The Pharma Innovation Journal 2021; SP-10(12): 1659-1666

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(12): 1659-1666

www.thepharmajournal.com
Received: 16-10-2021
Accepted: 18-11-2021

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# Evaluation of integrated pest management module in groundnut

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**Abstract**
Investigations on evaluation of integrated pest management module in groundnut was carried out at Oilseeds Research Station, Latur, Maharashtra during *Rabi*, 2020. Evaluation of integrated pests management module in groundnut including application of azadirachtin as bioinsecticides, hand collection of larvae & egg masses of defoliators and installation of pheromones traps, yellow sticky traps, Soybean & Castor as a trap crop for defoliators. IPM module was significantly superior in reducing the incidence of sucking pests *i.e.* aphids, leafhoppers, thrips and whiteflies due to installation of yellow sticky trap and spraying the crop with biopesticides at early stage of crop growth. Defoliators population and its damage was also control by installation of pheromone traps to catch the moths of lepidopterans pests and also spraying the crop with biopesticides at early stage of crop growth, enhancing the population of predators and pod yield of groundnut. It is observed that sucking & lepidopterans pests population before spray was statistically non-significant in IPM module plot. The pests population was significantly reduced one, three, seven and ten days after spraying in IPM module as compared to the farmers practice plot. Yield of groundnut pods obtained from farmers practice and IPM module plots was 1326.07 kg pods/ha and 1797.64 kg pods/ha respectively. The avoidable yield losses observed due to pest were 471 kg pods/ha. The per cent reduction in the yield due to pests was computed as 10.82 per cent. The incremental cost-benefit ratio (ICBR = 1:6.78) was recorded from farmers practice and IPM module plots.

**Keywords:** groundnut, pest management, sucking pests, IPM

## Introduction
Peanuts are known by many other local names such as earthnuts, groundnuts, goober peas, monkey nuts, pygmy nuts and pig nuts. It is also known as 'Indian Almond' and eaten as roasted or boiled. Despite its name and appearance, the peanut is not a nut, but rather a legume. India is the second largest producer of groundnuts in the world. Major groundnut growing states in India - Andhrapradesh, Gujarat, Karnataka, Maharashtra, Rajasthan and Tamil Nadu. In India groundnut is cultivated in an area of 4.73 million ha with a production of 6.72 million tonnes and productivity of 1422 kg/ha. Productivity of groundnut is very low (1422 kg/ha) in India when compared to the productivity of world 1647.4 kg/ha www.indiaagristat.com (2021) [1].
Among the several factor responsible for low productivity in groundnut, the biggest threat to groundnut cultivation is the vulnerable and wide spread attacking by insect pests is major one. More than 100 species of insect and mites are known to attack groundnut Nandagopal, (1992) [5]. The avoidable yield loss due to major insect pests of groundnut was recorded to the tune of 48.57 per cent in pod and 42.11 per cent in fodder Dabhade *et al*., (2012) [3].

## Material and Methods
### Preparatory Cultivation
A representative field of black clay loamy soil was selected, ploughed and levelled with tractor drawn implements thoroughly to obtain fine tilth suitable for seed germination.

### Field layout
The field experiment with groundnut crop using variety LGN-1 in *Rabi*, 2020 was conducted at the Research Farm of Department of Agricultural Entomology, Oilseeds Research Station, Latur, VNMKV, Parbhani (MS)-India. The experiment was conducted in a paired plot design with 4.2 m × 5 m plot size. The groundnut crop was sown on 10th November, 2020 in a gross

plot of 3.9 m × 4.9 m. The row to row distance of 30 cm and plant to plant distance of 10 cm was maintained. The crop was sown under protective irrigation.

**Sowing**
Sowing was done manually and one seed was sown per hill (seed rate 100 kg/ha) with a spacing of 30 cm × 10 cm during second week of November.

**Cultural Practices**
All the agronomic practices were followed as per the recommendations of VNMKV, Parbhani in raising groundnut crop during the experimental period.

**Inter cultivation**
Two hand weeding were done during the crop period to keep the crop weeds free.

**Fertilization**
The fertilizers were applied @ 20:40:40 NPK kg/ha as per the recommendations.

**Experimental Details**

| | | | |
|---|---|---|---|
| 1. | Experimental design | : | Paired Plot Design |
| 2. | Gross plot size | : | 4.2 m x 5.0 m |
| 3. | Net plot size | : | 3.9 m x 4.9 m |
| 4. | Spacing | : | 30 cm × 10 cm |
| 5. | Cultivar | : | LGN-1 |
| 6. | Replications | : | 14 |
| 7. | Treatments | : | 02 |

Treatment details

| Sr. No. | Treatments | Farmers practice (T1) | IPM module (T2) |
|---|---|---|---|
| 1) | Timely sowing | First fortnight of November | First fortnight of November |
| 2) | Sowing of trap crop | - | 1. Soybean for leaf miner<br>2. Castor as a trap crop for defoliators |
| 3) | Installation of pheromone traps at 45 DAS | - | 10 traps/ha |
| 4) | Installation of yellow sticky traps at 45 DAS | - | 15 traps/ha |
| 5) | Hand collection and destruction of lepidopterans larvae and its egg masses | - | At the end of each SMW |
| 6) | Application of Azadirachtin (10,000 ppm) at 20 and 30 DAS | - | 3mL/L |
| 7) | Need based application of recommended insecticide | Calendar based sprays of different insecticides | Lambda Cyhalothrin 5% EC |

**Preparation of insecticidal spray solution**
The insecticidal spray solution of desired concentration was freshly prepared every time at the site of experimentation just before the start of spraying operations.

$$V = \frac{C \times A}{\% \text{ a.i.}}$$

Whereas,
V = volume / weight of commercial insecticide in ml/g.
C = concentration required.
A = quantity of spray solution required in ml.
% a.i. = percentage of active ingredient in commercial product

**Application of Insecticide / Bioagent**
The insecticidal solutions were prepared by taking the required amount of insecticides in a given quantity of water. The total quantity of spray solution was used @ 500 litres/ha. The application of insecticides was made as per the treatment schedules presented in Treatmetnt details. The spraying operations were undertaken in the morning with the help of manually operated knapsack sprayer.

