***Original Research Article***

**Effect of Weather Parameters on Population Dynamics of Major Sucking Insect-Pests and Their Natural Enemiesof Soybean [*Glycine max* (L) Merrill]**

**ABSTRACT**

A two-year field trial was conducted during Kharif seasons of 2021 and 2022 at the Experimental Research Farm of Department of Entomology, School of Agricultural Sciences, Nagaland University, Medziphema campus on soybean variety JS 335 in order to study the population dynamics of major sucking insect-pests and their natural enemies in relation to weather parameters. Randomized Block Design (RBD) with three replications was used for the study. Three major sucking insect-pests namely, aphid (*Aphis glycines* Matsumura), whitefly (*Bemisia tabaci* Gennadius) and pod sucking bug (*Riptortus pedestris* Fabricius) and one coccinellid predator (*Coccinella transversalis*) were recorded during the various growth stages of the crop. In both the seasons of investigation, the peak population of aphid (23.33 aphids/leaf in 2021 and 24.33 aphids/leaf in 2022), whitefly (23.67 whiteflies/leaf in 2021 and 21.67 whiteflies /leaf in 2022) and pod sucking bug (4.00 adults/mrl in 2021 and 4.33 adults/mrl in 2022) was observed on 35th, 33rd and 38th standard meteorological week (SMW), respectively. The population of ladybird beetle recorded was ranged from 0.22 to 1.75 beetles/mrl during kharif, 2021 and 0.16 to 1.83 beetles/mrl during kharif, 2022. The findings from this investigation gives a brief idea about the peak activity of the insects in a season and also the impact of weather factors on the major sucking insect-pests of soybean.

***Keywords:*** population, abiotic, peak, population, correlation, significant.

**INTRODUCTION**

Soybean [*Glycine max* (L.) Merrill] belonging to family Leguminaceae, sub-family Papilionaceae, is one of the important oilseed cash crops of India (Chauhan and Joshi, 2005). Soybean is considered as a pulse crop but due to its high oil content and greater response to applied nitrogen, now it is placed in oil seed category. Soybean has become an important oilseed crop in India in a very short period with approximately 10 million ha area under its cultivation (Kumari and Yadu, 2020). The luxuriant crop growth, soft and succulent foliage attracts many insects and provides unlimited source of food, space and shelter. Soybean crop is reported to be attacked by about 380 species of insects in many parts of the world. About 65 insect species have been reported to attack soybean from cotyledon stage to harvesting stage (Bhavasar and Kumar, 2019). Several sucking insect pests are found to attack on the different crop stages of soybean. Of which the important sucking pests include- whitefly (*Bemisia tabaci* Gennadius), aphids (*Aphis gossypii* Glover and *Aphis craccivora* Koch) and jassids (*Empoasca kerri* Prethi) (Patel *et al.*, 2019). Population density of insect pests fluctuates with changing weather conditions. As the cultivation of soybean has expanded around the world, crop becomes susceptible to different environmental and biotic stress which has increased the pest infestations. Such information is essential in developing integrated pest management systems with ecological and economical balance (Suyal *et al*., 2018). Seasonal incidence studies helps in planning need based application of insecticides as it clearly reveals the insect’s peak activity as well as insect free periods during crop growth. Therefore, knowledge of how insect pests respond to density dependent factors *viz*. weather, temperature, climate variation is of fundamental importance in understanding insect pest management (Channakeshava *et al.*, 2020). Keeping these facts in view, the present investigation was planned to study the effect of weather parameters on population dynamics of sucking insect-pests infesting soybean crop.

