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# Effect of Intercropping on Groundnut Leaf Miner, Sucking Pests and Parasitoids in Groundnut-Cowpea Intercropping System

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**Abstract:** ***Among different ratios of groundnut-cowpea intercropping systems, the highest mean larval population of A. modicella was recorded in sole groundnut crop followed by 11:1 ratio of intercropping system (1.75 and 1.32 larvae/plant, respectively). 3:1 Intercropping system recorded 0.54 larvae/plant and it was on par with the 7:1 ratio (1.08 larvae/plant). 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). A total of 10 families of parasitoids were observed in bulk plot of 3:1 ratio groundnut- cowpea intercropping system.***

**Keywords:** Leaf miner, Thrips, Leaf hoppers and Parasitoids

## 1. 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). It provides high quality edible oil (48-50%) and easily digestible protein (26-28%). 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. 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 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.

## 2. 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 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 and for leaf miners the count was taken as no of larvae per plant. 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.

## 3. Results and Discussion

In 3:1 ratio the leaf miner population ranging from 0.08 larvae /plant ($35^{th}$SW) to 1.83 larvae/plant ($44^{th}$SW). At 7:1 ratio *A. modicella* incidence ranged from 0.05 to 1.85 larvae/plant from $35^{th}$ SW to $44^{th}$ SW *i.e.*, at harvesting stage. Among all intercropping ratios 3:1 ratio recorded significantly lower mean larval population (0.54 larvae/plant) which was on par with 7:1 ratio (1.08 larvae/plant) when compared to the groundnut sole crop (1.75 larvae/plant) followed by 11:1 ratio (1.32 larvae/plant), respectively.

The presence of more non host crop coverage resulted in the incidence of less leaf miner population in 3:1 ratio of

intercropping followed by 7:1 ratio of intercropping system and cowpea not being an alternate host where the less non host coverage resulted in incidence of more leaf miner population. Among all treatments, 3:1 ratio recorded lesser GLM incidence followed by 7:1. The more kinds of parasitoids *viz.,* Eulopidae, Eurytomidae and Bethylidae found in 3:1 ratio and this might be the possible reason to record the lesser GLM infestation in groundnut (Table 1).

The present results are in conformity with the findings of Shekarappa *et al.* (1990) the parasitization of leaf miner observed by Eulophidae, Eurytomidae, Braconidae, Bethylidae, Eupelmidae, Chalcididae, Pteromalidae and Ichneumonidae. Sivasubramanian and Palaniswamy (1984) who reported that the intercropping of groundnut with cowpea showed lesser incidence of leaf miner as compared to the monocrop of groundnut. Logiswaran and Mohanasundaram (1985) also reported that, intercropping groundnut with cowpea at 3:1 ratio (1.33 larvae/plant) was beneficial in reducing the GLM incidence as well as increasing the yield when compared to sole crop (1.90 larvae/plant).

The thrips incidence recorded from 36$^{th}$ SW (0.00 and 1.18 thrips/plant) to 44$^{th}$ SW (4.29 and 2.17 thrips/plant) but the peak incidence of thrips (5.75 and 6.25 thrips/plant) was noticed during 39$^{th}$ and 40$^{th}$ 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 2).

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).

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 35$^{th}$ SW (0.23 and 0.15 leaf hopper/plant) to 44$^{th}$ 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 40$^{th}$ and 42$^{th}$ 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 3).

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) 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 3).

The presence of parasitoids in groundnut + cowpea intercropping systems confirmed by collection of parasitoids belongining to the families *viz.,* Eulophidae, Encyrtidae, Eurytomidae, Platygasteridae, Trichogrammatidae, Mymaridae, Bethylidae, Ceraphronidae, Braconidae and Ichneumonidae by using yellow open pan trap (Plate 1.). The present results are in conformity with the findings of Shekarappa *et al.* (1990) the parasitization of leaf miner observed by Eulophidae, Eurytomidae, Braconidae, Bethylidae, Eupelmidae, Chalcididae, Pteromalidae and Ichneumonidae.

**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) who reported that groundnut + redgram system recorded higher economic returns than all other treatments. Sekhar (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 was less because of low price for cowpea.

## 4. Conclusion

The intercropping will change the crop ecosystem which attracts more natural enemies and reduces the pest population and also adds the extra income to the farmer.