**Method of recording observations**
The observations was recorded as per procedure described below

**Sucking pests**
Five plants were selected randomly from each net plot of experiment. The observations on total number of aphids, leafhoppers, thrips and whiteflies were recorded on trifoliate leaves of plants at 1, 3, 7 and 10 days after each application of biopesticides/insecticides. Then the data were converted into mean values for statistical analysis.

**Lepidopterans pests**
Five plants were selected randomly from the net plot of each treatment in each replication. The observations on total number of larval population of red hairy caterpillars, leaf miners were recorded at 1, 3, 7 and 10 days after each application of treatment. Then the data were converted in to mean values.

**Statistical analysis**
The experimental data were subjected to statistical analysis. The number of aphids, leafhoppers, thrips, whiteflies, leaf miner, and hairy caterpillar were transformed into square root transformation.

**Results and Discussion**

**Effect of spraying of biopesticides/chemical insecticides on population of aphids in farmers practice and IPM module**
The data presented in the Table 1 represented that the population of aphids was statistically non-significant before spray. The population of aphids was statistically significant after one, three, seven and ten days after spraying. The data pertaining to average number of aphids / trifoliate leaves / plant on groundnut after application of treatment are presented in table 1. It is observed from the table that mean aphids population before spray was 2.45 and 2.66 aphids / trifoliate leaves / plant in farmers practice and IPM module plot respectively. The mean aphids population observed one day after spraying was 2.49 and 0.30, three days after spraying was 2.69 and 0.56, seven days after spraying was 2.81 and 0.96 and ten days after spraying was 2.86 and 1.14 aphids/ trifoliate leaves/ plant in farmers practice and IPM module plots respectively. It is observed form the Table 1 that aphids population before spray was statistically non-significant. The aphids population was significantly reduced one, three, seven and ten days after spraying in IPM module as compared to the farmers practice plot.

**Table 1:** Effect of spraying of biopesticides /chemical insecticides on population of aphids in farmers practice and IPM module

| Replication | Average number of Aphids /Trifoliate Leaves /plant | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre Count | | 1 DAS | | 3 DAS | | 7 DAS | | 10 DAS | |
| | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ |
| $R_1$ | 2.20 (1.64)* | 3.00 (1.87) | 2.30 (1.67) | 0.30 (0.89) | 2.50 (1.73) | 0.50 (1.00) | 2.70 (1.79) | 0.80 (1.14) | 2.80 (1.82) | 1.20 (1.30) |
| $R_2$ | 2.50 (1.73) | 2.80 (1.82) | 2.50 (1.73) | 0.10 (0.77) | 2.70 (1.79) | 0.30 (0.89) | 3.00 (1.87) | 0.50 (1.00) | 3.00 (1.87) | 1.00 (1.22) |
| $R_3$ | 1.90 (1.55) | 2.30 (1.67) | 2.00 (1.58) | 0.60 (1.05) | 2.10 (1.61) | 1.00 (1.22) | 2.50 (1.73) | 1.20 (1.30) | 2.70 (1.79) | 1.50 (1.41) |
| $R_4$ | 1.70 (1.48) | 2.90 (1.84) | 1.80 (1.52) | 0.20 (0.84) | 2.00 (1.58) | 0.50 (1.00) | 2.20 (1.64) | 1.00 (1.22) | 2.50 (1.73) | 1.20 (1.30) |
| $R_5$ | 2.00 (1.58) | 3.20 (1.92) | 2.20 (1.64) | 0.40 (0.95) | 2.50 (1.73) | 0.60 (1.05) | 2.70 (1.79) | 0.90 (1.18) | 2.80 (1.82) | 1.10 (1.26) |
| $R_6$ | 2.70 (1.79) | 2.70 (1.79) | 2.70 (1.79) | 0.60 (1.05) | 3.00 (1.87) | 0.80 (1.14) | 3.20 (1.92) | 1.20 (1.30) | 3.00 (1.87) | 1.50 (1.41) |
| $R_7$ | 3.00 (1.87) | 1.90 (1.55) | 3.10 (1.90) | 0.20 (0.84) | 3.30 (1.95) | 0.50 (1.00) | 3.00 (1.87) | 0.80 (1.14) | 2.80 (1.82) | 1.00 (1.22) |
| $R_8$ | 3.20 (1.92) | 2.00 (1.58) | 3.00 (1.87) | 0.10 (0.77) | 3.30 (1.95) | 0.40 (0.95) | 3.20 (1.92) | 0.90 (1.18) | 3.00 (1.87) | 1.30 (1.34) |
| $R_9$ | 2.20 (1.64) | 2.60 (1.76) | 2.00 (1.58) | 0.20 (0.84) | 2.10 (1.61) | 0.40 (0.95) | 2.20 (1.64) | 0.70 (1.10) | 2.50 (1.73) | 0.90 (1.18) |
| $R_{10}$ | 2.50 (1.73) | 3.20 (1.92) | 2.40 (1.70) | 0.30 (0.89) | 2.60 (1.76) | 0.50 (1.00) | 2.80 (1.82) | 1.00 (1.22) | 3.00 (1.87) | 1.20 (1.30) |
| $R_{11}$ | 1.90 (1.55) | 3.00 (1.87) | 2.00 (1.58) | 0.10 (0.77) | 2.20 (1.64) | 0.30 (0.89) | 2.50 (1.73) | 0.60 (1.05) | 3.10 (1.90) | 0.80 (1.14) |
| $R_{12}$ | 2.30 (1.67) | 2.90 (1.84) | 2.50 (1.73) | 0.50 (1.00) | 2.70 (1.79) | 0.80 (1.14) | 3.00 (1.87) | 1.20 (1.30) | 3.00 (1.87) | 1.00 (1.22) |
| $R_{13}$ | 3.00 (1.87) | 1.80 (1.52) | 3.10 (1.90) | 0.20 (0.84) | 3.20 (1.92) | 0.60 (1.05) | 3.00 (1.87) | 1.40 (1.38) | 2.80 (1.82) | 1.30 (1.34) |
| $R_{14}$ | 3.20 (1.92) | 3.00 (1.87) | 3.30 (1.95) | 0.40 (0.95) | 3.50 (2.00) | 0.70 (1.10) | 3.30 (1.95) | 1.20 (1.30) | 3.10 (1.90) | 1.00 (1.22) |
| Mean | 2.45 (1.72) | 2.66 (1.78) | 2.49 (1.73) | 0.30 (0.89) | 2.69 (1.79) | 0.56 (1.03) | 2.81 (1.82) | 0.96 (1.21) | 2.86 (1.83) | 1.14 (1.28) |
| SE ± | 0.135 | 0.127 | 0.129 | 0.047 | 0.134 | 0.054 | 0.095 | 0.070 | 0.053 | 0.056 |
| 't' Value at 0.05% | -0.939 NS | | 15.792** | | 15.117** | | 18.830** | | 20.995** | |

