**ARTHROPOD DIVERSITY AND SUCCESSION OF INSECT PESTS IN BLACK GRAM ECOSYSTEM**

**ABSTRACT**

A field experiment was conducted at agronomy farm, B.A. College of Agriculture, Anand Agricultural University, Anand during *Kharif*, 2019 and 2020 to study the diversity and pest succession based on crop growth stages in black gram and the results revealed that the population of sucking pests *viz*., whitefly and jassid observed from seedling stage and remained up to maturity stage of the crop While flower thrips were noticed from flower bud stage to pod formation stage. The population of green stink bug was observed from vegetative stage to pod formation stage. Among the lepidopteran pests, the incidence of semilooper was observed from vegetative stage to pod maturity stage. bihar hairy caterpillar and leaf eating caterpillar were observed from seedling stage to pod maturity stage. Whereas, spotted pod borer population was observed with the initiation of flowering and remained till pod maturity stage of the crop. The natural enemies *viz.,* coccinellids and spiders were observed from vegetative stage to pod maturity of the crop. Moreover correlation studies indicated that whitefly, jassids, flower thrips, green stink bug, semilooper, leaf eating caterpillar, bihar hairy caterpillar and spotted pod borer were significant positively associated with each other. Besides, there was a significant positive companionship exhibited between natural enemies *viz*., coccinellids and spiders with insect-pests population in black gram ecosystem.

***Key words:***  succession, white fly, jassid, bihar hairy caterpillar, coccinellids, black gram

1. **INTRODUCTION**

Among a dozen of pulses growing in India, black gram (*Vigna mungo* L. Hepper.) is an important short duration pulse crop belonging to (family Leguminosae) grown in many parts of the country. In India, black gram referred with different local and vernacular names *viz*., urad bean, udid, mash and black mapte *etc.* (Radhika and Reddy, 2018). Black gram is a host for diverse array of arthropod pests such as whitefly, *Bemisia tabaci* Gennadius; jassid, *Empoasca kerri* Pruthi; and green leaf hopper, *Nephotettix* spp*.* Distant; grasshopper, *Atractomorpha* spp*.* Fabricius; black aphid, *Aphis craccivora* Koch; blister beetle, *Mylabris pustulata* Thunberg; leaf webber, *Grapholita critica* Meyr; grey weevil, *Myllocerus* spp*.* Boheman; leaf eating caterpillar, *Spodoptera litura* Fabricius; Bihar hairy caterpillar, *Spilosoma obliqua* Walker; gram caterpillar, *Helicoverpa armigera* Hubner; semilooper, *Plusia orichalcea* Fabricius; and green stink bug, *Nezara virudula* Linnaeus appeared as foliage feeders. Stem fly, *Ophiomyia phaseoli* Tryon emerged as stem borer. flower thrips, *Megalurothrips usitatus* Bagnall; and leaf miner, *Chromatomyia horticola* Goureau were classified as pollen feeders and tissue borers, spotted pod borer, *Maruca testulalis* Geyer and blue butterfly, *Lampides boeticus* Linnaeus are classified as pod borers, respectively (Kumar and Singh, 2016; Yadav et a*l*., 2020). The losses incurred due to defoliators, pod borers and sucking pests in black gram ranging from 27.7, 67.8 and 25.9 per cent, respectively (Justin et al., 2015). Among the sucking pests whitefly, a potential vector of mungbean yellow mosaic virus (MYMV) haunts farmer fields and cause a substantial loss to a tune of 30-70 per cent (Duraimurugan and Tyagi, 2014). Succession of insect pests is the result of different pests appeared during the crop period from sowing to harvesting at different crop development stages under different agro climatic zones to determine their status of incidence *i.e*., whether the pest is major, minor, regular or sporadic under the influence of different biotic and abiotic factors. Therefore, there is need to study the succession of insect pests in order to follow essential management tactics from the threat posed by insect pests in cultivation of black gram.

