***Original Research Article***

**Assessment of insect-pest association and their seasonal incidence on Arhar under *Gmelina arborea* based agroforestry system**

**ABSTRACT**

A two-year field investigation (2019-2021) was conducted at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, to characterize insect pest associations within *Gmelina arborea*-based agroforestry systems compared to sole cropping of Arhar, Cowpea, and Mustard. The study aimed to quantify pest populations, infestation levels, and seasonal incidence. Results from the Arhar + *Gmelina arborea* agroforestry system identified seven insect species. On Gmelina arborea, significant damage was observed from four species: Trunk borer (*Dihammus cervinus*, Coleoptera), Defoliator (*Calopepla leayana*, Coleoptera), Bark eating caterpillar (*Indarbela quadrinotata*, Lepidoptera), and Sap sucker/Tingid Bug (*Tingis beesoni*, Homoptera). Concurrently, three major pests were found on Arhar: Pod Borer (*Helicoverpa armigera*, Lepidoptera), Hairy caterpillar (*Spilosoma obliqua*, Lepidoptera), and Aphid (*Aphis craccivora* Koch, Hemiptera). This foundational data is crucial for developing robust, sustainable pest management strategies in agroforestry contexts, particularly in the face of evolving environmental challenges. Future research can leverage these findings to design integrated pest management (IPM) programs, enhance climate change resilience of agroforestry systems, explore the role of tree components in fostering beneficial insect populations, guide breeding efforts for pest-resistant crop and tree varieties, and facilitate the application of digital monitoring and predictive analytics for proactive pest control. Ultimately, this will contribute to improving the ecological and economic sustainability of agroforestry for regional farmers.

**1. INTRODUCTION**

In Agroforestry systems trees and crops are attacked by insects and pest at all stages of their growth just like other annual and perennial crops. Insects may attack one or more species within a system and across systems in the landscape, so pest management strategies should depend on the nature of the insect and magnitude of its damage (Rao *et al*., 2000). *Gmelina arbora* is a light demanding, moderately frost hardy species and comes up well with a temperature range of 1 to 48°C and mean annual rainfall of 760 to 4500 mm, grows well in soil pH ranging from 5.0 to 8.0with preference for moist fertile alluvial with sandy loam soil (Orwa *et al*., 2009, PROTA, 2016). Arhar is an important pulse crop in the semi-arid Tropics and sub-tropical farming systems, providing high quality vegetable protein, animal feed and firewood (Mittal and Ujagir, 2005). It use for grains, green manuring, fodder and forage as sole crop, intercrop, mixed crop and in sequential cropping systems. It is mainly consumed in the form of split pulse as Dal; an essential supplement of cereal based vegetarian diet. It is particularly rich in lysine, riboflavin, thiamine, niacin and iron (Singh and Yadav, 2005). More than 300 insect species belonging to 8 orders and 61 families have been found to infest pigeon pea starting from seedling stage and continues till harvesting and even during the storage condition (Kevel *et al*., 2010)

**2. MATERIAL AND METHODS**

The experimental site is situated inside the Dusty Farm area of JNKVV, Jabalpur, Madhya Pradesh, India. It is located between 22° 49' and 24° 8' N latitude and 78° 21' and 80° 58' E longitude. Its altitude is 412 m above the mean sea level. The mean annual rainfall of the locality is 1350 mm which is mostly received during mid June to end of September. The mean maximum temperature varies from 40-42°C during May-June and mean minimum temperature varies from 5.3-6.1°C during December- January.

To know the distribution and association of various insect-pest under different agroforestry systems (*Gmelina arborea* + Cow pea, *Gmelina arborea* + Arhar and *Gmelina arborea* + mustard) were surveyed at weekly interval and the observation were noted for the incidence of major insect-pests and minor pests from each replication where each replication consisting of 16 trees. Ten randomly selected branches in each plant were observed for major and minor pest. The observations were recorded on the various types and number of insect-pests and their related natural enemies at weekly intervals from eachagroforestry systems. To study infestation, ten trees were randomly selected per replication and from which five branches were randomly selected at lower and upper canopy levels. Based on the data collected on the infestation of various insect pests, the susceptibility and level of tolerance was screened.

**3. RESULT AND DISCUSSION**

Study was worked out on insect-pest communities under *Gmelina arborea* based agroforestry system with different agricultural cops. Result reveal that about 7 species on Arhar *+ Gmelina arborea* based agroforestry system. The data on mean number of various insect-pest population was recorded at weekly interval during the crop period from November to April of winter season at Jabalpur, Madhya Pradesh during 2019-20 and 2020-21.

