00 (1.00)	2.04 (1.42)	0.00	2194
SEM±	0.07	0.07	0.09	0.12	0.14	0.228	0.13	0.19	0.05	0.04	0.06	0.06	0.05	0.04	0.06	0.06	0.05	0.04	0.06	0.06	90.91	39.79
CD (0.05)	0.22	0.23	0.28	0.37	0.44	0.704	0.42	0.57	0.15	0.13	0.18	0.18	0.15	0.13	0.18	0.18	0.15	0.13	0.18	0.18	280.15	122.62
CV%	7.56	7.39	8.22	8.50	12.20	12.57	8.02	8.54	9.65	8.34	10.35	9.83	9.65	8.34	10.35	9.83	9.65	8.34	10.35	9.83	11.84	8.55

GN: groundnut CP: cowpea

Figures in parenthesis indicate square root transformed $\sqrt{x + 1}$ values

Table 6: Influence of different groundnut + cowpea intercropping ratios on the incidence of coccinellids during *kharij*, 2016-17

Treatments	Coccinellids (No of insects/ plant*)																							
	10 DAG		17 DAG		24 DAG		31 DAG		38 DAG		45 DAG		53 DAG		60 DAG		68 DAG		76 DAG					
	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP				
Groundnut + Cowpea (3:1)	0.03 (1.01)	0.33 (1.01)	0.05 (1.02)	0.15 (1.03)	0.18 (1.09)	0.50 (1.08)	1.38 (1.53)	1.50 (1.53)	3.28 (2.11)	3.50 (2.05)	1.75 (1.65)	2.50 (1.72)	2.4 (1.70)	2.60 (1.84)	2.63 (1.61)	2.63 (1.90)	2.00 (1.70)	2.25 (1.93)	2.00 (1.70)	2.63 (1.90)	2.45 (1.85)	3.00 (1.85)		
Groundnut + Cowpea (7:1)	0.03 (1.01)	0.30 (1.01)	0.03 (1.02)	0.13 (1.03)	0.33 (1.02)	0.45 (1.14)	1.15 (1.43)	1.20 (1.54)	1.18 (1.97)	2.00 (1.63)	1.43 (1.93)	2.15 (1.76)	2.13 (1.75)	2.12 (1.82)	2.35 (1.75)	2.50 (2.05)	1.20 (1.55)	1.43 (1.76)	1.20 (1.55)	2.00 (1.72)	2.00 (1.72)	2.00 (1.97)		
Groundnut + Cowpea (11:1)	0.00 (1.00)	0.20 (1.00)	0.10 (1.00)	0.10 (1.04)	0.05 (1.02)	0.30 (1.02)	0.53 (1.27)	0.45 (1.22)	0.08 (1.29)	1.20 (1.03)	0.08 (1.27)	1.50 (1.03)	0.20 (1.21)	1.00 (1.09)	0.20 (1.24)	1.20 (1.09)	0.10 (1.18)	0.4 (1.18)	0.10 (1.18)	0.4 (1.18)	0.35 (1.14)	1.20 (1.14)		
Groundnut sole crop	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.05 (1.02)	0.00 (1.00)	0.08 (1.04)	0.00 (1.00)	0.03 (1.01)	0.00 (1.00)	0.05 (1.02)	0.00 (1.00)	0.28 (1.12)	0.00 (1.00)	0.15 (1.09)	0.00 (1.00)	0.08 (1.05)	0.00 (1.00)	0.08 (1.05)	0.00 (1.00)	0.15 (1.09)	0.00 (1.00)		
Cowpea sole Crop	0.00 (1.00)	0.03 (1.01)	0.00 (1.00)	0.58 (1.44)	0.00 (1.00)	3.20 (1.99)	0.00 (1.00)	3.00 (1.97)	0.00 (1.00)	3.88 (2.11)	0.00 (1.00)	3.12 (2.01)	0.00 (1.00)	3.13 (2.01)	0.00 (1.00)	3.25 (2.04)	0.00 (1.00)	4.05 (2.24)	0.00 (1.00)	4.05 (2.24)	0.00 (1.00)	4.15 (2.03)		
SEM±	0.00	0.009	0.07	0.04	0.16	0.12	0.07	0.09	0.08	0.08	0.10	0.10	0.08	0.05	0.09	0.11	0.09	0.07	0.09	0.07	0.06	0.08		
CD (0.05)	0.00	0.02	0.22	0.14	0.29	0.39	0.23	0.30	0.27	0.24	0.31	0.31	0.25	0.16	0.28	0.35	0.28	0.24	0.28	0.24	0.19	0.26		
CV%	0.25	1.83	13.10	8.94	15.15	15.52	10.42	13.47	10.32	10.43	12.02	13.49	10.06	6.79	12.12	14.01	12.54	9.60	12.54	9.60	8.37	10.83		