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**Table 1:** Influence of different groundnut + cowpea intercropping ratios on groundnut leaf miner during *kharif*, 2016-17

| Treatments | *A.modicella* (No. of larvae/ plant) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 DAG | 17 DAG | 24 DAG | 31 DAG | 38 DAG | 45 DAG | 53 DAG | 60 DAG | 68 DAG | 76 DAG | Mean |
| | (35th SW) | (36th SW) | (37th SW) | (38th SW) | (39th SW) | (40th SW) | (41st SW) | (42nd SW) | (43rd SW) | (44th SW) | |
| Groundnut+ Cowpea (3:1) | 0.08 (1.03) | 0.40 (1.18) | 0.45 (1.20) | 0.93 (1.37) | 0.75 (1.32) | 0.48 (1.21) | 1.10 (1.43) | 0.73 (1.29) | 0.45 (1.20) | 1.83 (1.72) | 0.54 (1.31) |
| Groundnut+ Cowpea (7:1) | 0.05 (1.02) | 0.40 (1.18) | 0.50 (1.22) | 0.88 (1.42) | 1.00 (1.40) | 0.93 (1.37) | 1.18 (1.47) | 1.60 (1.51) | 1.52 (1.45) | 1.85 (1.36) | 1.08 (1.44) |
| Groundnut+ Cowpea (11:1) | 0.03 (1.01) | 0.23 (1.10) | 0.81 (1.34) | 1.06 (1.52) | 1.42 (1.55) | 1.37 (1.58) | 1.87 (1.66) | 1.88 (1.68) | 1.23 (1.30) | 1.50 (1.36) | 1.32 (1.52) |
| Groundnut sole crop | 0.25 (1.11) | 0.33 (1.14) | 1.00 (1.41) | 1.55 (1.58) | 1.68 (1.63) | 2.16 (1.76) | 2.75 (1.91) | 2.16 (1.76) | 1.36 (1.25) | 0.00 (1.51) | 1.75 (1.65) |
| Cowpea sole crop | 0.00 (1.00) | 0.00 (1.00) | 0.00 (1.00) | 0.00 (1.00) | 0.00 (1.00) | 0.00 (1.00) | 0.00 (1.00) | 0.00 (1.00) | 0.00 (1.00) | 0.00 (1.00) | 0.00 (1.00) |
| **SEM±** | 0.01 | 0.04 | 0.05 | 0.08 | 0.05 | 0.07 | 0.12 | 0.15 | 0.12 | 0.11 | 0.06 |
| **CD (0.05)** | 0.027 | 0.13 | 0.16 | 0.24 | 0.17 | 0.24 | 0.38 | 0.45 | 0.23 | 0.36 | 0.17 |
| **CV%** | 1.63 | 7.55 | 8.73 | 7.58 | 8.33 | 11.49 | 16.00 | 15.03 | 13.00 | 8.52 | 8.18 |

**GN: Groundnut** **DAG: Weeks after sowing** **SW: Standard week**
Figures in parenthesis indicate square root transformed √x+1 value

**Table 2:** Influence of different groundnut + cowpea intercropping ratios on the incidence of thrips during *kharif*, 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) | | Mean | |
| | GN | CP | GN | CP | GN | CP | GN | CP | GN | GN | CP | GN | CP | GN | CP | GN | CP | GN | 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 parenthesis indicate square root transformed √x+1 value.
*=Average of 10 plants**.**

**Table 3:** Influence of different groundnut + cowpea intercropping ratios on the incidence of *E. kerri* during *kharif*, 2016-17

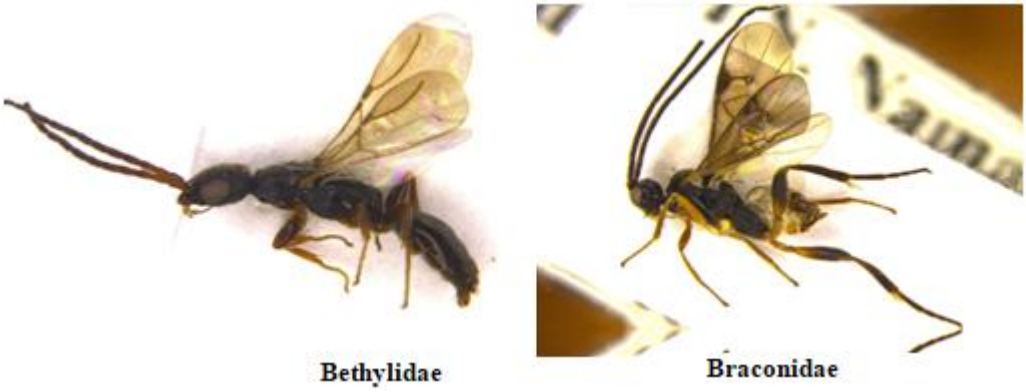
| **Treatments** | ***E. kerri* (No. of insects/ plant*)** | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **17 DAG** | | **24 DAG** | | **31 DAG** | | **38 DAG** | | **45 DAG** | | **53 DAG** | | **60 DAG** | | **68 DAG** | | **76 DAG** | | **Mean** | |
| | **( 36th SW)** | | **( 37th SW)** | | **( 38th SW)** | | **(39th SW )** | | **( 40th SW)** | | **(41st SW )** | | **( 42nd SW)** | | **( 43rd SW)** | | **(44th 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 √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 |