**MATERIALS AND METHODS**

An experiment was conducted during the two kharif seasons of 2021 and 2022 in the Experimental Farm of Department of Entomology, School of Agricultural Sciences, Nagaland University, Medziphema campus. The layout for the experimental study was Randomized Block Design (RBD) with three replications. To study the incidence of major sucking insect-pests infesting soybean, JS-335 was sown on 10th of July in both the seasons at a spacing of 45cm x 10cm in the ecological plots of size 4m x 3m. All the recommended agronomic practices were followed to grow the crop except measures for insect pest control. Observations were recorded from first week of August to second week of October during the two years. The data on the incidence of three sucking pests of soybean namely, aphids (*Aphis glycines*), whiteflies (*Bemisia tabaci*) and pod sucking bug (*Riptortus pedestris*) and one predator, coccinellid beetle (*Coccinella transversalis*) from each plot were taken at weekly intervals starting from 20 days after sowing (DAS) until the crop reached its maturity. For aphids and whiteflies, ten plants were randomly selected from each plot. From each plant, number of both the insects (nymphs and adults) were counted from three leaves each from top, middle and lower parts of the plant and mean number of insects per leaf was recorded. In case of pod sucking bugs and coccinellid beetles,the number of adults per metre row length (mrl) was recorded at three randomly selected places in a plot and mean was reported in numbers per metre (Suyal *et al.*, 2018). The mean insect population was pooled and expressed at weekly intervals by following suitable statistical techniques for different insects and correlated with meteorological parameters. Average weekly meteorological data during the observation period, such as maximum and minimum temperature, relative humidity and rainfall were collected from ICAR-Regional Research Centre, Jharnapani, Nagaland. Simple linear correlation analysis were performed to find out the relationship of weather parameters like temperature, relative humidity and rainfall with incidence of major sucking insect pests and their natural enemies of soybean.

**Table 1. Meteorological data of the experimental area during the period of investigation, *Kharif* 2021 and 2022**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Date** | **SMW** | **Temperature**  **(℃)** | | | | **Relative humidity**  **(%)** | | | | **Rainfall**  **(mm)** | |
| **Max.** | | **Min.** | | **Max.** | | **Min.** | |
| **2021** | **2022** | **2021** | **2022** | **2021** | **2022** | **2021** | **2022** | **2021** | **2022** |
| 2 Aug- 8 Aug | 31 | 32.27 | 33.64 | 25.10 | 23.86 | 91.57 | 93.43 | 78.43 | 67.57 | 34.00 | 48.80 |
| 9 Aug- 15 Aug | 32 | 33.20 | 33.27 | 24.53 | 23.89 | 92.86 | 96.00 | 67.86 | 71.43 | 25.20 | 14.70 |
| 16 Aug- 22 Aug | 33 | 32.47 | 33.61 | 24.93 | 24.24 | 95.57 | 91.00 | 77.00 | 72.29 | 41.80 | 27.50 |
| 23 Aug- 29 Aug | 34 | 32.37 | 34.11 | 24.29 | 24.46 | 91.86 | 93.86 | 67.71 | 68.43 | 7.00 | 64.20 |
| 30 Aug- 5 Sept | 35 | 32.31 | 32.66 | 24.29 | 24.33 | 92.86 | 93.43 | 72.86 | 68.00 | 52.90 | 9.00 |
| 6 Sept- 12 Sept | 36 | 33.19 | 33.36 | 24.01 | 24.41 | 94.57 | 89.29 | 68.43 | 66.57 | 49.10 | 21.70 |
| 13 Sept- 19Sept | 37 | 33.79 | 31.89 | 23.94 | 23.46 | 93.57 | 91.14 | 67.71 | 72.14 | 42.20 | 42.80 |
| 20 Sept- 26Sept | 38 | 32.11 | 33.54 | 23.31 | 24.03 | 94.00 | 91.00 | 67.71 | 65.43 | 13.10 | 15.30 |
| 27 Sept- 3 Oct | 39 | 33.70 | 32.80 | 23.77 | 23.24 | 93.14 | 90.71 | 66.00 | 70.43 | 8.10 | 81.20 |
| 4 Oct- 10 Oct | 40 | 32.29 | 31.94 | 23.06 | 23.47 | 94.29 | 95.29 | 71.14 | 73.71 | 5.00 | 31.00 |

\* SMW: Standard Meteorological Week

Source: ICAR Regional Research Centre, Jharnapani, Nagaland

**RESULTS AND DISCUSSION**

During the two years’ investigation, three major sucking insect- pests namely, aphids (*Aphis glycines*), whiteflies (*Bemisia tabaci*) and pod sucking bug (*Riptortus pedestris*) were found infestingat different growth stages of soybean crop and one coccinellid predator *i.e*. *Coccinella transversalis* was found devouring on aphids and whiteflies. This finding got its support from Naik et al. (2021) who also found four sucking pests namely, whitefly (*Bemisia tabaci* Gennadius), jassid (*Empoasca kerri* Pruthi), aphids (*Aphis craccivora* Koch) and thrips (*Thrips tabaci* Lindeman) and one natural enemy,namely, lady bird beetle (*Cheilomenes sexmaculata)* was observed to prey on these sucking pests.

