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Effect of intercropping on sucking pests, predators and parasitoids in groundnut-cowpea intercropping system

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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 leaf hoppers/ 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 leaf hoppers/ plant, respectively) and comparatively least population 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). 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. A total of 10 families of parasitoids were observed in bulk plot of 3:1 ratio groundnut- cowpea intercropping system.

Keywords: Thrips, leaf hoppers, coccinellids and parasitoids

Introduction

Groundnut (*Arachis hypogaea* L.) is an important oilseed and supplementary food crop of the world. It is fourth most important source of edible oil and third most important source of vegetable protein. Globally, the crop is raised on 26.4 million hectares with a total production of 37.1 million MT. The average productivity is 1400 kg/ha (IOPEPC 2017). The insect pests of groundnut inflict serious losses both directly as defoliators, sap suckers, root feeders and indirectly as vectors to dreaded viral diseases of the crop (Stalker and Campbell, 1983) ^[10]. 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. Cowpea is a short-duration pulse crop also considered as an Eco feast crop, which attracts aphids, thus increasing occurrence and encouraging multiplication of coccinellids and other predators in groundnut (Surulivelu, 2004) ^[11] Intercropping with cowpea can affect the microclimate of the agro ecosystem and ultimately produce an unfavorable environment for pests and favorable environment for natural enemies. 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 to identify the intercropping ratio which attracts more natural enemies and reduces the pest population with regarding economic sustainability of farmer.

Materials 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 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 30X10 cm was maintained in case of both groundnut and cowpea, sown with plant-to-plant distance

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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 and leaf hoppers were taken from top, middle and bottom portions of leaves. 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. A bulk plot of 3:1 ratio of groundnut- cowpea intercrop was raised in which parasitoids were collected by using open pan method at 10 days interval from sowing to harvesting.

Open Pan Method

To collect parasitoids, ten yellow color open pans were placed in the bulk plot randomly at one metre distance in the field and filled them with water which was already mixed with a drop of liquid soap to avoid surface tension and a pinch of salt to keep the water fresh for two days.

The water in the yellow pans was filtered through normal plastic coffee filter and that filtrate was collected into the 70% ethyl alcohol. From the collected specimens parasitoids were segregated, kept separately in the vials, sent them to Dr. Manickavasagam, Faculty of Agriculture, Annamalai University and identified 10 families.

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 1).

Lakshmi (2012) ^[4], 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) ^[2] 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 lowest 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) ^[4] 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) ^[2] 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 2).

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 3).

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.

The present findings are in line with Baskaran *et al.* (1993) who reported that growing intercrops such as cowpea and pearl millet reduce pest damage and favours natural enemies on groundnut. Manjula and Lakshmi (2014) ^[5] 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.

The presence of parasitoids in groundnut + cowpea intercropping systems confirmed by collection of parasitoids belonging to the families *viz.*, Eulophidae, Encyrtidae, Eurytomidae, Platygasteridae, Trichogrammatidae, Mymaridae, Bethyidae, Ceraphronidae, Braconidae and Ichneumonidae by using yellow open pan trap (Plate 1.).

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

Treatments	Thrips (No. of insects / plant*)																			
	17 DAG		24 DAG		31 DAG		38 DAG		45 DAG		53 DAG		60 DAG		68 DAG		76 DAG		Mean	
	(36 SW)		(37 SW)		(38 SW)		(39 SW)		(40 SW)		(41 SW)		(42 SW)		(43 SW)		(44 SW)			
	GN	CP	GN	CP	GN	CP	GN	CP	GN	GN	CP	GN	CP	GN	CP	GN	CP	GN	CP	GN
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 parenthesis indicate square root transformed $\sqrt{x+1}$ value. *=Average of 10 plants.