Table No. 1. Screening of major insect pest communities under Arhar+*Gmelina arborea* based agroforestry system during 2019-20 and 2020-21.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S. No** | **Common Name** | **Scientific Name** | **Order** | **Family** |
| **Gamhar (*Gmelina arborea)*** |
| 1. | Trunk borer | *Dihammus cervinus* | Coleoptera  | Cerambycidae |
| 2. | Defoliator | *Calopepla leayana* | Coleoptera | Chrysomelidae |
| 3. | Bark eating caterpillar | *Indarbela quadrinotata* | Lepidoptera | Cossidae |
| 4. | Sap sucker/ Tingid Bug | *Tingis beesoni* | Homoptera | Tingidae |
| **Arhar** |
| 1. | Pod Borer  | *Helicoverpa armigera* | Lepidoptera | Noctuidae |
| 2. | Hairy caterpillar | *Spilosoma obliqua* | Lepidoptera | Arctiidae |
| 3. | Aphid | *Aphis craccivora* Koch | Hemiptera | Aphididae |

**3.1 Incidence of Trunk borer (*Dihammus cervinus)***

The beetles feed on the soft bark of saplings, making shallow, irregular patches. In Gamhar increased formation of wood around the wound takes place due to partial girdling and injury to the cambium, mostly at a height of 1 meter above ground. The stem gets weakened due to extensive tunnelling by larva and may break off easily.

 the population dynamics and frequency of Trunk borer which started from fourth week of July (28th standard meteorological week). the minimum and maximum temperature was 25.0°C, 31.4°C and 25.6°C, 32.8.0°C recorded in 2019-20 and 2020-21 respectively. During the year 2019-20 the relative humidity was 82% in the morning and 64% in the evening and year 2020-21 relative humidity was recorded 83% in the morning and 66% in the evening.

**3.2 Incidence of Khamer defoliator (*Calopepla leayana)***

It is one of the monophagous insect. The beetle feed voraciously on leaves and buds. Young tress of *G. arborea* subject to repeated attack of the insect both larval and adult stages become weak and succumb. The heavy attack causes the leading shoots of the young tree to dry up and tree remains leafless for about four month in the growing season. Identification and quantitative assessment of Khamer defoliator *Calopepla leayana* which is one of the major insect started from from 1st week of August that is shown in the form of standard metrological week 29th the minimum and maximum temperature was 25.0°C, 34.9°C and 25.1°C, 33.0°C recorded in 2019-20 and 2020-21 respectively. During the year 2019-20 the relative humidity was 82% in the morning and 59% in the evening and year 2020-21 relative humidity was recorded 84% in the morning and 71% in the evening. Similar results were also reported by Mathur RN and Singh B (1960). Tripathy MK and Dandapat B (2020) from Odisha reported that *Calopepla leayana* is the major defoliator of this species recorded at Bhubaneswar during the study period (2017-18). Out of the total 22 species recoded 10 species were foliage feeders (47.61%),8 species were sap feeders (38.09%), one species each from shoot borer (4.76%) and bark feeder, and 2 species were recorded as root and bark feeders (9.52%).

**3.3 Incidence of Bark eating caterpillar (*Indarbela quadrinotata)***

The larvae excavate a hole at the branch initiation point and remains because of nocturnal in nature. It prepares tunnels frass materials made up of cellulose, excreta and saliva. Plants become weak and succumb to natural calamities due to boring by larvae. Bark eating caterpillar which was first time observed from fourth week of July up to first week of September. The minimum and maximum temperature was 25.0°C, 31.4°C and 25.6°C, 32.8.0°C recorded in 2019-20 and 2020-21 respectively. During the year 2019-20 the relative humidity was 82% in the morning and 64% in the evening and year 2020-21 relative humidity was recorded 83% in the morning and 66% in the evening. In this context similar work was conducted by Sasidharan KR and Varma RV (2008). Seasonal population variations of the bark eating caterpillar (*Indarbela quadrinotata*) in casuarinas plantation of Tamil Nadu. Kumar *et al.* (2020) done the work related to bark eating caterpillar. Estimating Bark Eating Caterpillar *Indaebela quadrinotata* in Populus deltoids using Ranked set sampling.