*Figures in parentheses are square root transformed values
**significant at 0.05 per cent

**Effect of spraying of biopesticides/chemical insecticides on population of leafhoppers in farmers practice and IPM module**

The data presented in the Table 2 represented that the population of leafhoppers was statistically non-significant before spray. The population of leafhoppers was statistically significant after one, three, seven and ten days after spraying.

The data pertaining to average number of leafhoppers /trifoliate leaves /plant on groundnut after application of treatment are presented in table 2. It is observed from the table that mean leafhoppers population before spray was 2.91 and 2.70 leafhoppers / trifoliate leaves / plant in farmers practice and IPM module plot respectively.

The mean leafhoppers population observed one day after spraying was 3.11 and 0.56, three days after spraying was 3.34 and 0.90, seven days after spraying was 3.56 and 1.17 and ten days after spraying was 3.53 and 1.23 leafhoppers/ trifoliate leaves/ plant in farmers practice and IPM module plots respectively. These investigations are in agreement with Biradar and Hegde (2016) [2], who reported that Azadirechtin found effective against leafhopper in groundnut by registering maximum reduction of pest population. Jasrotia *et al.* (2018) [4], recorded that the castor as a trap crop for reduced population of leafhopper.

It is observed form the Table 2 that leafhoppers population before spray was statistically non-significant. The leafhoppers population was significantly reduced one, three, seven and ten days after spraying in IPM module as compared to the farmers practice plots.

**Table 2:** Effect of spraying of biopesticides/chemical insecticides on population of leafhoppers in farmers practice and IPM module

| Replication | Average number of leafhoppers /Trifoliate Leaves /plant | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre Count | | 1 DAS | | 3 DAS | | 7 DAS | | 10 DAS | |
| | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ |
| $R_1$ | 2.20 (1.64)* | 2.50 (1.73) | 2.20 (1.64) | 0.40 (0.95) | 2.50 (1.73) | 0.60 (1.05) | 2.70 (1.79) | 1.00 (1.22) | 2.50 (1.73) | 1.20 (1.30) |
| $R_2$ | 3.00 (1.87) | 3.20 (1.92) | 3.10 (1.90) | 0.70 (1.10) | 3.20 (1.92) | 1.00 (1.22) | 3.40 (1.97) | 1.20 (1.30) | 3.50 (2.00) | 1.10 (1.26) |
| $R_3$ | 2.50 (1.73) | 2.70 (1.79) | 2.80 (1.82) | 0.30 (0.89) | 3.00 (1.87) | 0.70 (1.10) | 3.10 (1.90) | 0.90 (1.18) | 3.30 (1.95) | 1.00 (1.22) |
| $R_4$ | 2.80 (1.82) | 3.00 (1.87) | 2.90 (1.84) | 0.50 (1.00) | 3.10 (1.90) | 0.80 (1.14) | 3.30 (1.95) | 1.20 (1.30) | 3.00 (1.87) | 1.20 (1.30) |
| $R_5$ | 3.00 (1.87) | 2.60 (1.76) | 3.10 (1.90) | 0.80 (1.14) | 3.00 (1.87) | 1.20 (1.30) | 3.40 (1.97) | 1.50 (1.41) | 3.60 (2.02) | 1.30 (1.34) |
| $R_6$ | 3.30 (1.95) | 3.00 (1.87) | 3.50 (2.00) | 0.90 (1.18) | 3.70 (2.05) | 1.20 (1.30) | 3.90 (2.10) | 1.40 (1.38) | 4.00 (2.12) | 1.10 (1.26) |
| $R_7$ | 2.50 (1.73) | 2.20 (1.64) | 2.70 (1.79) | 0.20 (0.84) | 3.00 (1.87) | 0.50 (1.00) | 3.30 (1.95) | 0.70 (1.10) | 3.70 (2.05) | 1.00 (1.22) |
| $R_8$ | 2.20 (1.64) | 2.00 (1.58) | 2.50 (1.73) | 0.60 (1.05) | 2.80 (1.82) | 0.90 (1.18) | 3.00 (1.87) | 1.30 (1.34) | 3.40 (1.97) | 1.40 (1.38) |
| $R_9$ | 3.00 (1.87) | 2.60 (1.76) | 3.20 (1.92) | 0.40 (0.95) | 3.50 (2.00) | 0.70 (1.10) | 3.70 (2.05) | 1.10 (1.26) | 3.20 (1.92) | 1.10 (1.26) |
| $R_{10}$ | 3.10 (1.90) | 3.30 (1.95) | 3.50 (2.00) | 0.60 (1.05) | 4.00 (2.12) | 1.00 (1.22) | 4.20 (2.17) | 1.20 (1.30) | 3.90 (2.10) | 1.30 (1.34) |
| $R_{11}$ | 2.40 (1.70) | 2.50 (1.73) | 2.80 (1.82) | 0.20 (0.84) | 3.00 (1.87) | 0.50 (1.00) | 3.30 (1.95) | 0.90 (1.18) | 3.70 (2.05) | 1.00 (1.22) |
| $R_{12}$ | 2.70 (1.79) | 2.00 (1.58) | 2.90 (1.84) | 0.40 (0.95) | 3.10 (1.90) | 0.90 (1.18) | 3.50 (2.00) | 1.00 (1.22) | 3.90 (2.10) | 1.70 (1.48) |
| $R_{13}$ | 3.10 (1.90) | 2.20 (1.64) | 3.30 (1.95) | 0.80 (1.14) | 3.70 (2.05) | 1.10 (1.26) | 4.00 (2.12) | 1.30 (1.34) | 3.50 (2.00) | 1.50 (1.41) |
| $R_{14}$ | 5.00 (2.35) | 4.00 (2.12) | 5.10 (2.37) | 1.10 (1.26) | 5.20 (2.39) | 1.50 (1.41) | 5.00 (2.35) | 1.70 (1.48) | 4.20 (2.17) | 1.30 (1.34) |
| Mean | 2.91 (1.85) | 2.70 (1.79) | 3.11 (1.90) | 0.56 (1.03) | 3.34 (1.96) | 0.90 (1.18) | 3.56 (2.01) | 1.17 (1.29) | 3.53 (2.01) | 1.23 (1.31) |
| SE ± | 0.186 | 0.149 | 0.181 | 0.072 | 0.178 | 0.078 | 0.154 | 0.071 | 0.118 | 0.055 |
| 't' Value at 0.05% | 1.844 NS | | 18.671** | | 18.382** | | 19.383** | | 19.170** | |

