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Population Dynamics of Insect Pests and its Natural Enemieson Grain Amaranthin Relation with Weather Parameters

Anil[1*], Prabhu Ganiger[2] and Srinivas Reddy[2]

[1]*Department of Entomology, ICAR- Indian Agricultural Research Institute (IARI), New Delhi, India*
[2]*University of Agriculture Sciences, GKVK, Bangalore, India*
**Corresponding author*

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A B S T R A C T

Investigation on incidence of insect pests on grain amaranth was undertaken at MRS, Hebbal, Bengaluru. During study period, 19 insect pests have been recorded throughout the cropping period. Among these, Stem weevil, leaf webber, leaf eating caterpillar and sucking pests are the major one. Five natural enemies were recorded during the present investigation. The natural enemies viz., predatory lady bird beetle, *Cheilomenes sexmaculata*, *Cheilomenes vicina* (Muls) and *Propylea* sp. (Coleoptera: Coccinellidae) were found to be feed on aphids, Black bug, *Geocoris* sp., Assassin bug, *Irantha* sp. were attacking on *Spodoptera* sp. and braconid parasitoid, *Bracon* sp. (Hymenotera :Braconidae) on leaf webber were recorded. Stem weevil population per plant was negatively correlated with maximum temperature and positively correlated with other weather parameters. Whereas Leaf webber and Coreid bug was positively correlated with maximum temperature (0.43) and negatively correlated with minimum temperature.

Introduction

One of the greatest limiting factors in increasing the productivity of leaf amaranth is the damage caused by wide range of insect pests in general, whereas defoliators can cause economic loss (Akinolosotu, 1977). Aderolu *et al.*, (2013) reported 60 insect species associated with amaranthus crop. *Hymenia recurvalis* caused 8.8 per cent infestation, however, *H.recurvalis* and *Psarabasalis* were also common. Agarwal (1985) reported *Hypolixus* sp., is a major pest in cultivated amaranth. Leaf miner, *Liriomyza* sp. (Sorensen, 1995), aphid, *Myzus persicae* are major pest of amaranthus causing leaves to curl and become unattractive for marketing (Picker *et al*., 2004; Okunlola *et al.*, 2008). Richard (1989) reported that the leaf worms or cutworms *Spodoptera* sp., attack young seedlings.

Amaranth leaf webber or webworm larvae fold or web amaranth leaves using their silken webs and feed within the leaves. *Hymenia recurvalis, Psarabasalis, Herpetograma bipunctalis* are major pests of grain amaranth (Batra and Bhattacherjee, 1960; Bhattacherjee *et al.*, 1964 Clarke-Harris *et al.*, 2003; James *et al.*, 2010 and Grovida, 2015). Information on insect pests of grain amaranth with its natural enemies is scanty. The insect pests

occurring on grain amaranth is not much work carried out in India. Based on this information efforts were made to study was under taken.

Materials and Methods

Population dynamics of insect pests and natural enemies occurring on grain amaranth

Insect pests and natural enemies were collected from amaranth crop from MRS, Hebbal, Bengaluru. Slow moving and sedentary insects were collected by hand using the poison bottle. The plants were examined visually for insect pests and specimens were collected in vials containing 70 per cent alcohol (immature and soft bodied insects), labelled and taken to the laboratory. Beating sheets were used to collect camouflaged or hidden insect pests. Flying insects were collected using aerial nets. Insect pests were collected and preserved for identification. Natural enemies were also collected and preserved for identification.

A field experiment was laid out with plot size was 3.0×3.6m. Incidence of insect pest and natural enemies on grain amaranth were recorded at weekly intervals by randomly selecting five plants and later pest population and natural enemy population was correlated with weather parameters *viz.,* temperature (°C), relative humidity (%) and rainfall (mm).

The grain amaranth crop was cultivated by following the package of practices recommended by UAS, GKVK, Bengaluru under protected irrigation except plant protection measures.

