Environment and Ecology 41 (4D) : 3033—3042, October—December 2023
Article DOI: https://doi.org/10.60151/envec/VVLG2803
ISSN 0970-0420

Biodiversity and Succession of Insects of Blackgram (*Vigna mungo* (L.) Hepper) During *rabi* in the Western Undulating Zone of Odisha

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Received 10 June 2023, Accepted 7 October 2023, Published on 29 December 2023

ABSTRACT

The field experiment was conducted to study about insect biodiversity and their succession in blackgram crop at the crop research farm, College of Agriculture, OUAT, Bhawanipatna during *rabi* 21. Twenty seven insects belong to seven orders and twenty two families were recorded during different growth stages of crop in an overlapping manner. Beside the insects twelve numbers of predators, three numbers of parasitoids and two pollinators were also noticed. The highest diversity index and evenness of insects were recorded at 42 SMW (0.902 and 1.000) followed by 50 SMW (0.833 and 0.710) respectively. The diversity of insects was almost uniform because of the evenness of the species. The insect order homoptera and the insect white fly came under superdominant class of dominance during all the growth stages of crop, whereas coleoptera and hemiptera were categorized under sub-dominant class at vegetative stage and flowering to podding stage of crop growth respectively. The insect orders hemiptera, coleoptera, diptera and hymenoptera and the insects i.e., galerucid beetle, jassid, stem fly, aphids and thrips came under recedent class of dominance. The relative abundance and dominant status of insect's revealed that the maximum numbers of insects were belongs to orders homoptera (75.22%) followed by hemiptera (7.92%), coleoptera (6.30%), diptera (4.62%), hymenoptera (4.05%), orthoptera (0.89%), lepidoptera (0.86%) and odonata (0.09%). Chrysomelid beetles were noticed first during the early vegetative stage of crop followed by stem fly, white fly, leaf webber and semiloopers at the vegetative stage, tobacco caterpillar from late vegetative to pod filling stage, thrips in flowering stage, pod borers, pod bugs, aphids, pentatomid bugs and bihar hairy caterpillar from flowering to crop maturity stage and the pod fly and pod wasp from pod filling to pod maturity stage of the crop. Jassids, grasshoppers and predators like spiders, coccinellids beetles and parasitoids were appeared from mid vegetative stage and continued till fag end of the crop. The peak activities of insects were recorded from flowering to pod maturity stage of the crop.

Keywords Blackgram, Insect pests, Biodiversity, Pest succession.

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INTRODUCTION

Black gram (*Vigna mungo* (L.) Hepper) also known as urd, urad or mash in different parts of India. Dal of pulses is a common disc with cereals in our Indian society, which provides nearly 26% proteins, which is approximately three times that of cerials, as well as other minerals and vitamin and considered as poor man's meat. Pulses are referred as an unique jewel of Indian crop husbandry because of their ability to provide nutrients for human and to make high quality fodder for animals as well.

Khajuria *et al.* (2015) reported black gram is attacked by 40-60 insect pests from seedling to harvest in an overlapping manner at different stages of the crop growth and cause significant yield loss. The average yield loss of black gram due to insect pests at various stages of the crop growth accounts 10-15% by Bindra (1968), 17-38% by Odak and Thakur (1981) and 30 to 54.3% by Dhuri and Singh (1983) in India.

It has therefore the onus is on the entomologists to develop economically feasible and viable, ecologically sound and socially acceptable pest management programe by the minimization of the use of chemical insecticides and to conserve, increase and encourage the action of natural enemies. Therefore it is high time to collect the basic data on insect pests complex, species composition, their diversity, relative abundance and their succession and development of suitable management practices by utilization of minimum pesticides to avoid further increase in insecticide resistance developed by the insect pests, pest resurgence, secondary out break and environmental pollution under minimum insecticide application.