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

Treatments	<i>E. kerri</i> (No. of insects/ plant*)																			
	17 DAG		24 DAG		31 DAG		38 DAG		45 DAG		53 DAG		60 DAG		68 DAG		76 DAG		Mean	
	(36 th SW)		(37 th SW)		(38 th SW)		(39 th SW)		(40 th SW)		(41 st SW)		(42 nd SW)		(43 rd SW)		(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)	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)	4.98 (2.21)	8.18 (3.15)
Groundnut+ Cowpea (7:1)	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)	4.09 (2.01)	7.83 (2.74)
Groundnut+ Cowpea (11:1)	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)	4.50 (2.15)	6.75 (2.60)
Groundnut sole crop	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)	5.58 (2.30)	0.00 (1.00)
Cowpea sole crop	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)	0.00 (1.00)	10.64 (3.26)
SEM±	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	0.09	0.12
CD (0.05)	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	0.28	0.37
CV%	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	8.22	8.50

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

Figures in parenthesis indicate square root transformed $\sqrt{x+1}$ value. *=Average of 10 plants

Table 3: Influence of different groundnut + cowpea intercropping ratios on the incidence of coccinellids during *kharif*, 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	
	(35 th SW)		(36 th SW)		(37 th SW)		(38 th SW)		(39 th SW)		(40 th SW)		(41 st SW)		(42 nd SW)		(43 rd SW)		(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)	0.03 (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)	2.45 (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)	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)	0.35 (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)	0.15 (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)	4.15 (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	0.06	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	0.19	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	8.37	10.83

GN: Groundnut

CP: Cowpea

DAG: Days after sowing

SW: Standard week

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

*=Average of 10 plants.

Table 4: Yield and B: C ratio of groundnut + cowpea intercropping system 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	Cost of cultivation	Net returns	B:C ratio
Groundnut + Cowpea 3:1	1481	5120	70710	18536	52174	1:2.81
Groundnut + Cowpea 7:1	1879	2925	84001	20013	63988	1:3.10
Groundnut+ Cowpea 11:1	1687	1462	73553	21006	52546	1:2.50
Groundnut sole crop	1870	-	78929	23045	55884	1:2.42
Cowpea sole crop		2199	26388	12685	13703	1:1.08