Results and Discussion

Incidence of major insect pests of grain amaranth

The observations on insect pests and their natural enemies were recorded (Table 1 and 2) at weekly interval till harvest of the crop with (Table 3, 4 and 5 with Fig. 1 and 2).

Stem weevil, *Hypolixus truncatulus* (Fab.) (Coleoptera: Curculionidae)

The activity of stem weevil was noticed at seedling stage of the crop i.e. last week of September, 2016 39thStandard Meteorological Week (SMW) and recorded 0.94weevils per plant. The population of stem weevil increased gradually and reached peak (1.17 weevil/plant) during 43rd SMW. Stem weevil population was low (0.36 weevil per plant) at grain filling stage

Leaf webber, *Hymenia recurvalis* (Fab). (Lepidoptera: Crambidae)

The activity of leaf webber was observed at seedling stage of the crop i.e. first week of October, 2016 i.e. 40th SMW and recorded 0.50 caterpillars per plant. Leaf webber population gradually increased and reached the first peak. (1.57 caterpillar per plant) during 44th SMW and the second peak (1.64) was at 46th SMW. Leaf webber population gradually decreased (0.49) towards harvest of the crop

Ash weevil, (*Myllocerus discolor* and *Myllocerus dorsatus*) (Coleoptera: Curculionidae)

The incidence of ash weevil was observed from seedling stage of the crop i.e. last week of September, 2016 (39th SMW) and the population was 0.44 weevils per plant. Later population increased to 0.47 per plant during 40th SMW. The population was low (0.43) at 41st SMW and the weevil population was negligible during vegetative stage ranging from 0.10 to 0.17 per plant. The peak population (0.65) was noticed towards harvesting stage on 48th SMW.

Leaf eating caterpillar, *Spodoptera* sp. (Lepidoptera: Noctuidae)

The activity of leaf eating caterpillar started from seedling stage of the crop i.e. last week of September, 2016 (39th SMW) and the caterpillar population was 0.10 per plant. The population reached peak (0.84 caterpillars per plant) at43rd SMW i.e. at vegetative stage of the crop. At grain filling stage of crop the population decreased to 0.37 caterpillars per plant at 47th SMW.

Grasshopper, (*Neorthacris acuticeps* and *Gastrimargus* sp.) (Orthoptera: Acrididae)

The incidence of grasshoppers were observed from seedling stage of the crop i.e. last week of September, 2016 (39th SMW) and recorded 0.24 grasshopper per plant. The population reached peak on 40th SMW with 0.53 grasshoppers per plant at seedling stage. The population was fluctuating from flowering to grain filling stage. The population increased again on 44th SMW (Standard Meteorological Week) and recorded 0.37 grasshoppers per plant and low population (0.31) during 47th SMW.

Ear-head caterpillar, *Helicoverpa armigera* (Hub.) (Lepidoptera: Noctuidae)

The incidence of ear head caterpillar was observed from flowering stage of the crop i.e. last week of October, 2016 (43rd SMW) and recorded 0.40 caterpillar per plant. The population reached peak 0.47 caterpillars per plant during 44th SMW at grain filling stage. Later on during 47th and 48th SMW the population showed an increasing trend ranging from 0.30-0.49 caterpillar per plant.

Nineteen insect pests have been recorded throughout the cropping period. *Hymenia recurvalis* Fab. was found feeding on the crop throughout the growing period of amaranth. Similar reports on *H. recurvalis* has been reported by several workers *viz.,* Batra and Bhattacharjee (1960); Aderolu *et al.,* (2013) and Kigali *et al.,* (2013). Tobacco cut worm, *Spodoptera litura* (F.) was also observed to feed on leaves of amaranth during cropping period from seedling to grain filling stage. Similar reports on this pest were also reported by Aderlou *et al.,* 2013.