Keeping this point in view the present research was undertaken at the Research farm, College of Agriculture, Odisha University of Agriculture and Technology, Bhawanipatna to study the biodiversity of insects and their succession in black gram in the Western undulating zone of Odisha.

MATERIALS AND METHODS

The field experiment was conducted at College of Agriculture, Bhawanipatna to study the biodiversity and succession of insect pests of blackgram in the Western Undulating Zone of Odisha during *rabi* 2021. Variety NUL-7 (Vishwas) was shown on 5th October, 2021 at the rate of 15 kg/ha in the plot size of 20 × 15 m^2 with the spacing of 45 cm × 10 cm between the rows. Crops are grown with the recommended fertilizer dose i.e., 25:50:25 N_2, P_2O_5 and K_2O/ha respectively under insecticides free condition with an objective to allow insect population builds up.

The population of insect pests, natural enemies and pollinators were recorded after one month of germination of seeds till harvest of the crop at weekly interval during morning hours (8-9.0 AM) by sweep net (flying insects), yellow sticky trap (white fly, jassids, natural enemies) and visual observation (Thrips, larval population, naural enemies, beetles) to assess the insect population associated with crop during different growth stages. The insects caught in the net were killed right away by placing them in a polythene bag containing ethyl-acetate-soaked cotton. The collected dead insects were brought into the laboratory, segregated into various groups viz., coleopterans, lepidopterans, dipterans, hemipterans, hymenopterans, orthopterans, parsitoids, predators, spiders, pollinators and their population was counted. The insects were preserved both in dry and few in 70% ethyl alcohol and were later made identified by taxonomists. Yellow sticky traps were installed in the field at a distance of 10 meters and above the crop canopy to record the white fly and jassids population at weekly interval. In each plot, 20 flowers were collected at random and the number of thrips was counted by shaking of the flowers over a piece of white paper.

The dominance status of various taxa of the insect pests were described on the basis of relative abundance which determines the percentage of specimens of a given species in the total number of organism collected and the index of dominance was described with the following classes of domination as suggested by Slawinska and Jauekiew (2005).

<1 % = Subrecedent, 1-9% = Recedent

10-20 % = Sub-dominant, 21-30% = Dominant

31-60 % = Eudominant > 60 % = Superdominant

The diversity index to measure the species diversity in a community like Simpson's Index of Diversity and Simpson's Reciprocal Index were worked based on the methods suggests by Simpson (1949).

Simpson's index (D) : It means the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species) and the formula for calculating D as follows.

$$D = \frac{\sum n\,(n\text{-}1)}{N\,(N\text{–}1)}$$

Where n = The total number of organisms of a particular species.

N = The total number of organism of all species

Simpson's index of diversity (SID): 1-D

The value of this index ranges between 0 and almost 1, the greater the value, the greater the sample diversity. The index represents the probability that two individuals randomly selected from a sample will belong to different species. It is influenced by richness and evenness of the occurring species.

Simpson's reciprocal index: 1/D

This index's value begins with 1 as the lowest possible figure. This figure represents a community with only one species. The greater the value, the greater the variety. The number of species in the sample is the maximum value.

Equitability or evenness (E_0) was calculated by taking Simpson's Index (D) and expressing it as a proportion of the maximum value D. The equitability takes a value between 0, and 1 with 1 being considered as complete evenness.

The Simpson's index (D) which is a simple mathematical measure that characterizes species diversity in a community can also be worked out by taking the proportion of species relative to the total number of species (p_i) and squared. The squared proportions for all the species are summed and the reciprocal is taken as per the following:

$$D = \frac{1}{\sum_{i=1}^{s} P_i^2}$$

$$\text{Evenness } (E_D) = \frac{D}{D_{max}} = \frac{1}{\sum_{i=1}^{s} P_i^2} \times \frac{1}{S}$$

Where, D = Simpson's diversity index
Pi = Proportion of S made up of the i^{th} species
S = Total number of species in the community (richness).