*Figures in parentheses are square root transformed values
**significant at 0.05 per cent

**Effect of spraying on of biopesticides / chemical insecticides population of whiteflies in farmers practice and IPM module**

The data presented in the Table 3 represented that the population of whiteflies was statistically non-significant before spray. The population of whiteflies was statistically significant after one, three, seven and ten days after spraying.

The data pertaining to average number of whiteflies /trifoliate leaves/plant on groundnut after application of treatment are presented in table 3. It is observed from the table that mean whiteflies population before spray was 0.97 and 1.24 whiteflies / trifoliate leaves / plant in farmers practice and IPM module plot respectively.

The mean whiteflies population observed one day after spraying was 1.16 and 0.35, three days after spraying was 1.41 and 0.66, seven days after spraying was 1.86 and 1.11 and ten days after spraying was 2.39 and 1.25 whiteflies / trifoliate leaves / plant in farmers practice and IPM module plots respectively.

It is observed form the Table 3 that whiteflies population before spray was statistically non-significant. The whiteflies population was significantly reduced one, three, seven and ten days after spraying in IPM module as compared to the farmers practice plots.

**Table 3:** Effect of spraying of biopesticides/chemical insecticides on population of whiteflies in farmers practice and IPM module

| Replication | Average number of whitefly /Trifoliate Leaves /plant | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre Count | | 1 DAS | | 3 DAS | | 7 DAS | | 10 DAS | |
| | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ |
| $R_1$ | 1.20 (1.30)* | 1.30 (1.34) | 1.40 (1.38) | 0.30 (0.89) | 1.60 (1.45) | 0.50 (1.00) | 1.80 (1.52) | 1.00 (1.22) | 2.50 (1.73) | 1.00 (1.22) |
| $R_2$ | 0.80 (1.14) | 1.00 (1.22) | 1.00 (1.22) | 0.20 (0.84) | 1.20 (1.30) | 0.40 (0.95) | 1.50 (1.41) | 1.20 (1.30) | 1.40 (1.38) | 1.30 (1.34) |
| $R_3$ | 1.00 (1.22) | 1.20 (1.30) | 1.20 (1.30) | 0.50 (1.00) | 1.50 (1.41) | 0.90 (1.18) | 1.90 (1.55) | 1.30 (1.34) | 3.00 (1.87) | 1.40 (1.38) |
| $R_4$ | 1.10 (1.26) | 1.30 (1.34) | 1.30 (1.34) | 0.20 (0.84) | 1.60 (1.45) | 0.40 (0.95) | 2.20 (1.64) | 1.00 (1.22) | 2.80 (1.82) | 1.00 (1.22) |
| $R_5$ | 1.20 (1.30) | 2.00 (1.58) | 1.50 (1.41) | 0.40 (0.95) | 1.70 (1.48) | 0.60 (1.05) | 2.00 (1.58) | 0.70 (1.10) | 2.10 (1.61) | 1.20 (1.30) |
| $R_6$ | 0.90 (1.18) | 1.00 (1.22) | 1.00 (1.22) | 0.30 (0.89) | 1.00 (1.22) | 0.70 (1.10) | 1.80 (1.52) | 1.00 (1.22) | 2.00 (1.58) | 1.40 (1.38) |
| $R_7$ | 1.00 (1.22) | 1.30 (1.34) | 1.10 (1.26) | 0.40 (0.95) | 1.20 (1.30) | 0.70 (1.10) | 1.90 (1.55) | 1.30 (1.34) | 2.30 (1.67) | 1.50 (1.41) |
| $R_8$ | 0.50 (1.00) | 0.90 (1.18) | 0.80 (1.14) | 0.20 (0.84) | 1.00 (1.22) | 0.50 (1.00) | 1.60 (1.45) | 0.80 (1.14) | 2.00 (1.58) | 1.00 (1.22) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| R9 | 0.80 (1.14) | 1.20 (1.30) | 1.00 (1.22) | 0.40 (0.95) | 1.00 (1.22) | 0.80 (1.14) | 1.50 (1.41) | 1.60 (1.45) | 2.30 (1.67) | 1.40 (1.38) |
| R10 | 0.90 (1.18) | 1.00 (1.22) | 1.00 (1.22) | 0.20 (0.84) | 2.00 (1.58) | 0.60 (1.05) | 2.20 (1.64) | 1.00 (1.22) | 2.90 (1.84) | 1.40 (1.38) |
| R11 | 1.00 (1.22) | 1.30 (1.34) | 1.20 (1.30) | 0.40 (0.95) | 1.40 (1.38) | 0.80 (1.14) | 1.70 (1.48) | 1.30 (1.34) | 2.00 (1.58) | 1.20 (1.30) |
| R12 | 0.60 (1.05) | 0.90 (1.18) | 0.90 (1.18) | 0.20 (0.84) | 1.30 (1.34) | 0.50 (1.00) | 2.00 (1.58) | 1.20 (1.30) | 2.70 (1.79) | 1.30 (1.34) |
| R13 | 1.20 (1.30) | 1.40 (1.38) | 1.40 (1.38) | 0.50 (1.00) | 1.50 (1.41) | 0.90 (1.18) | 1.70 (1.48) | 1.00 (1.22) | 3.00 (1.87) | 1.00 (1.22) |
| R14 | 1.40 (1.38) | 1.50 (1.41) | 1.50 (1.41) | 0.70 (1.10) | 1.70 (1.48) | 1.00 (1.22) | 2.30 (1.67) | 1.20 (1.30) | 2.50 (1.73) | 1.40 (1.38) |
| Mean | 0.97 (1.21) | 1.24 (1.32) | 1.16 (1.29) | 0.35 (0.92) | 1.41 (1.38) | 0.66 (1.08) | 1.86 (1.54) | 1.11 (1.27) | 2.39 (1.70) | 1.25 (1.32) |
| SE ± | 0.066 | 0.077 | 0.061 | 0.040 | 0.082 | 0.052 | 0.068 | 0.062 | 0.125 | 0.049 |
| 't' Value at 0.05% | -5.302 NS | | 17.432** | | 7.987** | | 7.274** | | 8.296** | |