1. **Materials and Methods**

In order to study the pest succession and natural enemies in black gram, a field experiment was carried out on cultivar, T-9 during *Kharif*, 2019 and 2020 at Agronomy Farm, B.A. College of Agriculture, Anand Agricultural University, Anand. Sowing of the seeds was done by dibbling method on 17th July, 2019 and 19th July, 2020. The experimental plot covers an area of 20 × 10 m with a spacing of 45 × 10 cm. The plot was raised with complete agronomic practices except for insect pest management. The plot was divided in to six equal divisions and one division was considered as one repetition.Observations were recorded at weekly interval starting from one week after germination till the crop maturity. For sucking pests *viz*., whitefly and jassidobservationswere recorded from three leaves (upper, middle and lower) per plant from all 10 randomly selected plants in each division. Whereas, the population of flower thrips,was counted from 10 flowers from the same selected plants after attaining 50% flowering. Observations on number of green stink bugwere counted from the same selected plants in each division. For Lepidopteran pests *viz*., leaf eating caterpillar, Bihar hairy caterpillarand semilooper, number of larvae were recorded from 10 randomly selected plants in each division. In case of spotted pod borer number of larvae were recorded from the initiation of flowering till pod formation stage from the randomly selected 10 plants in each division. Similarly, the population of natural enemies *viz*., spiders and coccinellids (grub and adult) were recorded by counting from the randomly selected 10 plants randomly from each division and mean population was calculated. Besides, correlation studies between the insect pests and natural enemies was also worked out.

1. **Results and Discussion**

**3.1 Succession of insect-pests and natural enemies in black gram based on crop growth stages**

Diversity and Succession of insect-pests as well as natural enemies in black gram during *Kharif*, 2019 and 2020 are presented in (Table 1 & 2). In *Kharif*, 2019 black gram crop was first attacked by whitefly, *Bemesia tabaci*, jassid, *Empoasca kerri*, leaf eating caterpillar, *Spodoptera litura* and Bihar hairy caterpillar, *Spilosoma obliqua* at the seedling stage *i.e.,* at 15 DAS and their infestation was continued up to pod maturity stage of the crop. Whereas 25 DAS green stink bug, *Nezara. viridula* population was observed from vegetative stage to pod formation stage. Flower thrips, *Megalurothrips usitatus* population was first observed during the flowering stage *i.e.,* 35 DAS and remained up to pod formation stage (60 DAS). In case of spotted pod borer, *Maruca vitrata* initial population was observed during flowering stage and remained in the field up to pod maturity *i.e.,* up to 80 DAS.

Similar trend of succession was recorded during *Kharif*, 2020 as observed in *Kharif*, 2019. However, semilooper, *Trichoplusia ni* which was appeared in only *Kharif*, 2020 remained in the field from vegetative stage to pod maturity stage of the crop. Based on population density recorded during both the years, all the above mentioned insect pests are categorized as major except for semilooper and green stink bug which are categorized as minor insect-pests.

**3.2 Correlation ( r ) among the insect pest population and natural enemies**

During *Kharif*, 2019 whitefly population showed highly significant positive correlation with jassid, flower thrips, green stink bug, *S. litura*, *S. obliqua*, *M. vitrata*, coccinellids and spiders (r=0.94\*\*, 0.87\*\*, 0.77\*\*, 0.96\*\*, 0.96\*\*, 0.90\*\*, 0.92\*\* and 0.95\*\*, respectively) which indicated their simultaneous occurrence in the crop. (Table 3). Incidence of jassid showed highly positive companionship with flower thrips, green stink bug, *S. litura*, *S. obliqua*, *M. vitrata,* coccinellids and spiders (r=0.90\*\*, 0.79\*\*, 0.97\*\*, 0.95\*\*, 0.92\*\*, 0.95\*\* and 0.94\*\*, respectively). Flower thrips showed highly significant positive correlation with green stinkbug, *S. litura*, *S. obliqua, M. vitrata*, coccinellids and spiders (r=0.77\*\*, 0.90\*\*, 0.95\*\*, 0.92\*\*, 0.94\*\* and 0.94\*\*, respectively). Green stink bug incidence showed highly significant positive companionship with *S. litura*, *S. obliqua,* coccinellids and spiders (r= 0.84\*\*, 0.81\*\*, 0.81\*\* and 0.72\*\*, respectively). While green stink bug incidence showed significant positive companionship (r=0.64\*) with *M. vitrata*. Leaf eating caterpillar, *S. litura* showed highly significant positive correlation with *S. obliqua, M. vitrata,* coccinellids and spiders (r=0.96\*\*, 0.91\*\*, 0.94\*\* and 0.94\*\*, respectively). Bihar hairy caterpillar, *S. obliqua* showed highly significant positive correlation with *M. vitrata*, coccinellids and spiders (r=0.91\*\*, 0.96\*\* and 0.97\*\*, respectively). Spotted pod borer, *M. vitrata* showed highly significant positive companionship with coccinellids (grub and adult) and spiders (r=0.90\*\* and 0.94\*\*, respectively). Coccinellids (grub and adult) showed highly significant positive correlation with whitefly (r=0.92\*\*), jassid (r=0.95\*\*), flower thrips (r= 0.94\*\*), green stink bug (r= 0.81\*\*), *S. litura* (r= 0.94\*\*), *S. obliqua* (r= 0.96\*\*) and *M. vitrata* (r= 0.90\*\*). Besides, coccinellids exhibited highly significant positive correlation with spiders (r= 0.96\*\*). Spider, auniversal predator exhibited highly significant positive correlation with whitefly, jassid, flower thrips, green stink bug, *S. litura*, *S. obliqua* and *M. vitrata* (r= 0.95\*\*, 0.94\*\*, 0.94\*\*,0.72\*\*, 0.94\*\*,0.97\*\* and 0.94\*\*, respectively) in black gram ecosystem.