Hairy caterpillar, *Euproctis* sp. was observed and it defoliated the leaves of amaranth. Similar damage by hairy caterpillar *Spilosoma obliqua* was also reported by Manjula (2014) where larvae scraped the chlorophyll content of the amaranth leaf and later defoliated the plants completely. Two species of grasshoppers, *Neorthacris acuticeps* and *Gastromorpha* sp. were recorded on foliage of amaranth. Both nymphs and adults were found feeding on foliage and shoots. *N. acuticeps* was also reported on amaranth by Garcia *et al.,* (2011); Manjula (2014) and Aderlou *et al.,* (2013).

Stem weevil (*Hypolixus truncatulus*) was noticed on grain amaranth. Both grub and adult caused damage to the crop from seedling to flowering stage of the crop, which confirms the earlier reports of Aderolu *et al.,* (2013). The results of Torres *et al.,* (2011) and Lopez *et al.,* (2011) study revealed that the infestation of weevil was noticed almost during entire cropping period. Weevil population increased gradually as the crop grew but declined at crop maturity stage. The females oviposit in the stems, larvae fed by tunneling through the stem. This pest resulted in significant crop loss especially by foliage damage. The weevil cause considerable damage on leaves and stems of amaranth.

Table.1 Insect pests recorded on grain amaranth at MRS, Hebbal, Bengaluru

Sl. No.	Common Name	Scientific Name	Family	Order
1	Ear head caterpillar	*Helicoverpa armigera* (Hub.)	Noctuidae	Lepidoptera
2	Leaf webber	*Hymenia recurvalis* (Fab.)	Crambidae	Lepidoptera
3	Stem weevil	*Hypolixus truncatulus* (Fab.)	Curculionidae	Coleoptera
4	Leaf beetle	*Gametis versicolor* (Fab.)	Cetonidae	Coleoptera
5	Brown strippedbeetle	*Clinteria kluge* (Hope.)	Scarabaeidae	Coleoptera
6	Seed bug	*Spilostetchus hospes* (Fab.)	Lygaeidae	Hemiptera
7	Green bug	*Nezaraviridula*	Pentatomidae	Hemiptera
8	Seed bug	*Graptostetchus servus* (Fab.)	Lygaeidae	Hemiptera
9	Amaranth bug	*Cletus* sp. (Fab.)	Coreidae	Hemiptera
10	Horned coreid bug	*Cletomorpha* sp.(Fab.)	Coreidae	Hemiptera
11	Mirid bug	*Eurystylus* sp.(Stal.)	Miridae	Hemiptera
12	Yellow winged grasshopper	*Gastrimargus* sp.	Acrididae	Orthoptera
13	Wingless grasshopper	*Neorthacris acutipceps* (Bol.)	Pyrgomorphidae	Orthoptera
14	Stink bug	*Halyomorphapicus* (Fab.)	Pentatomidae	Hemiptera
15	Seed bug	*Nysius species* (Dall.)	Lygaeidae	Hemiptera
16	Ash weevil	*Myllocerus discolor*(Boh.)	Curculionidae	Coleoptera
17	Myllocerus weevil	*Myllocerus dorsatus*(Fab.)	Curculionidae	Coleoptera
18	White spotted flea beetle	*Monolepta signata* (Oliv.)	Chrysomeliae	Coleoptera
19	Stink bug	*Dolicoris indicus* (Mulst.)	Pentatomidae	Hemiptera

Table.2 Natural enemies on insect pests of grain amaranth at MRS, Hebbal, Bengaluru

Sl. No.	Common Name	Scientific Name	Family	Order
1	Ladybird beetle	*Cheilomenes sexmaculata* *Cheilomenes vicina* (Muls.)	Coccinellidae	Coleoptera
2	Fourteen spotted ladybird beetle	*Propylea* sp.	Coccinellidae	Coleoptera
3	Black bug	*Geocoris* sp.	Geocoridae	Coleoptera
4	Assassin bug	*Irantha* sp.	Reduviidae	Hemiptera
5	Braconidparasitoid	*Bracon* sp.	Braconidae	Hymenoptera