*Figures in parentheses are square root transformed values

**significant at 0.05 per cent

**Effect of spraying of biopesticides / chemical insecticides on population of thrips in farmers practice and IPM module**

The data presented in the Table 4 represented that the population of thrips was statistically non-significant before spray. The population of thrips was statistically significant after one, three, seven and ten days after spraying.

The data pertaining to average number of thrips /trifoliate leaves / plant on groundnut after application of treatment are presented in table 4. It is observed from the table that mean whiteflies population before spray was 0.99 and 1.01 thrips /trifoliate leaves / plant in farmers practice and IPM module plot respectively.

The mean thrips population observed one day after spraying was 1.21 and 0.25, three days after spraying was 1.37 and 0.69, seven days after spraying was 1.51 and 1.08 and ten days after spraying was 1.38 and 1.10 thrips / trifoliate leaves / plant in farmers practice and IPM module plots respectively. These investigations are in agreement with Biradar and Hegde (2016) [2], who reported that Azadirechtin found effective against thrips in groundnut by registering maximum reduction of pest population. Jasrotia *et al.* (2018) [4], recorded that the castor as a trap crop for reduced population of thrips.

It is observed form the Table 4 that thrips population before spray was statistically non-significant. The thrips population was significantly reduced one, three, seven and ten days after spraying in IPM module as compared to the farmers practice plot.

**Table 4:** Effect of spraying of biopesticides/chemical insecticides on population of thrips in farmers practice and IPM module

| Replication | Average number of Thrips /Trifoliate Leaves /plant | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre Count | | 1 DAS | | 3 DAS | | 7 DAS | | 10 DAS | |
| | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ |
| R1 | 0.90 (1.18)* | 1.00 (1.22) | 1.00 (1.22) | 0.20 (0.84) | 1.10 (1.26) | 0.40 (0.95) | 1.30 (1.34) | 0.80 (1.14) | 1.10 (1.26) | 1.00 (1.22) |
| R2 | 1.00 (1.22) | 0.80 (1.14) | 1.30 (1.34) | 0.10 (0.77) | 1.50 (1.41) | 0.30 (0.89) | 1.50 (1.41) | 0.70 (1.10) | 1.40 (1.38) | 1.10 (1.26) |
| R3 | 0.80 (1.14) | 1.00 (1.22) | 1.20 (1.30) | 0.30 (0.89) | 1.40 (1.38) | 0.70 (1.10) | 1.60 (1.45) | 1.00 (1.22) | 1.50 (1.41) | 1.30 (1.34) |
| R4 | 1.20 (1.30) | 1.10 (1.26) | 1.50 (1.41) | 0.30 (0.89) | 1.70 (1.48) | 0.80 (1.14) | 1.80 (1.52) | 1.10 (1.26) | 1.80 (1.52) | 1.20 (1.30) |
| R5 | 1.50 (1.41) | 1.30 (1.34) | 1.60 (1.45) | 0.50 (1.00) | 1.60 (1.45) | 1.00 (1.22) | 1.70 (1.48) | 1.20 (1.30) | 1.50 (1.41) | 1.40 (1.38) |
| R6 | 0.80 (1.14) | 1.00 (1.22) | 1.00 (1.22) | 0.30 (0.89) | 1.10 (1.26) | 0.50 (1.00) | 1.20 (1.30) | 0.90 (1.18) | 1.00 (1.22) | 1.30 (1.34) |
| R7 | 0.70 (1.10) | 0.80 (1.14) | 1.10 (1.26) | 0.10 (0.77) | 1.20 (1.30) | 0.80 (1.14) | 1.20 (1.30) | 1.10 (1.26) | 1.30 (1.34) | 1.50 (1.41) |
| R8 | 1.10 (1.26) | 1.00 (1.22) | 1.30 (1.34) | 0.40 (0.95) | 1.50 (1.41) | 0.70 (1.10) | 1.60 (1.45) | 1.20 (1.30) | 1.50 (1.41) | 1.30 (1.34) |
| R9 | 1.20 (1.30) | 1.20 (1.30) | 1.20 (1.30) | 0.50 (1.00) | 1.50 (1.41) | 1.00 (1.22) | 1.70 (1.48) | 1.30 (1.34) | 1.60 (1.45) | 1.00 (1.22) |
| R10 | 0.50 (1.00) | 0.90 (1.18) | 0.90 (1.18) | 0.20 (0.84) | 1.00 (1.22) | 0.90 (1.18) | 1.20 (1.30) | 1.30 (1.34) | 1.00 (1.22) | 1.10 (1.26) |
| R11 | 0.90 (1.18) | 1.00 (1.22) | 1.00 (1.22) | 0.20 (0.84) | 1.20 (1.30) | 0.70 (1.10) | 1.50 (1.41) | 1.00 (1.22) | 1.40 (1.38) | 0.50 (1.00) |
| R12 | 1.00 (1.22) | 1.00 (1.22) | 1.20 (1.30) | 0.10 (0.77) | 1.30 (1.34) | 0.50 (1.00) | 1.70 (1.48) | 1.20 (1.30) | 1.60 (1.45) | 0.80 (1.14) |
| R13 | 1.30 (1.34) | 1.20 (1.30) | 1.50 (1.41) | 0.20 (0.84) | 1.70 (1.48) | 0.60 (1.05) | 1.70 (1.48) | 1.30 (1.34) | 1.50 (1.41) | 1.10 (1.26) |
| R14 | 1.00 (1.22) | 0.80 (1.14) | 1.20 (1.30) | 0.10 (0.77) | 1.40 (1.38) | 0.70 (1.10) | 1.50 (1.41) | 1.00 (1.22) | 1.10 (1.26) | 0.80 (1.14) |
| Mean | 0.99 (1.22) | 1.01 (1.23) | 1.21 (1.31) | 0.25 (0.87) | 1.37 (1.37) | 0.69 (1.09) | 1.51 (1.42) | 1.08 (1.26) | 1.38 (1.37) | 1.10 (1.26) |
| SE ± | 0.069 | 0.041 | 0.056 | 0.037 | 0.061 | 0.056 | 0.056 | 0.050 | 0.066 | 0.072 |
| 't' Value at 0.05% | -0.298 NS | | 17.507** | | 9.173** | | 7.170** | | 2.914** | |