**Aphid, *Aphis glycines***

The first count of aphids was initiated on 31st SMW in both the years which showed a lowest mean population of 2.67 and 2.00 aphids/leaf in 2021 and 2022 respectively, which reached its peak population of 23.33 aphids/leaf in 2021 and 24.33 aphids/leaf in 2022 during 35th SMW. Thereafter, the population started declining until the crop reaches maturity. This indicates that the infestation was visible from vegetative to flowering stage and persisted till pod formation stage. Moreover, it was also observed that the aphid infestation during the year 2022 was comparatively higher than 2021. Similar findings are also reported by Bhamare *et al*. (2018) and Chaudhari *et al*. (2020) also reported that the population of *A. glycines* on soybean was at its peak in 35th SMW (first week of September). Shabana *et al*. (2018) reported that infestation by aphid, *Aphis glycines* on soybean crop was observed during late vegetative stage, which was also in accordance with the present finding

The correlation study of aphids with the abiotic factors during 2021 revealed a significant positive correlation with maximum temperature (r=0.638\*) at 5% level of significance. However, it had a non-significant positive correlation with minimum temperature and rainfall, but non-significant and negatively correlated with maximum and minimum relative humidity. In the following year, it showed a significant negative correlation with minimum temperature (r=-0.784\*\*) at 1% level of significance. On the other hand, the aphid population had a non-significant positive correlation with maximum and minimum relative humidity and non-significant but negatively correlated with maximum temperature. The present finding is in line with the work of Gehlot and Prajapat (2021) who reported that population of aphid on green gram had positive correlation with minimum and maximum temperature. Kumar and Kandibane (2021) also reported that the correlation study of bean aphids in black gram had significant positive correlation with maximum temperature and non-significant positive correlation with maximum and minimum relative humidity and rainfall, which is in line with the present finding.

**Whitefly, *Bemisia tabaci***

In both the experimental years, the first count of whitefly was initiated on 31st SMW (first week of August) with a mean population of 7.33 whiteflies/leaf in 2021 and 8.33 whiteflies /leaf in 2022 which increased from next week, thereby reaching its peak population of 23.67 whiteflies/leaf and 21.67 whiteflies /leaf in 2021 and 2022 respectively during 33rd SMW (third week of August). Then the whiteflies population started declining in both the years until it reached maturity. From the two experimental years, it was observed that infestation by whiteflies on the crop commenced from 31st up to 40th SMW. The minimum population of whiteflies was observed on 40th SMW (6.67 whiteflies/leaf) and 31st SMW (8.33 whiteflies/leaf) during 2021 and 2022, respectively. In comparison within the two years, whitefly population was slightly higher in the year 2022 than 2021. The present finding was in line with the work of Marabi *et al*. (2017) reported that whitefly infestation in kharif soybean started from 29th to 41st SMW. Brahman *et al*. (2018) and Swathi *et al*. (2020) also reported that *Bemisia tabaci* first appeared on soybean in the first week of August in vegetative stage and persisted up to pod maturity stage of crop which is similar with the present finding. Kushram *et al*. (2021) reported that whiteflies first appeared on the soybean crop in the last week of July and reached its peak during last week of August.

The correlation studies in the year 2021 revealed that , the population of whiteflies was found to be significant and positively correlated with maximum temperature (r=0.635\*) at 5% level of significance but it had non-significant positive correlation with minimum temperature and rainfall, non- significant and negatively correlated with maximum and minimum relative humidity. However, in the year 2022, it was significant and negatively correlated with minimum temperature (r=-0.672\*) at 5% level of significance, positively significant with rainfall (r=0.664\*) but non-significant positive correlation with maximum and minimum relative humidity. On the other hand, the whiteflies population was non- significant but negatively correlated with maximum temperature. The present finding is in agreement with Marabi *et al*. (2017) who reported that population of whiteflies in kharif soybean had significant positive correlation with maximum temperature, while maximum and minimum relative humidity had non-significant and negative correlation with whitefly population. Chaudhari *et al*. (2020) reported that whiteflies were positively significant correlation (r = 0.676) with rainfall in soybean crop. Yadav *et al*. (2015) found that population of whitefly decreased with the increase in rainfall which was in contradiction with the present finding. The difference may be due to difference in the geographical location or presence of natural enemies.