Table.3 Incidence of defoliators and ear head caterpillar on grain amaranth at MRS, Hebbal, Bengaluru

Standard Met. Week	Date of observation	Number of insect pests per plant					
		Stem weevil	Leaf Webber	Ash weevil	Grasshopper	*Spodoptera*	Ear head caterpillar
39	28/09/2016	0.94	0.00	0.44	0.24	0.10	0.00
40	04/10/2016	0.94	0.50	0.47	0.53	0.14	0.17
41	10/10/2016	0.74	0.57	0.43	0.37	0.07	0.00
42	16/10/2016	0.81	0.77	0.10	0.16	0.30	0.00
43	22/10/2016	1.17	0.71	0.20	0.30	0.84	0.40
44	28/10/2016	0.4	1.57	0.17	0.37	0.44	0.47
45	03/11/2016	0.38	1.27	0.10	0.30	0.07	0.20
46	09/11/2016	0.37	1.64	0.10	0.27	0.13	0.20
47	15/11/2016	0.57	1.29	0.14	0.31	0.37	0.32
48	20/11/2016	0.36	0.49	0.65	0.16	0.16	0.49

Table.4 Incidence of sucking pests on grain amaranth at MRS, Hebbal, Bengaluru

SMW*	Date of observation	Mean number of insect pests per plant			
		Aphids/6leaves/plant.	Horned Coreid bug	Coreid bug	Green bean bug
39	28/09/2016	0.00	1.83	1.22	0.16
40	04/10/2016	0.00	1.50	1.00	0.15
41	10/10/2016	0.02	1.91	1.27	0.02
42	16/10/2016	0.00	1.34	0.89	0.02
43	22/10/2016	0.02	1.51	1.00	0.18
44	28/10/2016	0.02	2.04	1.36	0.27
45	03/11/2016	0.07	1.63	1.09	0.05
46	09/11/2016	0.00	2.10	1.38	0.00
47	15/11/2016	0.00	1.82	2.04	0.02
48	20/11/2016	0.04	4.08	1.38	0.00

* Standard Meteorological Week

Table.5 Incidence of natural enemies on insect pests of grain amaranth at MRS, Hebbal, Bengaluru

SMW*	Date of observation	Mean no. of lady bird beetle	Parasitization (%)
39	28/09/2016	0.17	0.03
40	04/10/2016	0.17	0.04
41	10/10/2016	0.13	0.00
42	16/10/2016	0.00	0.00
43	22/10/2016	0.03	0.00
44	28/10/2016	0.20	0.00
45	03/11/2016	0.07	0.00
46	09/11/2016	0.00	0.00
47	15/11/2016	0.04	0.00
48	20/11/2016	0.40	0.00

* Standard Meteorological Week

Table.6 Correlation of major insect pests of grain amaranth with weather parameters

Insect pests	Temperature (%)		RH (%)		RF (mm)
	Max.	Min.	Morning	Afternoon	
Stem weevil	-0.42	0.50	0.34	0.53	0.25
Leaf webber	0.43	-0.14	-0.64*	-0.38	-0.49
Earhead caterpillar	0.59	-0.62	-0.59	-0.71*	-0.60
Ash weevil	-0.34	-0.13	0.63*	0.23	0.40
Leaf eating caterpillar	0.20	-0.09	-0.57	-0.20	-0.38
Coried bug	0.42	-0.68*	-0.35	-0.60	-0.07
Horned coreid bug	-0.33	0.31	-0.04	0.28	-0.13