RESULTS AND DISCUSSION

Field experiment was carried out during *rabi* 2021 and data were generated on biodiversity of insects and their succession in black gram crop. The results obtained from the present investigation are presented here under along with the tables and the figures.

Biodiversity of insects in black gram crop at Bhawanipatna

Biodiversity study of insects at Bhawanipatna which is coming under western undulating zone of Odisha revealed that about twenty seven numbers of insects have been recorded in an overlapping manner during the various phases of crop growth in blackgram. The insects belongs to seven orders are i.e., coleoptera, lepidoptera, hemiptera, homoptera, thysanoptera, diptera and orthoptera, which are coming under twenty two families i.e., acrididae, trigonidiidae, chrysomelidae, cicadellidae, pyralidae, aphididae, aleurodidae, curculionidae, coreidae, delphacidae, pentatomidae, thripidae, agromyzidae, arctidae, noctuidae, lycaenidae, pterophoridae, phycitidae, chrysomelidae, meloidae, membracidae and cercopidae (Table 1). During the crop periods, twelve predators, three parasitoids, and two pollinators were counted (Table 2). Seventy numbers of insects were previously reported by Nayak *et al*. (2005), 30

Table 1. Biodiversity of insect in black gram crop at Bhawanipatna during *rabi* 2021.

Sl. No.	Common name	Scientific family	Order and family	Damaging stage of the Insect	Plants part damage
1	Grasshopper	*Atractomorpha* sp. *Patanga japonica* *Oxya velox*	Orthoptera Acrididae	Nymphs and adults	Leaves
2	Cricket	*Trigonidium* sp.	Orthoptera Trigonidiidae	Nymphs and adults	Leaves
3	Galerucid beetle	*Madurasia obscurella*	Coleoptera Chrysomelidae	Adults	Leaves
4	Jassida	*Nephotettix* sp. *Empoasca kerri*	Hemiptera Cicadellidae	Nymphs and adults	Sap sucking on leaves
5	Leaf webber	*Grapholita critica*	Lepidoptera Pyralidae	Larva	Leaf webbing and scrapping
6	Aphids	*Aphis craccivora*	Hemiptera Aphididae	Nymphs and adults	Sap sucking on leaves, stem and pods
7	White fly	*Bemisia tabaci*	Homoptera Aleurodidae	Nymphs and adults	Sap sucking on leaves
8	Gray weevil	*Mylloceros* sp.	Coleoptera Curculionidae	Adults	Leaves
9	Pod bug	*Clavigralla gibbosa* *Riptortus* sp.	Hemiptera Coreidae	Nymphs and adults	Sap sucking on pods
10	Plant bug	*Nilaparvata lugens*	Hemiptera Delphacidae	Nymphs and adults	Sucking pest
11	Pentatomid bug	*Nezara viridula* *Bagrada* sp.	Hemiptera Pentatomidae	Nymphs and adults	Sap sucking on pods
12	Thrips	*Magalothrips* sp.	Thysanoptera Thripidae	Nymphs and adults	Sap sucking on flowers
13	Pod fly	*Melanagromyza* sp.	Diptera Agromyzidae	Maggot	Pod
14	Stem fly	*Ophiomyia phaseoli*	Diptera Agromyzidae	Maggot	Stem
15	Hairy caterpillar	*Spilarctia oblique* *Amsacta moorei*	Lepidoptera Arctidae	Larva	Leaves
16	Gram pod borer	*Helicoverpa armigera*	Lepidoptera Noctuidae	Larva	Leaves, pod
17	Tobacco caterpillar	*Spodoptera litura*	Lepidoptera Noctuidae	Larva	Leaves, pod
18	Semilooper	*Plusia* sp.	Lepidoptera Noctuidae	Larva	Leaves, pod
19	Blue butterfly	*Lampides boeticus*	Lepidoptera Lycaenidae	Larva	Flowers and pod
20	Spotted pod borer	*Maruca vitrata*	Lepidoptera Pyralidae	Larva	Pod borer
21	Plume moth	*Exelastis atomosa*	Lepidoptera Pterophoridae	Larva	Pods
22	Pea pod borer	*Etiella zinckenella*	Lepidoptera Phycitidae	Larva	Pods
23	Flea beetle	Unidentified	Coleoptera Chrysomelidae	Adult	Leaves
24	Coreid bug	*Cletus* sp.	Hemiptera Coreidae	Nymphs and adults	Plant parts and pods
25	Blister beetle	*Mylabris pustulata*	Coleoptera Meloidae	Adults	Buds and flowers
26	Cow bug	*Otinotus oneratus*	Hemiptera Membracidae	Nymphs and adults	Stems
27	Spittle bug	Unidentified	Hemiptera Cercopidae	Nymphs and adults	Leaves and stems