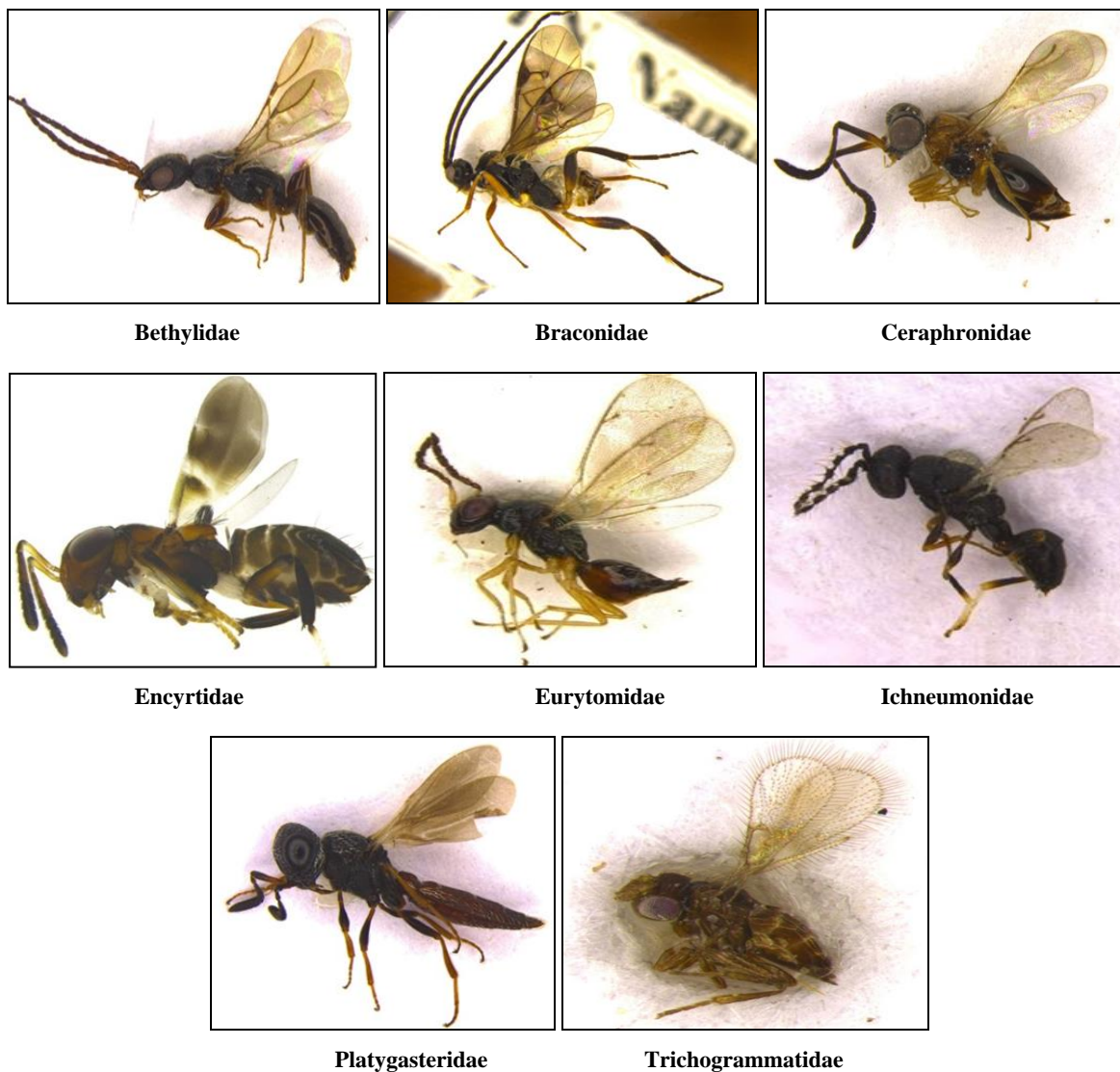


Plate 1: Different parasitoids collected from groundnut + cowpea intercropping system

Yield and Economics

Yield of sole groundnut crop and groundnut + cowpea 7:1 ratio intercropping systems was nearly 1870.00 kg/ha and the yield of 11:1 ratio of groundnut + cowpea intercropping was 1687 kg/ha. The 3:1 ratio of groundnut + cowpea intercropping recorded 1481 kg/ha. Cost of cultivation incurred towards land preparation, seed rate, sowing, weeding, irrigation and harvesting *etc.* was high for sole groundnut crop 23045.00 Rs/ha and it was very low for 3:1 ratio of groundnut + cowpea intercropping *i.e.*, 18536.99 Rs/ha. Highest gross returns obtained for 7:1 ratio of groundnut + cowpea intercropping *i.e.*, 84001.00 Rs/ha and lowest gross returns was obtained for 3:1 ratio of groundnut + cowpea intercropping *i.e.*, because the seed cost of cowpea was very less *i.e.*, 16.00 Rs/ha and low returns from the cowpea.

The net returns and B: C ratio were high for 7:1 ratio groundnut+ cowpea intercropping system *i.e.*, 63988 Rs/ha and 1:3.10, respectively due low cost of cultivation and highest yield of intercrop. The net returns and B: C ratio was very low for 3:1 ratio of groundnut+ cowpea intercropping (Table 4.).

The present findings are in accordance with Singh *et al.* (1991) [7, 8] who reported that groundnut + redgram system recorded higher economic returns than all other treatments. Sekhar (1995) [6] noticed that additional income was obtained

with groundnut + pigeonpea system. Lakshmi (2012) [4] reported that the yield of groundnut was more in 3:1 ratio groundnut+ cowpea intercropping where the net returns was less because of low price for cowpea.

Conclusion

The groundnut-cowpea intercropping at optimum ratio (7:1) attracts the more natural enemies like predators and parasitoids and reduces the pest population like sucking pests and defoliators and also adds extra income to the farmer with high B: C ratio (1:3.10) when compared to all other intercropping ratios. Because of intercropping is a non-chemical method, it reduces the cost of cultivation and adds more income to the farmer.

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