In *Kharif*, 2020 population of whitefly was highly significant positively correlated with the population of jassid, flower thrips, green stink bug, *S. litura*, *S. obliqua,* coccinellids (grub and adult) and spiders with ‘r’ value 0.97\*\*, 0.87\*\*, 0.79\*\*, 0.93\*\*, 0.93\*\*, 0.85\*\* and 0.75\*\*, respectively (Table 4). However, significant positive (r=0.59\*) association was established with *M. vitrata* population. A highly significant positive correlation was also noticed between jassid and flower thrips (r=0.90\*\*), green stink bug (r=0.75\*\*), *S. obliqua* (r=0.92\*\*) and coccinellids (grub and adult) (r=0.76\*\*) whereas, with *M. vitrata* and spiders jassids showed significant (r= 0.61\* and 0.65\*) positive association. Besides, semilooper and *S. litura* established a non- significant positive association with jassid population.

### Table 1: Diversity of insect-pests as well as natural enemies in black gram ecosystem (*Kharif*, 2019 and 2020)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sr. No.** | **Common name** | **Scientific name** | **Family** | **Order** | **Occurrence** | | **Economic status** | |
| **2019** | **2020** | **2019** | **2020** |
| 1 | Whitefly | *Bemisia tabaci* (Gennadius) | Alyerodidae | Hemiptera | Regular | | Major | Major |
| 2 | Jassid | *Empoasca kerri* (Pruthi) | Cicadellidae | Hemiptera | Regular | | Major | Major |
| 3 | Flower thrips | *Megalurothrips usitatus* (Bagnall) | Thripidae | Thysonoptera | Regular | | Major | Major |
| 4 | Green stink bug | *Nezara viridula* (Linnaeus) | Pentatomidae | Hemiptera | Regular | | Minor | Minor |
| 5 | Semilooper | *Trichoplusia* ni (Fabricius) | Noctuidae | Lepidoptera | Occasional | | Minor | Minor |
| 6 | Leaf eating  caterpillar | *Spodoptera litura* (Fabricius) | Noctuidae | Lepidoptera | Regular | | Major | Major |
| 7 | Bihar hairy  caterpillar | *Spilosoma obliqua* (Walker) | Erebidae | Lepidoptera | Regular | | Major | Major |
| 8 | Spotted pod borer | *Maruca vitrata* (Geyer) | Crambidae | Lepidoptera | Regular | | Major | Major |
| 9 | Lady bird beetle | *Coccinella transversalis* (Fabricius) | Coccinellidae | Coleoptera | Regular | | - | - |
| 10 | Spider | Unidentified |  |  | Regular | | - | - |