Table 2. Biodiversity of natural enemies and pollinators biodiversity in black gram crop at Bhawanipatna during *rabi* 2021.

Sl. No.	Scientific family/ Common name	Order and family	Predators and parasitoids
1	*Apanteles* sp.	Hymenoptera Braconidae	Parasitoid
2	Unidentified	Hymenoptera Ichneumonidae	Parasitoid
3	Unidentified	Hymenoptera Chalcididae	Parasitoid
4	*Polisters* sp.	Hymenoptera	
	Vespa sp.	Vespidae	Predator
5	*Menochilus sexmaculatus* *Coccinella transversalis* *Micraspis discolor* *Illeis cincta* *Micraspis univittata*	Coleoptera Coccinellidae	Predator
6	*Cantheconidia* sp.	Hemiptera Pentatomidae	Predator
7	*Chrysoperla* sp.	Neuroptera Chrysopidae	Predator
8	Assassin bug	Hemiptera Reduviidae	Predator
9	Preying mantis	Mantodea Mantidae	Predator
10	Mirid bug	Hemiptera Miridae	Predator
11	Spider (Unidentified)	Araneae	Predator
12	Rove beetles (*Paederus* sp.)	Coleoptera Staphylindae	Predator
13	Ground beetles	Coleoptera Carabidae	Predator
14	Dragon flies	Odonata Aeshnidae	Predator
15	Ants	Hymenoptera Formicidae	Predator
16	*Apis dorsata*	Hymenoptera Apidae	Pollinator
17	*Xylocopa* sp.	Hymenoptera Apidae	Pollinator

numbers by Dhuri and Singh (1983), 25 numbers by Duraimurugan and Tyagi (2014), 16 numbers by Chandra *et al.* (2010), 13 numbers by Yadav and Patel (2015) and 10 numbers by Rajawat *et al.* (2021) of insects at different growth stages of blackgram crop in overlapping manner at different location in India.

Species diversity index and evenness

The diversity of the different orders of insects during the meteorological weeks (42 SMW-50 SMW) of the crop revealed that the number of individuals varies between 31-627 with the diversity index of 0.523 - 0.902. The diversity of insects in different orders was almost uniform because of the evenness of the species. At 43 SMW and 44 SMW the diversity indices reduced to 0.523 and 0.573 with the evenness of 0.605 and 0.520 respectively (Table 3). Based on the results, the highest diversity index and evenness were recorded at 42 SMW (0.902 and 1.000) followed by 50 SMW (0.833 and 0.710) respectively. The evenness value of 1.0 indicates the maximum possible evenness in the community. Present study revealed high evenness would indicate a high diversity and probably healthy condition of a fauna and was in agreement with De Jong (1975), who had reported positive correlation exists between diversity and evenness.

Table 3. Species diversity and evenness of insects belongs to different orders in black gram at Bhawanipatna during *rabi* 2021.