GN: Groundnut CP: Cowpea DAG: Days after Germination SW: Standard week

Figures in parentheses indicate square root transformed $\sqrt{x+1}$ values.

* Average of 10 plants

Table 7: Influence of different groundnut + cowpea intercropping ratios on the population of spiders during *kharif*, 2016-17

Treatments	Spiders (No./ plant*)																			
	10 DAG (35 th SW)		17 DAG (36 th SW)		24 DAG (37 th SW)		31 DAG (38 th SW)		38 DAG (39 th SW)		45 DAG (40 th SW)		53 DAG (41 st SW)		60 DAG (42 nd SW)		68 DAG (43 rd SW)		76 DAG (44 th SW)	
	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP
Groundnut + Cowpea (3:1)	0.33 (1.14)	0.55 (1.23)	0.95 (1.35)	1.28 (1.48)	1.88 (1.14)	1.00 (1.40)	1.00 (1.40)	1.20 (1.38)	1.75 (1.65)	1.75 (1.65)	1.38 (1.53)	3.25 (2.05)	2.25 (1.77)	1.75 (1.65)	2.25 (1.78)	2.25 (2.01)	2.50 (1.83)	2.25 (1.75)	2.25 (1.79)	3.25 (2.05)
Groundnut + Cowpea (7:1)	0.20 (1.09)	0.78 (1.32)	0.98 (1.16)	1.05 (1.39)	1.35 (1.14)	0.78 (1.32)	0.78 (1.32)	0.78 (1.39)	1.03 (1.40)	1.78 (1.32)	1.50 (1.57)	2.00 (1.69)	2.00 (1.70)	1.88 (1.67)	2.00 (1.72)	2.25 (1.77)	2.00 (1.72)	2.75 (1.64)	2.50 (1.86)	2.55 (1.86)
Groundnut + Cowpea (11:1)	0.10 (1.04)	0.50 (1.21)	0.78 (1.07)	0.35 (1.15)	0.80 (1.04)	0.43 (1.18)	1.05 (1.31)	1.05 (1.31)	0.65 (1.27)	0.55 (1.23)	1.05 (1.41)	2.78 (1.87)	1.53 (1.54)	1.03 (1.40)	1.15 (1.44)	2.78 (1.83)	0.90 (1.37)	2.80 (1.33)	1.25 (1.49)	1.89 (1.49)
Groundnut sole crop	0.20 (1.09)	0.65 (1.27)	0.00 (1.00)	0.53 (1.29)	0.00 (1.00)	0.53 (1.29)	0.00 (1.00)	0.00 (1.00)	0.53 (1.29)	0.00 (1.00)	0.75 (1.31)	0.00 (1.00)	0.00 (1.00)	1.00 (1.41)	0.88 (1.36)	0.00 (1.00)	0.85 (1.35)	0.00 (1.00)	0.75 (1.31)	0.00 (1.00)
Cowpea sole crop	0.00 (1.00)	0.00 (1.00)	1.00 (1.41)	0.00 (1.00)	1.10 (1.45)	0.00 (1.00)	1.25 (1.49)	0.00 (1.00)	0.00 (1.00)	1.75 (1.64)	0.00 (1.00)	3.00 (2.09)	3.50 (2.09)	0.00 (1.00)	0.00 (1.00)	4.25 (2.26)	0.00 (1.00)	4.00 (2.21)	0.00 (1.00)	3.50 (2.02)
SEM±	0.04	0.06	0.09	0.13	0.11	0.10	0.12	0.12	0.12	0.14	0.11	0.13	0.13	0.11	0.13	0.18	0.13	0.12	0.11	0.11
CD(0.05)	0.14	0.18	0.30	0.24	0.15	0.32	0.28	0.28	0.28	0.25	0.35	0.41	0.40	0.36	0.32	0.46	0.42	0.39	0.35	0.35
CV%	8.76	11.34	15.18	12.71	16.05	15.84	16.97	15.48	14.71	14.26	14.57	14.71	15.32	14.40	14.20	14.52	16.13	15.68	13.43	13.15