*Figures in parentheses are square root transformed values

**significant at 0.05 per cent

**Effect of spraying of biopesticides/chemical insecticides on population of leaf miners in farmers practice and IPM module**

The data presented in the Table 5 represented that the population of leaf miners was statistically non-significant before spray. The population of leaf miners was statistically significant after one, three, seven and ten days after spraying.

The data pertaining to average number of leaf miners larvae / plant on groundnut after application of treatment are presented in Table 5. It is observed from the table that mean leaf miners larvae population before spray was 0.99 and 1.01 / plant in farmers practice and IPM module plots respectively.

The mean leaf miners larvae population observed one day after spraying was 1.09 and 0.19, three days after spraying was 1.22 and 0.61, seven days after spraying was 1.10 and 0.87 and ten days after spraying was 1.08 and 0.84 / plant in farmers practice and IPM module plots respectively.

It is observed from the Table 5 that leaf miners larvae population before spray was statistically non-significant. Leaf miners larvae population was significantly reduced one, three, seven and ten days after spraying in IPM module as compared to the farmers practice plots

**Table 5:** Effect of spraying of biopesticides/chemical insecticides on population of leaf miners in farmers practice and IPM module

| Replication | Average number of Leaf miners /Trifoliate Leaves /plant | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre Count | | 1 DAS | | 3 DAS | | 7 DAS | | 10 DAS | |
| | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ |
| $R_1$ | 1.20 (1.30)* | 1.00 (1.22) | 1.30 (1.34) | 0.40 (0.95) | 1.50 (1.41) | 0.70 (1.10) | 1.30 (1.34) | 1.00 (1.22) | 1.20 (1.30) | 1.10 (1.26) |
| $R_2$ | 1.00 (1.22) | 0.80 (1.14) | 1.10 (1.26) | 0.30 (0.89) | 1.20 (1.30) | 0.50 (1.00) | 1.00 (1.22) | 0.60 (1.05) | 0.70 (1.10) | 0.50 (1.00) |
| $R_3$ | 0.80 (1.14) | 0.50 (1.00) | 1.00 (1.22) | 0.10 (0.77) | 1.00 (1.22) | 0.40 (0.95) | 0.80 (1.14) | 0.80 (1.14) | 1.00 (1.22) | 0.80 (1.14) |
| $R_4$ | 0.90 (1.18) | 0.70 (1.10) | 1.00 (1.22) | 0.20 (0.84) | 1.10 (1.26) | 0.40 (0.95) | 1.00 (1.22) | 0.70 (1.10) | 0.90 (1.18) | 0.70 (1.10) |
| $R_5$ | 0.50 (1.00) | 0.80 (1.14) | 0.80 (1.14) | 0.40 (0.95) | 1.00 (1.22) | 0.80 (1.14) | 1.10 (1.26) | 1.00 (1.22) | 0.80 (1.14) | 0.60 (1.05) |
| $R_6$ | 1.00 (1.22) | 1.00 (1.22) | 1.20 (1.30) | 0.00 (0.71) | 1.20 (1.30) | 0.50 (1.00) | 1.00 (1.22) | 0.70 (1.10) | 1.20 (1.30) | 0.90 (1.18) |
| $R_7$ | 0.70 (1.10) | 1.00 (1.22) | 1.00 (1.22) | 0.30 (0.89) | 1.10 (1.26) | 0.90 (1.18) | 1.40 (1.38) | 1.00 (1.22) | 1.00 (1.22) | 0.70 (1.10) |
| $R_8$ | 0.90 (1.18) | 1.20 (1.30) | 1.00 (1.22) | 0.20 (0.84) | 1.20 (1.30) | 0.70 (1.10) | 0.90 (1.18) | 0.80 (1.14) | 1.20 (1.30) | 1.00 (1.22) |
| $R_9$ | 1.00 (1.22) | 0.90 (1.18) | 1.20 (1.30) | 0.10 (0.77) | 1.50 (1.41) | 0.50 (1.00) | 1.20 (1.30) | 0.90 (1.18) | 1.40 (1.38) | 0.80 (1.14) |
| $R_{10}$ | 1.20 (1.30) | 0.80 (1.14) | 1.40 (1.38) | 0.00 (0.71) | 1.50 (1.41) | 0.70 (1.10) | 1.00 (1.22) | 1.00 (1.22) | 1.30 (1.34) | 1.10 (1.26) |
| $R_{11}$ | 0.90 (1.18) | 1.00 (1.22) | 1.00 (1.22) | 0.30 (0.89) | 1.20 (1.30) | 0.60 (1.05) | 1.00 (1.22) | 0.80 (1.14) | 1.20 (1.30) | 1.00 (1.22) |
| $R_{12}$ | 1.00 (1.22) | 1.20 (1.30) | 1.10 (1.26) | 0.20 (0.84) | 1.30 (1.34) | 0.80 (1.14) | 1.20 (1.30) | 1.00 (1.22) | 1.00 (1.22) | 0.80 (1.14) |
| $R_{13}$ | 0.60 (1.05) | 0.80 (1.14) | 0.90 (1.18) | 0.10 (0.77) | 1.00 (1.22) | 0.60 (1.05) | 1.00 (1.22) | 1.10 (1.26) | 1.20 (1.30) | 1.00 (1.22) |
| $R_{14}$ | 1.10 (1.26) | 1.00 (1.22) | 1.20 (1.30) | 0.00 (0.71) | 1.30 (1.34) | 0.50 (1.00) | 1.50 (1.41) | 0.80 (1.14) | 1.00 (1.22) | 0.70 (1.10) |
| Mean | 0.91 (1.19) | 0.91 (1.19) | 1.09 (1.26) | 0.19 (0.83) | 1.22 (1.31) | 0.61 (1.06) | 1.10 (1.26) | 0.87 (1.17) | 1.08 (1.26) | 0.84 (1.16) |
| SE ± | 0.055 | 0.051 | 0.043 | 0.038 | 0.048 | 0.042 | 0.052 | 0.040 | 0.053 | 0.050 |
| ‘t’ Value at 0.05% | 0.111 NS | | 13.248** | | 9.866** | | 4.163** | | 7.848** | |