MSW	No. of individuals	Simpsons index (D)	Simpsons index of diversity (1-D)	Simpson's reciprocal index (1/D)	Evenness (E)
42	104	0.097	0.902	1.000	1.000
43	31	0.476	0.523	2.100	0.605
44	109	0.427	0.573	2.082	0.520
45	220	0.291	0.708	3.084	0.064
46	627	0.265	0.734	3.608	0.601
47	309	0.214	0.785	4.174	0.695
48	214	0.166	0.833	4.858	0.607
49	260	0.207	0.792	4.209	0.526
50	241	0.166	0.833	4.971	0.710

The diversity of the insects during the meteo-

Table 4. Species diversity and evenness of different insect pests in black gram at Bhawanipatna during *rabi* 2021.

MSW	No. of individuals	Simpsons index (D)	Simpsons index of diversity (1-D)	Simpson's reciprocal index (1/D)	Evenness (E)
42	246	0.509	0.490	1.960	4.086
43	336	0.819	0.180	1.220	0.403
44	579	0.951	0.048	1.051	0.262
45	852	0.669	0.330	1.490	0.247
46	1698	0.755	0.244	1.320	0.220
47	1653	0.895	0.104	1.117	0.159
48	905	0.913	0.086	1.095	0.156
49	419	0.376	0.623	2.659	0.364
50	566	0.831	0.169	1.200	0.239

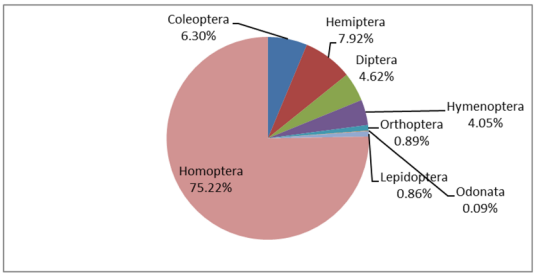

Fig. 1. Order-wise relative abundance of insects in black gram crop during *rabi* 2021 at Bhawanipatna, Odisha.

rological weeks (42 SMW-50 SMW) of the crop revealed that the number of individuals varies between 246-1698 with the diversity index of 0.048 - 0.623. The diversity was found almost uniform because of the evenness of the species. At 43 SMW and 44 SMW the diversity indices reduced to 0.048 and 0.086 with the evenness of 0.262 and 0.156 respectively as presented in Table 4.

Abundance and dominance status of insects in black gram

The relative abundance and dominant status of insect's population during different growth stages in black gram revealed that the maximum number of insects was belong to order homoptera (75.22%) followed by hemiptera (7.92%), coleoptera (6.30%), diptera (4.62%), hymenoptera (4.05%), orthoptera (0.89%), lepidoptera (0.86%) and odonata (0.09%) (Fig. 1).

It was observed that the insects belongs to order homoptera came under superdominant class during all the growth stages of the crop i.e., vegetative, flowering to podding and podding to pod maturity stage with overall mean of 75.22% (Table 5). The insect orders coleoptera and hemiptera were categorized under sub-dominant class at vegetative stage and flowering to podding stage of crop growth respectively. This confirms that galerucid beetle and flea beetle were important insects during vegetative stage of crop. The overall dominance status of insect orders revealed that hemiptera, coleoptera, diptera and hymenoptera were categorized under recedent class with overall mean percentage of 7.92, 6.30, 4.62 and 4.05 respectively. The insect order came under sub-recedent class were lepidoptera, orthoptera and odonata with the overall mean percentage of 0.86. 0.89 and 0.09, although the class of lepidoptera during vegetative and podding to maturity stage of crop growth was recedent class of dominance (Table 5).

Present study revealed that only white fly came under superdominant class during all the three stages of crop growth with over all percentage mean of 87.36. The galerucid beetle came under sub-dominant class during vegetative stage of crop with mean % of 9.73 and it conforms that it is an important insect during vegetative stage of black gram. The insects like the galerucid beetle, jassid, stem fly, aphids and thrips were categorized under recedent class of dominance with overall % mean of 3.39, 2.76, 2.58, 2.27 and 1.17 respectively followed by semilooper under sub-recedent class (Table 6).