* Significant at 0.05 levels

Fig.1 Incidence of defoliator pests on grain amaranth

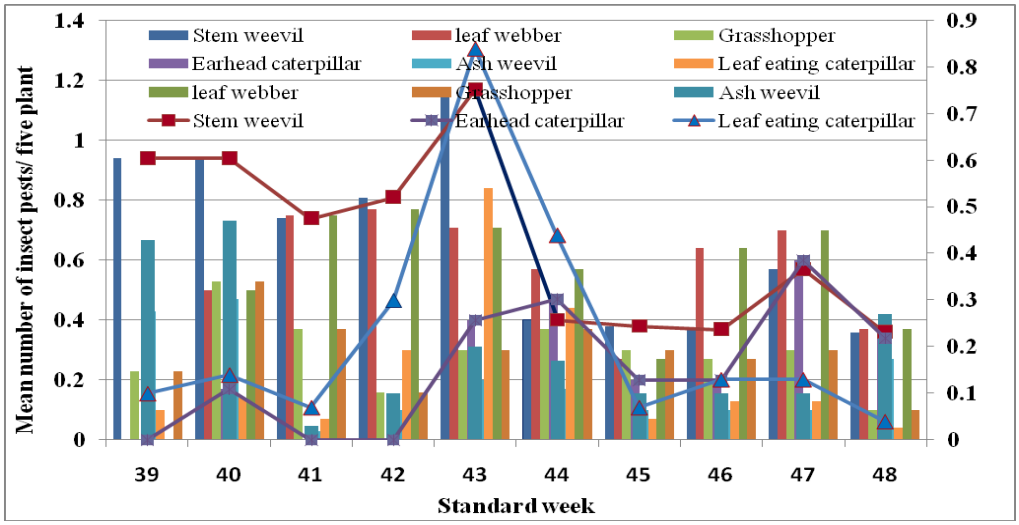
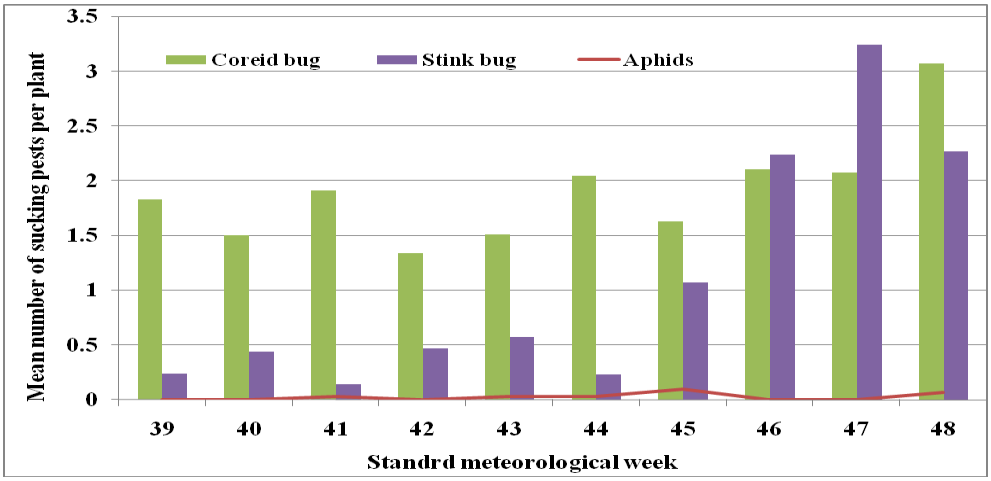


Fig.2 Incidence of sucking pests on grain amaranth



Sucking pests on grain amaranth

Aphids, *Aphis* sp. (Hemiptera: Aphididae): The incidence of aphid started from mid of the seedling stage of the crop i.e. second week of October, 2016 41st (SMW) and recorded 0.02 aphids per plant. The population of aphids reached peak 0.07 aphids per plant at 45th SMW at grain filling stage. The population was negligible (0.04) at harvest stage of the crop (Table 4).

Horned coreid bug, *Cletomorpha* sp. (Hemiptera: Coreidae)

The incidence of horned coreid bug commenced from seedling stage of the crop at 39thSMW and recorded 1.83 bugs per plant. The bugs were noticed throughout the cropping period. First peak of 1.91 bugs per plant was recorded during 41st SMW, second peak of 2.04 bugs per plant was observed during 44th SMW and last peak (2.1 bugs per plant) was recorded during 46th SMW. The bug population was at most peaks (4.08) at the end of harvest stage of the crop (Table 4).