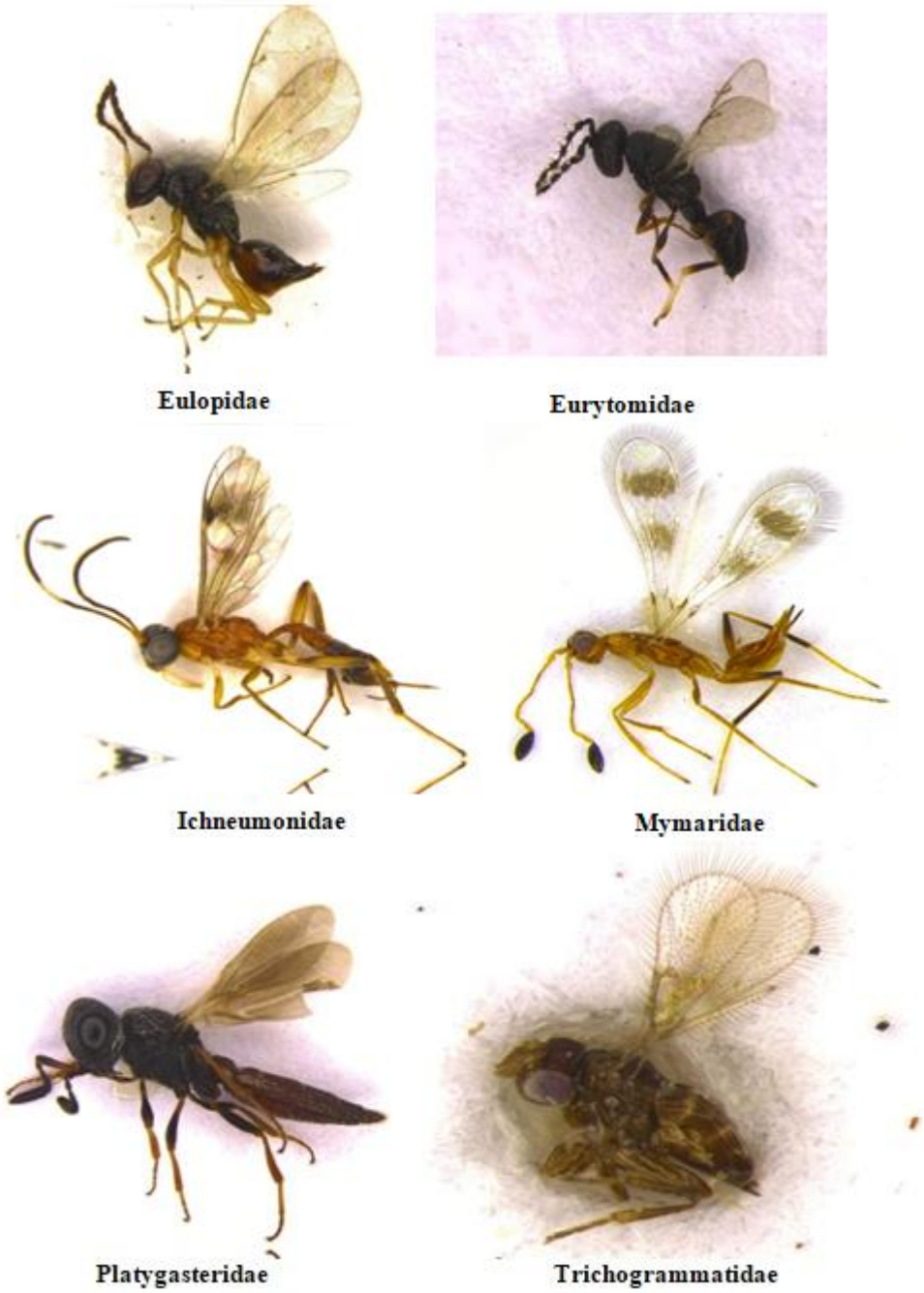




**Plate 1:** Different parasitoids collected from groundnut + cowpea intercropping system