Succession of insects during different growth

Table 5. Relative and overall abundance and dominance status of insects orders in black gram during different stages at Bhawanipatna during *rabi* 2021.

	Vegetative stage		Flowering to podding stage		Podding to pod maturity stage		Overall mean (%)	
Name of the orders	Mean (%)	Dominant class	Mean (%)	Dominant class	Mean (%)	Dominant class	Mean (%)	Dominant class
Coleoptera	13.07	Sub-dominant	4.61	Recedent	5.60	Recedent	6.30	Recedent
Hemiptera	5.86	Recedent	9.32	Sub-dominant	8.56	Recedent	7.92	Recedent
Diptera	1.29	Recedent	5.30	Recedent	4.90	Recedent	4.62	Recedent
Hymenoptera	0.00	Subrecedent	3.18	Recedent	8.07	Recedent	4.05	Recedent
Orthoptera	0.68	Subrecedent	0.85	Subrecedent	1.04	Recedent	0.89	Subrecedent
Odonata	0.00	Subrecedent	0.28	Subrecedent	0.56	Subrecedent	0.09	Subrecedent
Lepidoptera	1.06	Recedent	0.30	Subrecedent	2.51	Recedent	0.86	Subrecedent
Homoptera	78.00	Superdominant	76.00	Superdominant	68.70	Superdominant	75.22	Superdominant

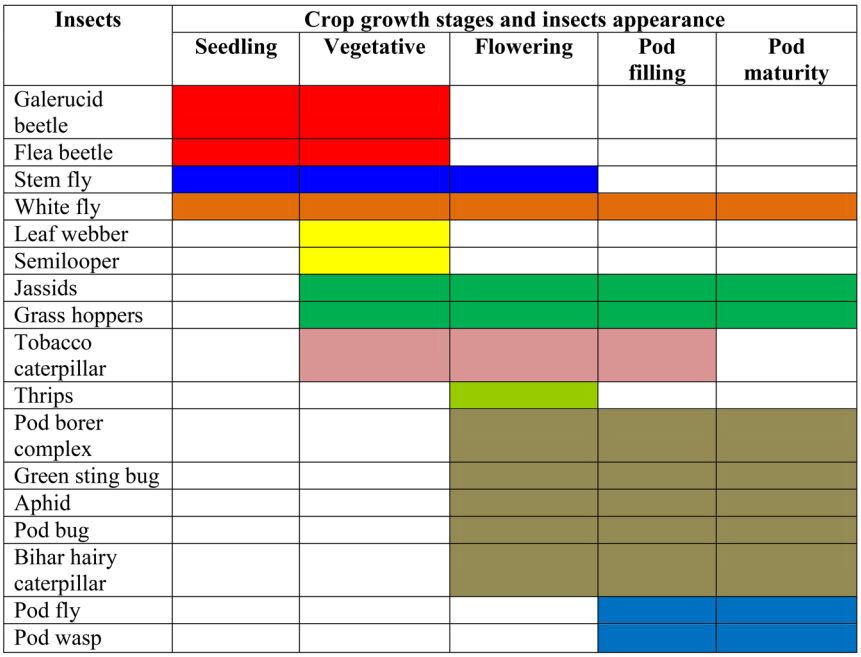

Fig. 2. Pest succession of major insect pests in black gram at Bhawanipatna, Odisha during *rabi* 2021.

stages

Insect pests, their natural enemies and pollinators were recorded in an overlapping manner at different growth stages of black gram (Fig. 2). Insect population were low in the first third weeks i.e., seedling stage of the crop. During this stage of the crop growth the insects recorded were galerucid beetle, flea beetle followed by stem fly and remain active till flowering stage. Stem fly, *Ophiomyia phaseoli* appeared first in black gram crop i.e., two weeks after germination as reported earlier by Sain *et al.* (2020) and Yadav *et al*. (2020). According to Menon and Saxena (1970) and Srivastava and Singh (1976) *M. obscurella* was a serious insect of the black gram in the early stage of crop. Urdbean was first attacked by galerucid beetle, when the crop was just in two leaf stage and remained active till flowering both in *kharif* and summer season was well documented, Nayak *et al.* (2005).