**Table 2. Succession of insect-pests and natural enemies in black gram in relation to crop growth stages (*Kharif*, 2019 and 2020)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Duration/growth**  **stages**  **Insect-pests** | **Days after sowing (DAS)** | | | | |
| **15** | **25** | **35** | **60** | **80** |
| **Crop growth stages (CGS)** | | | | |
| **Seedling** | **Vegetative** | **Flowering** | **Pod formation** | **Pod maturity** |
| Whitefly |  |  |  |  |  |
| Jassid |  |  |  |  |  |
| Flower thrips |  |  |  |  |  |
| Green stinkbug |  |  |  |  |  |
| Semilooper |  |  |  |  |  |
| Leaf eating caterpillar |  |  |  |  |  |
| Bihar hairy caterpillar |  |  |  |  |  |
| Spotted pod borer |  |  |  |  |  |
| Coccinellids |  |  |  |  |  |
| Spider |  |  |  |  |  |

**Table 3. Correlation coefficient between insect-pests and their natural enemies (*Kharif*, 2019)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Insect-pests** | **Whitefly** | **Jassid** | **Flower thrips** | **Green stink**  **bug** | **Leaf eating**  **caterpillar** | **Bihar hairy**  **caterpillar** | **Spotted pod**  **borer** | **Coccinellids (grub &**  **adult)** | **Spider** |
| Whitefly | - | - | - | - | - | - | - | - | - |
| Jassid | 0.94\*\* | - | - | - | - | - | - | - | - |
| Flower thrips | 0.87\*\* | 0.90\*\* | - | - | - | - | - | - | - |
| Green stink bug | 0.77\*\* | 0.79\*\* | 0.77\*\* | - | - | - | - | - | - |
| Leaf eating caterpillar | 0.96\*\* | 0.97\*\* | 0.90\*\* | 0.84\*\* | - | - | - | - | - |
| Bihar hairy caterpillar | 0.96\*\* | 0.95\*\* | 0.95\*\* | 0.81\*\* | 0.96\*\* | - | - | - | - |
| Spotted pod borer | 0.90\*\* | 0.92\*\* | 0.92\*\* | 0.64\* | 0.91\*\* | 0.91\*\* | - | - | - |
| Coccinellids (grub & adult) | 0.92\*\* | 0.95\*\* | 0.94\*\* | 0.81\*\* | 0.94\*\* | 0.96\*\* | 0.90\*\* | - | - |
| Spider | 0.95\*\* | 0.94\*\* | 0.94\*\* | 0.72\*\* | 0.94\*\* | 0.97\*\* | 0.94\*\* | 0.96\*\* | - |

\* Significant at 0.05 % level \*\* Significant at 0.01 % level

### Table 4 . Correlation coefficient (r) between insect-pests in black gram and their natural enemies (*Kharif*, 2020)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Insect-pests** | **Whitefly** | **Jassid** | **Flower thrips** | **Green stink bug** | **Semilloper** | **Leaf eating**  **caterpillar** | **Bihar hairy**  **caterpillar** | **Spotted pod**  **borer** | **Coccinellids (grub &**  **adult)** | **Spider** |
| Whitefly | - | - | - | - | - | - | - | - | - | - |
| Jassid | 0.97\*\* | - | - | - | - | - | - | - | - | - |
| Flower thrips | 0.87\*\* | 0.90\*\* | - | - | - | - | - | - | - | - |
| Green stink bug | 0.79\*\* | 0.75\*\* | 0.57 | - | - | - | - | - | - | - |
| Semilooper | 0.57 | 0.44 | 0.18 | 0.77\*\* | - | - | - | - | - | - |
| Leaf eating caterpillar | 0.93\*\* | 0.58 | 0.72\*\* | 0.89\*\* | 0.76\*\* | - | - | - | - | - |
| Bihar hairy caterpillar | 0.93\*\* | 0.92\*\* | 0.90\*\* | 0.78\*\* | 0.44 | 0.63\* | - | - | - | - |
| Spotted pod borer | 0.59\* | 0..61\* | 0.80\*\* | 0.26 | -0.06 | 0.44 | 0.59\* | - | - | - |
| Coccinellids (grub &adult) | 0.85\*\* | 0.76\*\* | 0.66\* | 0.86\*\* | 0.79\*\* | 0.91\*\* | 0.83\*\* | 0.37 | - | - |
| Spider | 0.75\*\* | 0.65\* | 0.39 | 0.67\* | 0.87\*\* | 0.82\*\* | 0.82\*\* | 0.09 | 0.77\*\* | - |