*Figures in parentheses are square root transformed values

****significant at 0.05 per cent

**Effect of spraying of biopesticides/chemical insecticides on population of hairy caterpillars in farmers practice and IPM module**

The data presented in the Table 6 represented that the population of hairy caterpillars was statistically non-significant before spray. The population of hairy caterpillars was statistically significant after one, three, seven and ten days after spraying.

The data pertaining to average number of hairy caterpillars larvae / plant on groundnut after application of treatment are presented in Table 6. It is observed from the table that mean hairy caterpillars larvae population before spray was 0.86 and 0.89 / plant in farmers practice and IPM module plots respectively.

The mean hairy caterpillars larvae population observed one day after spraying was 1.03 and 0.17, three days after spraying was 1.18 and 0.52, seven days after spraying was 1.21 and 0.85 and ten days after spraying was 1.01 and 0.38 / plant in farmers practice and IPM module plots respectively.

It is observed from the Table 6 that hairy caterpillars larvae population before spray was statistically non-significant hairy caterpillars larvae population was significantly reduced one, three, seven and ten days after spraying in IPM module as compared to the farmers practice plots.

**Table 6:** Effect of spraying of biopesticides / chemical insecticides on population of hairy caterpillars in farmers practice and IPM module

| Replication | Average number of Hairy caterpillars /Trifoliate Leaves /plant | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre Count | | 1 DAS | | 3 DAS | | 7 DAS | | 10 DAS | |
| | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ | $T_1$ | $T_2$ |
| $R_1$ | 0.90 (1.18)* | 0.80 (1.14) | 1.00 (1.22) | 0.20 (0.84) | 1.10 (1.26) | 0.50 (1.00) | 1.20 (1.30) | 0.80 (1.14) | 1.00 (1.22) | 0.30 (0.89) |
| $R_2$ | 1.00 (1.22) | 0.90 (1.18) | 1.20 (1.30) | 0.30 (0.89) | 1.30 (1.34) | 0.60 (1.05) | 1.30 (1.34) | 0.80 (1.14) | 1.10 (1.26) | 0.20 (0.84) |
| $R_3$ | 0.80 (1.14) | 1.00 (1.22) | 1.00 (1.22) | 0.20 (0.84) | 1.10 (1.26) | 0.50 (1.00) | 1.20 (1.30) | 0.70 (1.10) | 1.20 (1.30) | 0.70 (1.10) |
| $R_4$ | 0.70 (1.10) | 0.90 (1.18) | 0.90 (1.18) | 0.30 (0.89) | 1.00 (1.22) | 0.60 (1.05) | 1.10 (1.26) | 0.90 (1.18) | 1.00 (1.22) | 0.50 (1.00) |
| $R_5$ | 0.90 (1.18) | 1.00 (1.22) | 1.00 (1.22) | 0.10 (0.77) | 1.20 (1.30) | 0.40 (0.95) | 1.30 (1.34) | 0.70 (1.10) | 1.10 (1.26) | 0.10 (0.77) |
| $R_6$ | 1.00 (1.22) | 0.80 (1.14) | 1.20 (1.30) | 0.10 (0.77) | 1.30 (1.34) | 0.50 (1.00) | 1.20 (1.30) | 1.00 (1.22) | 0.90 (1.18) | 0.40 (0.95) |
| $R_7$ | 0.90 (1.18) | 0.70 (1.10) | 1.00 (1.22) | 0.20 (0.84) | 1.00 (1.22) | 0.70 (1.10) | 1.10 (1.26) | 0.90 (1.18) | 1.00 (1.22) | 0.00 (0.71) |
| $R_8$ | 0.70 (1.10) | 0.60 (1.05) | 0.90 (1.18) | 0.00 (0.71) | 1.10 (1.26) | 0.50 (1.00) | 1.20 (1.30) | 0.80 (1.14) | 0.70 (1.10) | 0.40 (0.95) |
| $R_9$ | 0.80 (1.14) | 0.90 (1.18) | 1.00 (1.22) | 0.20 (0.84) | 1.20 (1.30) | 0.60 (1.05) | 1.40 (1.38) | 0.90 (1.18) | 1.00 (1.22) | 0.50 (1.00) |
| $R_{10}$ | 1.00 (1.22) | 1.10 (1.26) | 1.20 (1.30) | 0.30 (0.89) | 1.40 (1.38) | 0.70 (1.10) | 1.20 (1.30) | 1.10 (1.26) | 1.10 (1.26) | 1.40 (1.38) |
| $R_{11}$ | 0.60 (1.05) | 0.90 (1.18) | 0.90 (1.18) | 0.20 (0.84) | 1.00 (1.22) | 0.50 (1.00) | 1.10 (1.26) | 1.00 (1.22) | 1.00 (1.22) | 0.20 (0.84) |
| $R_{12}$ | 0.80 (1.14) | 1.00 (1.22) | 1.00 (1.22) | 0.10 (0.77) | 1.30 (1.34) | 0.30 (0.89) | 1.20 (1.30) | 0.70 (1.10) | 0.90 (1.18) | 0.10 (0.77) |
| $R_{13}$ | 1.00 (1.22) | 0.80 (1.14) | 1.10 (1.26) | 0.20 (0.84) | 1.20 (1.30) | 0.60 (1.05) | 1.30 (1.34) | 0.90 (1.18) | 1.20 (1.30) | 0.40 (0.95) |
| $R_{14}$ | 0.90 (1.18) | 1.00 (1.22) | 1.00 (1.22) | 0.00 (0.71) | 1.30 (1.34) | 0.30 (0.89) | 1.20 (1.30) | 0.70 (1.10) | 1.00 (1.22) | 0.10 (0.77) |
| Mean | 0.86 (1.16) | 0.89 (1.18) | 1.03 (1.24) | 0.17 (0.82) | 1.18 (1.30) | 0.52 (1.01) | 1.21 (1.31) | 0.85 (1.16) | 1.01 (1.23) | 0.38 (0.94) |
| SE ± | 0.311 | 0.315 | 0.330 | 0.219 | 0.346 | 0.270 | 0.350 | 0.311 | 0.329 | 0.251 |
| 't' Value at 0.05 % | -0.618 NS | | 26.234** | | 12.362** | | 8.056** | | 6.884** | |