Soon after, whitefly (*Bemisia tabaci*) and jassid (*Empoasca kerri*) appeared and their presence were

Table 6. Relative abundance and dominance status of insects in black gram during different growth stages at Bhawanipatna during *rabi* 2021.

Name of the insects	Vegetative stage Mean (%)	Dominant class	Flowering and podding stage Mean (%)	Dominant class	Podding and pod maturity stage Mean (%)	Dominant class	Overall mean (%) Mean (%)	Dominant class
Whitefly	88.37	Superdominant	88.72	Sperdominant	84.01	Superdominant	87.36	Superdominant
Jassid	0.00	Subrecedent	3.56	Recedent	2.65	Recedent	2.76	Recedent
Thrips	0.00	Subrecedent	0.64	Recedent	3.08	Recedent	1.17	Recedent
Aphids	0.00	Subrecedent	0.00	Subrecedent	8.76	Recedent	2.27	Recedent
Stem fly	0.77	Subrecedent	3.80	Recedent	0.95	Subrerecedent	2.58	Recedent
Galerucid beetle	9.73	Sub-dominant	2.97	Recedent	0.42	Subrecedent	3.39	Recedent
Semilooper	1.11	Recedent	0.28	Subrecedent	0.10	Subrecedent	0.47	Subrecedent

noticed throughout the crop period. According to Sain *et al.* (2020) and Ojha *et al.* (2022), whitefly and jassid were appeared black gram crop at early stage and continued throughout the crop periods. The population of sucking pests starting from 2nd week of sowing and appeared throughout the crop growth period was well documented by Radhika *et al.* (2018). Whitefly appeared in seedling stage (15-21 days after sowing) and their incidence was noticeable throughout the growth season, reaching its peak activity at 50-56 days after sowing in *kharif* and summer green gram and black gram crop have been reported earlier by Duraimurugan and Tyagi (2014).

Different species of grasshoppers (*Atractomorpha* sp., *Patanga japonica* and Oxya velox) were noticed during vegetative stage and their population was noticed throughout the growth season. According to Yadav *et al.* (2020) black gram crop was attacked by the nymphs and adults of grasshoppers at the vegetative stage and young pod stage. Present study revealed that there was no any definite pattern of population growth during crop periods.

The semilooper, *Trichoplusia* ni incidence was noticed first at the vegetative stage of the crop and was followed by *Spodoptera litura* and leaf webber. The foliage feeding insects viz., *Spodoptera litura*, *Spilosoma oblique* and *Trichoplusia* ni infestation from vegetative to pod maturity stage *in* black gram was well documented by Yadav and Patel (2015). The occurrence of different species of coccinellids beetles were appeared first during vegetative stage and were noticed throughout the crop season.

The incidence of thrips were noticed during the flowering to podding stage and their infestation was restricted to flowers only. The infestation of thrips from flowering to pod filling stages in black gram has been reported earlier by Chandra and Rajak (2004).

The pytophagous bihar hairy caterpillar (*Spilosoma obliqua*) and red hairy caterpillar (*Amsacta moori)* were recorded from flowering till crop maturity stage. Among the pod borer complex the blue butterfly, *Catocrysops cajanus* appeared first during flowering stage and followed by spotted pod borer, *Maruca testulalis* and continued till pod maturity stage of the crop and was also reported earlier by Sain *et al.* (2020). Ojha *et al.*(2022) observed *M. vitrata* from 29 DAS at the reproductive stage and continued till maturity of the crop in green gram crop. According to Nayak *et al*. (2005) after six weeks crop growth of urdbean, when the crop is in flowering and podding stage, thrips and pod borers (*L. boeticus, Helicoverpa armigera* and *Maruca* sp.) were observed and caused damage. Larvae of blue butterfly, *Lampides boeticus* and pod borer, *Helicoverpa armigera* exhibited their incidence from flowering to pod formation stage while *Maruca vitrata* appeared from flowering stage to pod maturity. During the flowering and pod formation, the pod borers such as *Maruca* sp., *Helicoverpa armigera* and *Lampides boeticus* were noticed and caused damage to the flowers and pods.

