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Infestation of *Helicoverpa armigera* (Hubner) on Bajra, *Pennisetum glaucum* (L) in Anand district of Gujarat, India

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Abstract
A heavy incidence of *Helicoverpa armigera* was noticed on bajra crop during flowering as well as milking stage at Borsad taluka of Anand district in Gujarat. The incidence of larva/ear head was observed during the survey which showed more than four larvae per plant from the different village area during summer season. Due to infestation of ear head worm in bajra, the flowering and ear heads stages are heavily damaged which leads to the pollens and seeds are feeding by the early and later instar larvae (3rd to 5th instar larvae) of *H. armigera*. The bajra crop was showed reduction in grain formation and yield of crop as compared to earlier years as per the farmers view. During these summer season, the heavy infestation of *H. armigera* in bajra crop to almost all the areas of Borsad taluka of Anand district which showed habitat and behavioral change in the rigid noctuid pest.

Keywords: Helicoverpa armigera, bajra and survey

Introduction
A cereal crops which includes rice, wheat maize, sorghum, millet, barley, *etc*. is the staple food for most of the world's population. Cereals are grown over 73% of the total world harvested area which contribute over 60% of the world food production [3]. Among the cereals, bajra is also used as staple food for the developing countries in which it is called as pearl millet. It is commonly known as pearl, cat tail, spiked or bulrush millet in English is world's sixth important. Its botanical name is *Pennisetum glaucum* which belongs to the family of Gramineae with sub-family Peniceidae. In India, it is popularly known as Bajri in Rajasthani, Gujarati and Marathi,; Sajje in Kannada; Kambu in Tamil; Bajra in Hindi, Urdu and Panjabi and Sajjalu in Telugu [2]. In United States of America, Australia and South Africa, it is primarily grown as forage crop. Bajra is the fourth most important food grain crop after rice, wheat and sorghum in India. As an arid and semi-arid crop, bajra is the module of dry land eco-system which share of total food grain production of the country to the tune of 10.7 percent. India is the largest producer of this crop, both in terms of area (7.8 Million ha) and production (9.25 million ton), with an average productivity of 1270 kg/ha. The major pearl millet growing states in India are Rajasthan, U.P., Haryana, Gujarat and Maharastra [1]. Due to low yield potential also the crop is not applied with plant protection measures for the management of insect pests during the crop season. However, important high yielding hybrid varieties were attracted heavy incidence of insect pests. The crop is attacked by a number of insect pests, *viz*., Ear head worm, *Helicoverpa armigera* Hubner; Gujarat hairy caterpillar, *Amsacta moorei*; Army worm, *Cirphis unipuncta* H.; Stem borer, *Chilo zonellus*; Blister beetle, *Cylindrothorax ruficolis* F.; Shoot fly, *Atherigona varia socata* M.; Surface grasshopper, *Chrotogonus brachypterous* B. and White grub, *Holotrichia consanguinea* B[10]. *Helicoverpa armigera* is a highly polyphagous insect with 172 host plant species from 40 families that have been recorded in Australia, approximately 200 species from 30 families in China [7] and 46 species from 19 families in South Africa [6]. Over last few years a pest known as pearl millet ear head worm, *H. aremigera* Hubner is appearing in the summer sown bajra crop [2].

Materials and Methods
The present investigation was carried out for monitoring the activity of ear head worm on bajra plants during summer 2020 at Borsad taluka vicinity area of Anand district of Gujarat.

During the survey, there were ten randomly field of nearby village area was selected and the larval count was carried out from bajra plant during the summer season. There was two field/village selected for the survey work. The crop area was divided into 10 quadrates of size 1 m x 1 m. Three ear head were selected randomly from each quadrate for observation. Absolute population of larvae/ear head/plant was recorded in the morning hours. The mean data of larval population were collected from the each village area on bajra ear head. Initially the farmers were reported the incidence of *H. armigera* infestation on flowering stage of bajra during month of April in the villages Kanakapura, Kathol, Gorva, Dehvan, kalu, Badalpur, Kathana, Kanbha, Aniyad, Divel of Borsad taluka. Subsequently, the population of this pest was also infested milking stage and hard ear head stage of different villages like Ravadapura, Uneli, Chuva, Rudel and Kankapura of Borsad taluka. The area was surveyed for larval count numbers with the help of skilled farmers in the month of May on milking stage and hard ear head stage of bajra crop. The farmers were informed me for the incidence of this pest and the area was surveyed for the infestation during second week to fourth week of May, 2020. As the commencement of June, the bajra crop was harvested by the farmers.

Results and Discussion

The larvae were survey in the vicinity area of Borsad taluka nearby villages and it was found to damage the flowering and ear head stage of bajra crop. It was also found that it is the period of high temperature about more than 42 ^{0}C during the summer month. During this temperature range, no other crops are grown in the summer season of this area. The pest has to forcefully feed to bajra crop due to lack of other most preferred host in this areas.