**3.4 Incidence of Sap sucker/ Tingid Bug (*Tingis beesoni)***

*Tingis beesoni*leads to the top dying, which assembles in crowded on the leaves and soft tissues. The nymphs and adults suck the sap at the base of the leaf axils, which results in discoloration of leaf in the form of patches on both the sides of lamina. Damage typically appears first on mature leaves and later new flush. The population dynamics and prevalence of sap sucker which started from the first week of August the minimum and maximum temperature was 25.0°C, 34.9°C and 25.1°C, 33.0°C recorded in 2019-20 and 2020-21 respectively. During the year 2019-20 the relative humidity was 82% in the morning and 59% in the evening and year 2020-21 relative humidity was recorded 84% in the morning and 71% in the evening. It leads to the top dying of the tree. In this context similar work was conducted by Meshram PB and Bhowate S (2017). Plantation of *Gmelina arborea* is facing the great problem of major insect pest i.e. sap sucker / lace bug *Tingis beesoni* resulting in top dying of shoots in tropical forest of Madhya Pradesh. The nymphs and adults of bug feed entirely at the base of leaf blade on the under surface and the leaf axils. The shoot dry up, tum black and sooty mould grows all over plants leading to the top dying. The results revealed that lace bug; *T. beesoni* was responsible for causing the top dying of *G. arborea*.

**3.5 Incidence of Pod Borer *(Helicoverpa armigera)***

The larvae bore into pods and consume the developing seed. The mature larva bore circular holes on fruits. The internal tissues are eaten several and completely hollowed out. This pest mainly bored fruits within round holes, fed leaves, shoots and buds. Pod borer *Helicoverpa armigera* was observed on the second week of October up to second week of November with the minimum and maximum temperature was 22.07°C, 31.07°C and 24.0°C, 32.7°C recorded in 2019-20 and 2020-21 respectively. During the year 2019-20 the relative humidity was 91% in the morning and 78% in the evening and year 2020-21 relative humidity was recorded 91% in the morning and 75% in the evening. In this context the similar result was shown by Pawar *et al.,* (2015) observed that pod borer, *Helicoverpa armigera* (Hub.), start the infesting the crop during the reproductive stage i.e. 44 SW and 45 SW (0.01 eggs/plant and 0.35 larvae/plant) and population stock the pests egg and larva available up to maturity stage i.e. 01 SW (1.8 eggs/plant and 0.15 larvae/plant).

**3.6 Incidence of Hairy caterpillar *(Spilosoma obliqua)***

They feed on the leaves, buds and flowers of many plants. It cuts the juvenile plants and eat away all the green matter of the leaves. Hairy caterpillar *Spilosoma oblique* was observedthe second week of July with the minimum and maximum temperature was 25.1°C, 36.06°C and 24.6°C, 33.1°C recorded in 2019-20 and 2020-21 respectively. During the year 2019-20 the relative humidity was 80% in the morning and 59% in the evening and year 2020-21 relative humidity was recorded 71% in the morning and 62% in the evening.In this context same survey was done by Pudasini (2020). Bihar hairy caterpillar (*Spilosoma obliqua*) is a serious polyphagous insect pest. An experiment was conducted to determine the host preference of Bihar hairy caterpillar in Entomology laboratory, Lamjung Campus at room temperature from March to April, 2019.

**3.7 Incidence of Aphid *Aphis craccivora Koch (*Hemiptera: Aphididae)**

aphid (*Aphis craccivora* Koch) is a major pest of the Arhar. It caused direct injury to leaves and stems. It feed by sucking sap from their host-plants. It lives on leaves, young shoots, inflorescences and growing points, causing rolling, chlorosis, dwarfing of whole plants, make honey dew like structure on young leaves and shoots. The population dynamics and prevalence of *Aphis Craccivora koch* which started from second week of January and it was found upto last week of February the minimum and maximum temperature was 6.04°C, 22.9°C and 8.0°C, 22.7°C recorded in 2019-20 and 2020-21 respectively. During the year 2019-20 the relative humidity was 84% in the morning and 43% in the evening and year 2020-21 relative humidity was recorded 89% in the morning and 48% in the evening. *Aphis Craccivora koch* is a floral visitor beneficial insect. Similar incidence period reported by Kulkarni and Patel (2001) from Gujarat conducted experiments during winter 1998-99 and they reported that aphid incidence occurred between the first week of January and the fourth week of February with high incidence during the first week of February.