GN: Groundnut CP: Cowpea DAG: Days after Germination SW: Standard week

Figures in parentheses indicate square root transformed $\sqrt{x+1}$ values.

* Average of 10 plants

Table 8: Yield and B: C ratios of groundnut + cowpea intercropping systems with reference to the pest incidence during *kharif*, 2016-17

Treatments	Yield of groundnut crop (kg ha ⁻¹)	Yield of cowpea (kg/ha ⁻¹)	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net returns (Rs.)	B:C ratio
Groundnut + Cowpea 3:1	1481	5120	70710	18536	52174	01:02.8
Groundnut + Cowpea 7:1	1879	2925	84001	20013	63988	01:03.1
Groundnut + Cowpea 11:1	1687	1462	73553	21006	52546	01:02.5
Groundnut sole crop	1870	-	78929	23045	55884	01:02.4
Cowpea sole crop	-	2199	26388	12685	13703	01:01.1

CONCLUSION

The study concluded that the 7:1 and 3:1 ratio of groundnut – cowpea intercropping recorded lesser mean population of sucking pests and more number of natural enemies so that they got similar yields when compared to sole groundnut but due to the low input cost those ratios recorded highest B: C ratio (1: 3.10 and 1: 2.81) and net returns (Rs 63988 and Rs 5217 ha⁻¹, respectively).

LITERATURE CITED

- Duffield S J and Reddy Y V R 1997** Distribution and increment of predators of *Helicoverpa armigera* in intercropped sorghum and short duration pigeonpea. *Crop Research*, 14: 315-335.
- Girija T, Hegde M and Bhat J 2015** Influence of groundnut based intercropping system on *Spodoptera litura*. *Journal of Ecofriendly Agriculture*, 10(2): 163-167.
- Kennedy F J S, Rajamanickam K and Raveendran T S 1990** Effect of intercropping on insect pests of groundnut and their natural enemies. *Journal of Biological Control*, 4(1):63-64.
- Lakshmi P R 2012** Influence of different groundnut intercropping systems on insect pest complex. M.sc. (Ag). Thesis. Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad, A.P.
- Manjula K and Lakshmi P R 2014** Positive influence of intercrops on coccinellids and spider fauna in groundnut. *International Journal of Plant, Animal and Environmental Sciences*, 4: 207-209.
- Ministry of Agriculture and Farmers Welfare, Government of India. 2014-15.** <http://indiastat.com>.
- Sekhar P R, Rao N V, Venkataiah M and Rajasri M 1995** Influence of intercrops of pigeonpea and chickpea on pod borer incidence. *Indian Journal of Pulses Research*, 8(1): 41-44.
- Singh T V K, Singh K M and Singh R N 1991** Impact of intercropping: IV. Yields of groundnut. *Indian Journal of Entomology*, 53(3): 369-372.
- Surulivelu T 2004** Pest Control in Organic Cotton. Research Notes. Available online, www.cicr.org.in.
- Stalker H T and Campbell W N 1983** Resistance of wild species of peanut to an insect pest complex. *Peanut Science*. 10: 32-33.