Taxonomic Tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Lepidoptera
Family: Noctuidae
Genus: Helicoverpa
Species: *Helicoverpa armigera*

Survey of *Helicoverpa armigera* on Bajra

The larval stage data were collected from the farmers by using surveying the information from them. As per the farmers view, initially the pest was laid their eggs at flowering stage of the bajra crop during the April, 2020 in some villages of Borsad taluka. The pattern of oviposition was singly as well as in batches on the ear head of bajra as per the farmers view. The larva were hatched from eggs were infesting on flowering stage of the crop (Fig. 1 & Plate 1). As the crop grown, the milking grain stage was also affected and attacked by the larvae in Ravadapura, Uneli, Chuva, Rudel and Kankapura villages. The farmers were reported the heavy infestation of larval population on bajra ear head. Based on that information, the area was surveyed as per the methodology described in materials and methods. The early infestation was started on ear head at the second week of May. Later on, the pest was found feeding on the hard ear head stage too. However, the milking stage of crop was the ideal stage for feeding purpose of this pest. During the survey work, the different larval instar was observed feeding on the bajra ear head stage. Among them, starting from third instar to sixth instar larvae was found on the ear head of bajra. The feeding potential of these larval instars was more and made damage to bajra host. The grain formation was reduced as compared to normal season years. The farmers were not applying any control measures to crop due to grains were used for the feeding purpose as well as straw used for fodder to cattle.

There was maximum total number of 4.10 larvae/ear head/plant (Table 1) observed which showed their havock during these year 2020 (Covid-19 era). There were total five villages surveyed in which, bajra crop was heavily attacked by *H. armigera* larvae in the field condition. The pest was active from second to last week of May, 2020. There were all the fields of bajra severely attacked by this pest in this area. The farmers were grown bajra crop with different hybrid varieties like Sagar laxmi, Pioneer, Gujarat gold *etc*. The pest cause heavy damage during these summer season, 2020.

The peak activity was found during the second fortnight of May, 2020 as per the data showed in the Table 1 and Fig. 1 & Plate 2. The total mean number of larva/ear head/plant was ranges from 3.87 to 4.10 in different villages. Further, the data showed that the maximum number of larva/ear head/plant was observed in Ravdapura village (4.10). The second highest number of larva/ear head/plant was observed in Kankapura (4.03) followed by Uneli (4.00), Chuva (3.93) and Rudel (3.87). Further, it has been observed that the pest was causing maximum damage at milking stage of ear head. The affected ear head become loose and dried from the damaged portion. Later on, it was also found that it made damage to hard ear head stage too which showed its influence for its feeding potential to this host. It has been also surveyed that large number of larva feeding on single ear head which show its feeding potentiality on this host. It has been also found that damage caused by larva to ear head may ranges from 7 to 8 percent as per the number of larvae prevailed/plant. As per the farmers view, the farmers were found average 8 to 10 per cent loss in yield as compared to earlier years yield. The farmers were also told that they have not observed such pest with a huge number of larva more than 20 years of their life with farming of bajra crop in this region.

The similar types of observation are also recorded by different scientists on bajra and other host plants. The maximum pest population of *H. armigera* (0.34 larvae per plant was observed in Cv. AHB-1666 of bajra[9]. The pest incidence commenced from seventh week after sowing in variety GHB-558 and was found active from August to September in the crop [8]. The pest population increased in the last week of August and reaching to a peak level of 1.56 larvae per ear head. Then it was decreased (0.82 larvae/ear head) during the first week of September and remained active steady up to second week of September. The peak activity of *H. armigera* in pearl millet during last week of August was also reported [4]. The present finding is also in close agreement with the report of who [5, 11] stated that incidence of *H. armigera* commenced from 7th week after sowing and was found active from August to September in pearl millet. Insect and bird pests infesting pearl millet reviewed in India which includes white grubs *Holotrichia* spp. and shootfly, *Atherigona* approximate are most important pests, besides *Myllocerus* spp. (grey weevil), *Marasmia trapezalis* (leaf roller), *Autoba* (*Eublemma*) *silicula* (earhead worm) and *Peregrinus maidis* (plant hopper). *Rhinyptia* spp. (adults) and *Heliothis* (*Helicoverpa*) *armigera* in the north-western arid zones and ear head midge in the south are becoming important pests. This finding showed new pests as a result of host cross over are continuously being recorded [12].

Plate 1: Larval feeding on flowering stage of bajra crop

Plate 2: Larval feeding on milking stage of bajra crop

Fig 1: Infestation of Helicoverpa armigera on Bajra ear head

Table 1: Ear head worm larval mean population in different village of bajra crop

Plant	Ravadapura	Kankapura	Uneli	Chuva	Rudel
	Larval population/ear head/plant				
1	3.67	4.00	4.33	4.67	3.67
2	5.33	4.67	3.67	4.33	3.00
3	3.67	4.33	4.33	4.33	3.67
4	4.33	3.67	4.00	3.67	3.33
5	3.33	4.33	4.00	3.67	3.00
6	4.67	4.33	4.00	3.33	3.67
7	5.00	3.33	3.67	4.33	3.67
8	3.67	4.00	3.33	3.67	4.33
9	3.67	4.00	4.00	3.67	5.33
10	3.67	3.67	4.67	3.67	5.00
Total Mean	4.10	4.03	4.00	3.93	3.87

Conclusion

In this study, it has observed that from last few years the pest is continuously attacking on bajra crop in different part of Gujarat. The activity of this pest is observed from second week of April to third week of May at Borsad taluka of Anand district during this year. Therefore, additional studies have to be required to know the insect pests diversity and the pest status of bajra crop in the region. The comprehensive information generated from the present study would be useful in further understanding of the biodiversity, behavioral change, host preference and suitability of this pest associated with bajra crop in other parts of the country. This study would certainly have implications and alarming situation in ETL and pest management study for this pest.

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