Coreid bug, (*Cletus* sp.) (Hemiptera: Coreidae)

The activity of coreid bug was observed at seedling stage of the crop i.e. at 39th SMW and recorded 1.22 bugs per plant. The population reached its first peak (1.27) at 41st SMW and second peak 1.36 bugs per plant was recorded at 44th SMW. Further an increasing trend of bugs was noticed during grain filling stage and reached its at most peak (2.04 bugs/plant) at 47th SMW (Standard Meteorological Week) (Table 4).

Green bean bug, (*Nezaravi ridula*) (Hemiptera: Pentatomidae)

The activity of green bean bug was observed at seedling stage of the crop i.e. last week of September, 2016 (39th SMW) and recorded 0.16 bug per plant. The population decreased during two subsequent weeks i.e. 0.02 bugs per plant during 41st and 42nd SMW, respectively. Later the population of bugs reached peak 0.27 bugs per plant at 44th SMW and thereafter showed a decreasing trend towards grain filling stage of the crop (Table 4)

Aphid, *Aphis* sp. was noticed on grain amaranth. Both nymphs and adults were found to suck the sap and cause yellowing and drying of leaves. They were found in congregation on under surface of leaves and succulent stems, which conforms the earlier reports of Srivastava and Butani (2009). Pentatomid bug, *Nezaravi ridula* L. a green coloured bug was observed during the present investigation and found to suck the sap from the tender grains. Similar report of the pest was also reported by Garcia *et al.,* (2011) and Manjula (2014). Coreid bug was noticed on grain amaranth from seedling stage to crop maturity stage. It was found to suck the juice from the grains, causing shrinking and shriveling of grains. These findings are in line with the results of Oke and Ofuya (2011) on population dynamics of *Cletus* sp. on amaranth in Nigeria and its infestation started at milky stage and continued to accumulate as the crop growth advanced.

Natural enemies on insect pests of grain amaranth

Five natural enemies were recorded during the present investigation. Two species of predatory ladybird beetle were found to be feed on aphids. Mirid bug and reduviid bug were attacking *Spodoptera* sp. and *Bracon* sp. parasitoid on leaf webber. The results are in line with studies of Manjula (2014) who recorded four species of lady bird beetles predators on various pests of amaranth.

Lady bird beetle, *Cheilomenes sexmaculata* (Coleoptera: Coccinellidae)

The population of coccinellid grub was 0.17 grubs/ plant at 39thSMW. Later population of grubs decreased gradually at 44th SMW and recorded 0.20 grubs/ plant. Subsequently the population of grub was increased suddenly during 48thSMW with 0.4 beetles per plant (Table 5).

Braconidparasitoid, *Bracon* sp. (Hymenoptera: Braconidae)

The activity of braconid was observed from 39th SMW to 40th SMW and recorded 0.04 wasp /plant (Table 5).

Correlation of insect pests of grain amaranth with weather parameters

The average number of stem weevils per plant showed negative correlation with maximum temperature (-0.42), and positive correlation with remaining weather parameters. The number of leaf webber's per plant showed positive correlation with maximum temperature (0.43), and was negatively correlated with remaining weather parameters *viz.* minimum temperature (-0.14), highly significant negative correlation with morning relative humidity (-0.64) and negatively correlated with afternoon relative humidity (-0.38) and negatively correlated with rainfall. The number of ash weevil per plant showed negative correlation with maximum (-0.34) and minimum (-0.13) temperature and positive correlation with remaining weather parameters (Table 6).

Incidence of leaf eating caterpillar also showed positive correlation with maximum temperature (0.20) and negative correlation with remaining weather parameters. Incidence of coreid bug showed significantly negative correlation with minimum temperature (-0.68) and positive correlation with maximum temperature (0.42) (Table 6).

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