\* Significant at 0.05 % level \*\* Significant at 0.01 % level

Flower thrips, population showed highly significant positive correlation with *S. litura* (r=0.72\*\*), *S. obliqua* (r=0.90\*\*) and *M. vitrata* (r=0.80\*\*).While with coccinellids (grub and adult), flower thrips showed significant (r=0.66\*) positive correlation. Green stink bug showed highly significant positive correlation with semilooper, *S. litura*, *S. obliqua*, coccinellids (grub and adult) with ‘r’ value 0.77\*\*, 0.89\*\*, 0.78\*\* and 0.86\*\*, respectively. With spiders green stink bug showed significant positive correlation (r=0.67\*). Semilooper had established highly significant positive correlation with *S. litura*, coccinellids (grub and adult) and spiders (r=0.76\*\*, 0.79\*\* and 0.87\*\*) and highly significant correlation with spiders (r= 0.71\*\*). But, semilooper showed non-significant positive association with *S. obliqua* while negative association with *M. vitrata*. Leaf eating caterpillar, *S. litura* population showed highly significant positive correlation with coccinellids (grub and adult) and spiders (r= 0.91\*\* and 0.82\*\*) while the pest showed significant positive correlation with *S. obliqua* (r = 0.63\*). However, *M. vitrata* showed non-significant positive association with *S. litura.* Bihar hairy caterpillar, *S. obliqua* established highly significant positive correlation with coccinellids (grub and adult) and spiders (r= 0.83\*\* and 0.82\*\*) while the pest showed significant positive correlation (r= 0.59\*) with *M. vitrata*. In case of spotted pod borer, *M. vitrata*, the pest showed non significant positive association with coccinellids (grub and adult) and spiders. Coccinellids (grub and adult) exhibited highly significant positive correlation with whitefly, jassid, green stink bug, semilooper, *S. litura* and *S. obliqua* (r= 0.85\*\*, 0.76\*\*, 0.86\*\*, 0.79\*\*, 0.91\*\* and 0.83\*\*). With flower thrips, coccinellids (grub and adult) showed significant positive association (r=0.66\*). Besides, coccinellids (grub and adult) showed highly significant positive correlation with spiders (r= 0.77\*\*). Spiders showed highly significant positive correlation with whitefly, semilooper, *S. litura* and *S. obliqua* with ‘r’ value 0.75\*\*, 0.87\*\*, 0.82\*\* and 0.82\*\* whereas with jassid and green stink bug spider exhibited significant positive correlation (r= 0.65\* and 0.67\*)However, flower thrips and *M. vitrata* established non-significant impact on spider population.

Overall, there was a significant positive association between/among the insect pests and two natural enemies *viz*., coccinellids (grub and adults) and spiders with their hosts in black gram ecosystem. The present findings are in line with the earlier researchers Singh and Singh, (1977), Kumar and Singh (2016), Duraimurugan and Tyagi, (2014), Dhuri and Singh, (1983), Yadav et al., (2020) and Sain et al., (2020) who reported that succession and association of insect-pests and natural enemies in black gram ecosystem. The information on simultaneously occurrence of the pest in crop ecosystem will be very useful in formulating the management strategy.

**CONCLUSION**

In culmination, from the findings it was revealed that the population of whitefly and jassids were observed from seedling stage to maturity stage of the crop. In case of flower thrips population was observed from flower bud formation stage to pod formation stage and green stinkbug population was observed from vegetative stage to pod formation stage. Among the lepidopteran pests, bihar hairy caterpillarand leaf eating caterpillar observed from seedling stage to pod maturity stage of the crop whereas, spotted pod borerwas observed with the initiation of flowering and continued till pod maturity. The natural enemies of the insect pests *viz.,* coccinellids and spiders were observed from vegetative stage to pod maturity.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

As the author(s), I hereby declare that no generative AI technologies, including Large Language Models (such as Chat GPT, COPILOT, etc.) or text-to-image generators, have been used in the writing or editing of this manuscript

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