**Pod sucking bug, *Riptortus pedestris***

The incidence of pod sucking bug during the two experimental years was observed during the pod filling stage i.e., 36th SMW (second week of September) which continued up to 40th SMW in both the experimental years. The first incidence of adults in both the years started from 36th SMW with 1.00 adults/mrl and the population gradually increased in the next few weeks reaching its peak at 38th SMW (last week of September) in both the years with 4.00 adults/mrl and 4.33 adults/mrl in 2021 and 2022 respectively . It was also observed that the pod bug was observed during pod formation stage of the crop and it gradually decreased with the maturity of the crop. The infestation of pod bug was comparatively higher in the year 2022 than in 2021. The above finding is in line with the work of Gangrade and Kapoor (1973) who noticed *Riptortus linearis* on soybean during early September in Madhya Pradesh.

The correlation of pod bugs with the abiotic factors during 2021 revealed a significant negative correlation with minimum temperature (r=-0.725\*), but non-significant correlation with maximum temperature, maximum and minimum relative humidity and rainfall. On the other hand, during the year 2022, it showed a non-significant correlation with all the abiotic factors. The finding was in accordance with Bhavasar and Kumar (2019) who reported that the population of pod bug showed significant negative correlation with minimum temperature, non-significant negative correlation with maximum temperature and rainfall, while it showed non-significant positive correlation with maximum relative humidity. Sarma and Dutta (1997) also observed that none of the meteorological factors had any significant effect on pod bug population.

**Coccinellid beetle, *Coccinella transversalis***

During both the experimental years, predatory coccinellid beetles started their incidence from 31st SMW (first week of August) with a mean population of 0.33 and 0.22 beetles/mrl in 2021 and 2022 respectively, which increased gradually in the following weeks until it reached its maximum population of 1.75 and 1.83 beetles/mrl in 2021 and 2022 respectively, during 34th SMW (last week of August). The beetle population decreased afterwards until it completely disappeared from 39th SMW onwards. The predatory beetle was also observed in the field with the incidence of aphids and whiteflies on which it feeds on them and persists until their preys are available in the field. The present finding is similar with Yadav *et al*. (2015) who reported that the predatory beetle was recorded in soybean crop from 2nd week of August, reached its peak (2.4/mrl) during first week of September. Chunni Kumari *et al.* (2020) found that two species of coccinellid beetles in soybean crop commenced from second week of August to first week of October.

The correlation of coccinellid beetles with the abiotic factors during 2021 revealed a significant positive correlation with minimum temperature (r=0.689\*) while it had a non-significant positive correlation with maximum temperature, minimum relative humidity and rainfall; non- significant and negatively correlated with maximum relative humidity. On the other hand, it had a significant positive and negative correlation with rainfall (r=0.697\*) and minimum temperature (r=-0.699\*), respectively in 2022. In the same year, it had non-significant positive correlation with maximum and minimum relative humidity but, it was found to be non- significant but negatively correlated with maximum temperature. The present finding is in line with Chaudhari *et al*. (2020) who reported that coccinellid predators were positively significant correlation (r = 0.676) with rainfall in soybean crop. Yadav *et al*. (2015) found that population of coccinellid predators decreases with the increase in maximum temperature and it increased with increase in rainfall, which is in accordance with the present finding.