**4. CONCLUSION**

This two-year study in Jabalpur, Madhya Pradesh, identified seven significant insect pest species within the Arhar + *Gmelina arborea* agroforestry system, highlighting a diverse pest complex impacting both tree and crop components. The key findings include that the Pests of *Gmelina arborea*: The Trunk borer (*Dihammus cervinus*), Defoliator (*Calopepla leayana*), Bark eating caterpillar (*Indarbela quadrinotata*), and Sap sucker/Tingid Bug (*Tingis beesoni*) were the primary threats, causing direct damage to the tree's health and vigour. Pests of Arhar: The Pod Borer (*Helicoverpa armigera*), Hairy caterpillar (*Spilosoma obliqua*), and Aphid (*Aphis craccivora Koch*) were major pests affecting the pulse crop, potentially leading to yield losses. Moreover the Seasonal Incidence: Each pest exhibited specific periods of activity, influenced by local temperature and humidity. For instance, tree pests were prominent from late July/early August, while Arhar pests appeared from October (Pod Borer) or January (Aphid). This detailed understanding of pest associations and their seasonal dynamics is crucial for developing targeted Integrated Pest Management (IPM) strategies. Such strategies will need to consider the unique threats to both the tree and crop components, while also exploring potential beneficial interactions within the agroforestry system, ultimately enhancing its productivity and sustainability for farmers in the region.

**Ethical values**

This article does not contain any studies with human or animal subjects. The current experimental research and field study, including the collection of plant material, comply with relevant institutional

**REFERENCES**

Keval, R., Kerketta, D., Nath, P., & Singh, P. S. (2010). Population fluctuations of pod fly of some variety of pigeon pea. Journal of Food Legume, 23(2), 164–165.

Kulkarni, A. V., & Patel, I. S. (2001). Seasonal abundance of mustard aphid and associated bioagents in Indian mustard (Brassica juncea) crop. Indian Journal of Agricultural Sciences, 71(10), 681–682.

Kumar, A., Chandra, G., & Kumar, S. (2020). Estimating Bark Eating Caterpillar Indaebela quadrinotata in Populus deltoids using Ranked set sampling. Indonesian Journal of Applied Statistics, 3(1).

Mathur, R. N., & Singh, B. (1960). A list of insect pests of forest insects of India and neighbouring countries. Forest Bulletin. Dehradun (N.S.) (Ent.), 171(Part 1), 1–165.

Meshram, P. B., & Bhowate, S. (2017). Role of lace bug Tingis beesoni and control measures in top dying of Gmelina arborea plantations. Journal of Entomology and Zoology Studies, 5(3), 389–393.

Mittal, V., & Ujagir, R. (2005). Evaluation of Naturalyte Spinosad against pod borer complex in early pigeon pea. Indian Journal of Plant Protection, 33(2), 211–215.

Orwa, C., Mutua, A., Kindt, R., Jamna das, R., & Anthony, S. (2009). Agroforestry Database: a tree reference and selection guide version 4.0. World Agroforestry Centre.

Pawar, U. A., Mahale, A. S., & Ambhure, K. G. (2015). Seasonal incidence of gram pod borer, Helicoverpa armigera (Hub.) and natural enemies in pigeon pea. Department of Entomology, P.G. Institute, College of Agriculture, J.N.K.V.V Jabalpur, 6(1), 140–143.

PROTA. (2016). PROTA4U web database. Plant Resources of Tropical Africa. Retrieved from http://www.prota4u.info

Pudasaini, R., Gurung, A., Gire, B., & Sitaula, S. (2020). Host preference of Bihar hairy caterpillar Spilosoma obliqua in laboratory condition. Journal of Entomology and Zoology Studies, 8(1), 992–996.

Rao, M. R., Singh, M. P., & Day, R. (2000). Insect-pest problems in tropical agroforestry systems: Contributory factors and strategies for management. Agroforestry Systems, 50(3), 243–277.

Sasidharan, K. R., & Varma, R. V. (2008). Seasonal population variations of the bark eating caterpillar (Indarbela quadrinotata) in casuarinas plantation of Tamil Nadu. International Society for Tropical Ecology, 49(1), 79–83.

Singh, S. S., & Yadav, S. K. (2005). Bio efficacy of modern insecticides, biopesticides and their combination against pod borers in pigeon pea. Indian Journal of Entomology, 67(2), 133–136.

Tripathy, M. K., & Dandapat, B. (2020). Seasonal incidence and population dynamics of important insect pests infesting Gambhar Gmelina arborea Roxb. at coastal agro ecosystem of Odisha, India. Journal of Entomology and Zoology Studies, 8(2), 1767–1773.