*Figures in parentheses are square root transformed values
**significant at 0.05 per cent

**Effect of different treatment on yield of groundnut crop**

Yield of groundnut pods obtained from farmers practice and IPM module plots are presented in Table 7. It is clearly evident from the data presented in table that mean yield obtained from farmers practice plot was 1326.07 kg pods / ha and from IPM module plots was 1797.64 kg pods / ha. The avoidable yield loses observed due to pest were 471 kg pods / ha. The per cent reduction in the yield due to pests was computed as 10.82 per cent.

**Table 7:** Effect of different treatments on yield of groundnut

| Replication | Yield pods kg/ha | |
|---|---|---|
| | T1 - Farmers Practice | T2 – IPM Module |
| R1 | 1504 | 2025 |
| R2 | 1215 | 1689 |
| R3 | 1331 | 1620 |
| R4 | 1446 | 1765 |
| R5 | 1417 | 1822 |
| R6 | 1302 | 1909 |
| R7 | 1215 | 1678 |
| R8 | 1244 | 1724 |
| R9 | 1435 | 2025 |
| R10 | 1238 | 1707 |
| R11 | 1261 | 1736 |
| R12 | 1296 | 1938 |
| R13 | 1157 | 1649 |
| R14 | 1504 | 1880 |
| Mean | 1326.1 | 1797.6 |

**ICBR: Incremental Cost-Benefit Ratio of groundnut with IPM practices to farmer's practice.**

Data regarding table 8 all the treatments were recorded satisfactory incremental cost-benefit ratio. The incremental cost-benefit ratio (ICBR) (1:6.78) was recorded with IPM practices as compared to farmer's practices plot.

**Table 8:** Incremental Cost-Benefit Ratio of groundnut with IPM practices to farmer's practice

| Tr. No | Treatments | Chemicals and traps | Quantity of chemical required for two spray | Cost A (Rs/ha) | Cost B (Rs/ha) | Total Cost (A+ B) | Pod yield kg/ha | Increase in yield compared to Farm. Practice kg/ha | Value of additional yield over untreated control (Rs./ha) | Net Profit Rs./ha | ICBR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T2 | IPM Module | Azadirachtin | 3000 ml | 1560 | 400 | 1960 | 1797.6 | 471.5 | 23575 | 20100 | 6.78 |
| | | Lamda cyhalothrin | 500 ml | 415 | 400 | 815 | | | | | |
| | | Special Practices | - | 700 | - | 700 | | | | | |
| T1 | Farmers Practice | - | - | - | - | - | 1326.1 | - | - | - | - |

Cost A: Cost of Insecticide required for two sprays
Cost B: Labour charges
Avg. Market price of groundnut: Rs. 50 /kg

## Conclusions

Evaluation of integrated pests management module in groundnut including application of azadirachtin as bioinsecticides, hand collection of larvae of defoliators and also collection of egg masses and installation of pheromones traps, yellow sticky traps, Soybean & Castor as a trap crop for defoliators comparison to farmers practices.

The pests population was significantly reduced one, three, seven and ten days after spraying in IPM module as compared to the farmers practice plot.

IPM module was significantly superior in reducing the incidence of sucking pests *i.e*. aphids, leaf hoppers, thrips and whiteflies due to installation of yellow sticky trap and spraying the crop with biopesticides at early stage of crop growth. Defoliators and defoliator damage also control by installation of pheromone traps to catch the moths of lepidopterans pests and also spraying the crop with biopesticides at early stage of crop growth, enhancing the population of predators and pod yield of groundnut. The incremental cost-benefit ratio (ICBR = 1:6.78) was recorded from farmers practice and IPM module plots.

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