**Table 2: Population dynamics of major sucking insect-pests and natural enemies of soybean during August to October 2021 and 2022**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SMW** | **Aphids**  **(3 leaves/plant)** | | **Whiteflies (3 leaves/plant)** | | **Pod sucking bug**  **(mrl)** | | **Coccinellid beetle**  **(mrl)** | |
| ***2021*** | ***2022*** | ***2021*** | ***2022*** | ***2021*** | ***2022*** | ***2021*** | ***2022*** |
| 31 | 2.67 | 2.00 | 7.33 | 8.33 | 0.00 | 0.00 | 0.33 | 0.22 |
| 32 | 11.67 | 13.67 | 19.67 | 18.33 | 0.00 | 0.00 | 1.36 | 0.46 |
| 33 | 12.33 | 15.67 | 23.67 | 21.67 | 0.00 | 0.00 | 1.66 | 1.59 |
| 34 | 14.67 | 14.33 | 14.33 | 13.67 | 0.00 | 0.00 | 1.75 | 1.83 |
| 35 | 23.33 | 24.33 | 13.33 | 13.67 | 0.00 | 0.00 | 1.53 | 1.66 |
| 36 | 9.67 | 9.67 | 11.33 | 11.67 | 1.00 | 1.00 | 0.93 | 0.88 |
| 37 | 5.67 | 8.33 | 9.33 | 11.00 | 2.00 | 2.33 | 0.48 | 0.51 |
| 38 | 4.67 | 5.67 | 10.67 | 10.00 | 4.00 | 4.33 | 0.22 | 0.16 |
| 39 | 4.33 | 5.00 | 9.33 | 10.33 | 3.67 | 4.00 | 0.00 | 0.00 |
| 40 | 3.67 | 3.33 | 6.67 | 8.67 | 3.33 | 3.67 | 0.00 | 0.00 |
| ***SEm±*** | ***0.72*** | ***0.78*** | ***0.90*** | ***0.96*** | ***0.36*** | ***0.33*** | ***0.02*** | ***0.01*** |
| ***CD (P=0.05)*** | ***2.15*** | ***2.32*** | ***2.68*** | ***2.84*** | ***1.08*** | ***0.97*** | ***0.05*** | ***0.04*** |

SMW- Standard Meteorological Week,

mrl- meter row length

**Fig.1. Population dynamics of sucking pests of soybean and natural enemies in relation to weather parameters during Kharif, 2021 and 2022**

**Table 3: Correlation coefficients (r) of major sucking insect-pests and natural enemies of soybean in relation to weather parameters recorded during Kharif, 2021 and 2022**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Pests & Natural enemies*** | ***Pearson’s correlation coefficient*** | | | | | | | | | |
| ***Temperature (ºC)*** | | | | ***Relative humidity (%)*** | | | | ***Rainfall***  ***(mm)*** | |
| ***Max.*** | | ***Min.*** | | ***Max.*** | | ***Min.*** | |
| ***2021*** | ***2022*** | ***2021*** | ***2022*** | ***2021*** | ***2022*** | ***2021*** | **2022** | **2021** | **2022** |
| Aphids | 0.638\* | -0.493 | 0.529 | -0.784\*\* | -0.238 | 0.472 | -0.059 | 0.404 | 0.520 | 0.532 |
| Whiteflies | 0.635\* | -0.499 | 0.463 | -0.672\* | -0.207 | 0.428 | -0.133 | 0.535 | 0.489 | 0.664\* |
| Pod bugs | -0.371 | -0.192 | -0.725\* | 0.293 | 0.405 | -0.196 | -0.085 | -0.333 | -0.126 | -0.626 |
| Coccinellid beetle | 0.441 | -0.338 | 0.689\* | -0.699\* | -0.174 | 0.482 | 0.092 | 0.483 | 0.466 | 0.697\* |

***Note:*** df = (10-2) = 8 r0.05 = 0.632 r0.01 = 0.765

\* = Significant at 5% level of significance

\*\* = Significant at 1% level of significance

Those values which do not assign any symbol are non-significant at 5% level of significance

**CONCLUSION**

During the two years’ investigation period, soybean crop was attacked by three sucking pests *viz.*, aphid (*Aphis glycines* Matsumura), whitefly (*Bemisia tabaci* Gennadius) and pod sucking bug (*Riptortus pedestris* Fabricius). The activity of aphid and whitefly was noticed right from vegetative stage whereas the activity of pod sucking bug was observed during pod formation stage. Among the predators, ladybird beetle (*Coccinella transversalis)* was found preying on aphids and whiteflies. From the correlation study, it was also observed that the population of aphid was greatly influenced by temperature, whitefly population was mainly influenced by temperature and rainfall while pod bug was influenced by minimum temperature during one year, whereas there was no impact of weather factors on its population in the following year.

**FUTURE SCOPE**

Investigation of the population dynamics of insect pests and their natural enemies is a key goal in pest management. Understanding population dynamics offers insights into the seasonal variations and peak activities of insect pests. Analyzing the relationship between insect pests and their populations also reveals how weather affects these pest populations. This information paves the way for creating effective management strategies aimed at controlling these pests. These findings will aid in developing a pest monitoring system and environmentally sustainable integrated pest management approaches.

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