Different species of bugs viz., pentatomid bug and pod bugs (*Riptortus* sp and *Clavigralla* sp.), mirid bugs, coreids bugs, spittle bugs were noticed during the study period. However, the pentatomid bugs (*Nezara virudula*) were recorded from flowering to pod maturity stage and the pod bugs (*Riptortus* sp. and *Clavigralla* sp.), mirid bugs, coreids bugs were appeared in the pod filling stage and continued till maturity stage of the crop. According to Duraimurugan and Tyagi (2014) pod bugs were observed during pod formation stage of green gram and black gram and remained active till pod maturation. The maximum bug i.e., *Nezara viridula, Clavigralla gibbosa* and *Riptortus* sp. infestation has been reported earlier by Nayak *et al.* (2005) during flowering to podding stage of black gram crop.

The aphid population was noticed from flowering stage of the crop and continued till harvest of the crop. However the present result is contradictory to earlier reports, Sain *et al.* (2020), who had reported that aphid incidence was generally noticed during vegetative stage of the crop.

Pod fly and pod wasp were appeared from pod filling to maturity stage of crop. According to Nayak *et al.* (2005) pod fly is the important insect of black gram during pod maturity stage of crop. The insect predators like spiders, coccinellid beetles and parasitoids were recorded throughout the crop growth period and same finding was reported earlier by

Nayak *et al*. (2005).

CONCLUSION

The findings of the present study on insect biodiversity and their succession can be utilized by the entomologists for the development of IPM program against insect pests of black gram for the Western undulating zone of Odisha. Higher incidence of insects and natural enemies were recorded during the reproductive to pod maturity stage of the crop, so farmers are advised for two round spray of insecticides, one during flowers initiation stage and second at pod initiation stage for an economically feasible and viable, ecologically sound and socially acceptable pest management program. Spraying of chemical molecules should be avoided during podding to pod maturity stage of crop to save the natural enemies.

ACKNOWLEDGMENT

I would like to show my profound and sincere gratitude to Dr. Sandeepta Kumar Nayak sir, Associate Professor, Department of Entomology, College of Agriculture (OUAT), Bhawanipatna and Chairman of my Advisory Committee for giving me the opportunity to do research and providing invaluable guidance throughout the research. I'd like to express my appreciation and gratitude to Dr J Padhi Sir, Professor and Head, Department of Entomology, College of Agriculture, OUAT and member of my Advisory Committee for his immense amount of support throughout my entire research work. A debt of gratitude is owed to Dr Arabinda Dhal, Jr Pathologist and officer in charge, AICRP on forage crops and utilization, Directorate of Research, OUAT, Bhubaneswar, member of my Advisory Committee for his persistent help and indeed the positivity and encouragement that he has offered me throughout my dissertation.I would like to show my profound appreciation to Dr CR Satapathy Sir, Emeritus scientist, OUAT, Bhubaneswar who has the attitude and substance of a genius, who is a spirit of adventure in regard to research and an encouragement in regard to teaching. This dissertation would not have been possible without his guidance and perseverance. I would like to owe my special thanks to Deepayan Padhy Sir for his invaluable time, continual support and patience which has made my dissertation to complete successfully. I am extremely grateful to all the department staffs Baikuntha Bhaina, Kalpana mam along with my seniors Swapnalisha didi, Swagatika didi, Anjan Bhai, Sashank bhai who have always offered me a helping hand to accomplish my thesis.

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