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Insect pests of maize at different altitudes of north Kashmir, J&K

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Abstract
The present experiment was conducted at SKUAST-K Wadura campus, 1590 meters above mean sea level (AMSL) and Imberzal Wari, 2120 m AMSL. The maize variety C-4 was sown in a randomised block design with three replications. Investigation revealed that the crop was infested by 21 insect species at different phenological stages among which cut worm, *Agrotis* spp, maize stem borer, *Chilo partellus* Swinhoe and army worm, *Mythimna separata* Walker appeared as major insect pests at Crop Research Farm, Faculty of Agriculture, Wadura, while at Imberzal Wari, a total of 17 insect pest species were recorded and among them cutworm, *Agrotis* spp and maize stem borer, *C. partellus* were major ones.

Keywords: Altitude, insect pest, maize

1. Introduction
Maize (*Zea mays* Linnaeus) is the world's top ranking food crop followed by wheat and rice. Maize is sown and harvested somewhere in the world in every month of the year [29]. Globally, maize is grown over an area of 183.57 million hectare with 1068.79 million metric tonnes production and productivity of 5.8 metric tonnes per hectare [35]. India produced 23.70 million tonnes of maize grains from an area of 9.30 million hectare having an average productivity of 2.57 tonnes per hectare [16].

Maize crop is versatile in economic uses as well and as such referred to as 'a miracle crop' [32]. It provides the industrial raw material for the production of glucose, starch, dextrin, cornflakes, corn oil etc. along with nutritional needs [7]. Besides a large number of pharmaceutical products, alcoholic beverages are also commercially prepared from maize. The cobs are used for cleaning, brushing, polishing, abrasives for soaps, ceramics, glues and adhesives; as a carrier for pesticides, rubber compounds and tyres [5]. In India, about 28% of maize produced is used for food purpose, about 11% as livestock feed, 48% as poultry feed, 12% in wet milling industry (starch and oil production) and 1% as seed. Maize, known as 'Queen of cereals' because of its immense yield potential, is the highest yielding cereal crop of the world [32] and is particularly important in countries like India where food security is most vulnerable due to ever increasing population that has outnumbered the available food resources. In Kashmir valley, maize is usually cultivated at higher altitude terrains, karewas and plains under rainfed agriculture. The huge gap between attained and attainable yield under Kashmir conditions can be attributed to various biotic stresses. About 15.6 per cent of loss in yield due to biotic stress is caused by insect pests alone [14].

Maize plant is attacked by 140 species of insect pests causing a varying degree of damage. However, only about a dozen are quite serious [26, 31]. Among these insect pests, only ten species cause serious damage from sowing till storage [3]. However, due to changing global climatic patterns and due to change in host range of pests, many new pests previously not known on maize have been reported to feed on maize and a latitudinal shift in the distribution of insect pests has been observed [12]. Therefore, this trend calls for revised studies on the insect pests of maize crop and hence the present investigation was undertaken.

2. Materials and Methods
The present investigation was carried at following two locations with different altitudes.

1. Faculty of Agriculture, Wadura, SKUAST-K which is located at latitude 34˚21'00.6" N,

longitude 074˚23'47.3" E and an altitude of 1590 meters above mean sea level (AMSL).
2. Imberzal Wari located at latitude 34˚24'11.0"N, longitude 74˚25'02.4" E and an altitude of 2120 meters AMSL.

2.1 Crop studied: Maize crop (variety C-4) was grown following standard package of practices for Kashmir valley as given by SKUAST-K except plant protection measures.
2.2 Method of observation: The crop was observed under natural infestation conditions in the field. Insect pests were recorded on the maize plants following plant inspection method (PIM) as adopted by Subharani and Singh [33] for pest complex study and trapping of insect pests was also done by using light traps and yellow sticky traps [36]. Weekly visual observations were taken from the plants of maize crop in addition to the catch provided by light traps and yellow sticky traps. The crop observations for infestation by insect pests was taken on the basis of presence of dead hearts, presence of damaged plant parts, number of insect pests per plant in case of bugs, hoppers, weevils, beetles, grasshoppers etc. and number per centimetre square of leaf or cob sheath in case of aphids [23]. For soil borne insects such as cutworm, the status was ascertained by digging a soil pit in dimensions of 20 × 20 ×10 centimetre [11] and for white grubs and wireworms, soil was excavated in dimensions of 20 × 20 × 21 centimetre [34].
2.3 Specimen identification: The insect pests so recorded were preserved and properly identified.

3. Results and Discussion

The observations presented in Table 1 and 2 revealed that 21 and 17 insect pest species, infesting the maize crop at different phenological stages, were recorded at Faculty of Agriculture, Wadura and Imberzal Wari respectively.
At FOA, Wadura, out of 21 insect pest species, 6 were found belonging to order Lepidoptera; 8 to order Coleoptera; 5 to order Hemiptera and 2 to order Orthoptera representing 11 families in total with a share of 29 per cent of insect pests to Lepidoptera, 38 per cent to Coleoptera, 24 per cent to Orthoptera and 9 per cent to Hemiptera (figure 1a). At Imberzal Wari, out of 17 insect pest species, 3 were found belonging to order Lepidoptera; 9 to order Coleoptera; 3 to order Hemiptera and 2 to order Orthoptera representing 12 families with 17 per cent of insect pests belonging to Lepidoptera, 53 per cent to Coleoptera, 18 per cent to Hemiptera and 12 per cent to Orthoptera (figure 1b). These observations are in close proximity with the findings of Fletcher [14] who reported 14 insect species infesting the maize crop, whereas 22 insect species were recorded by Boupha *et al* [9]; however, Patra *et al.* [23] recorded 24 insect species as pests in the crop. The present findings are also supported by the work of Ahad *et al.* [2] and Kumar *et al.* [20] who recorded 17 and 11 insect pest species, respectively infesting maize at different stages of growth. However, much higher number of insect species (120) infesting maize was reported by Gurney [18]. Similarly, Painter [22] opined that 180 different insect species infested corn; whereas, Shapiro *et al.* [28] and Areekul *et al.* [4] recorded 75 insect species on maize crop while as Rajagopal and Channabasavanna [25] recorded 55 insect species infesting maize. Sekhar *et al.* [27] reported three different species of beetles on the crop and Ahad *et al.* [1] recorded five species of beetles infesting maize crop. Though, Erhan *et al.* [15] recorded as many as 9 insect species infesting the crop and Beres [6] reported seven aphid species from maize and Deole *et al.* [13] recorded 3 lepidopteran species as borers in Maize. The variation in insect numbers could possibly be due to varietal difference and different agro climatic conditions.

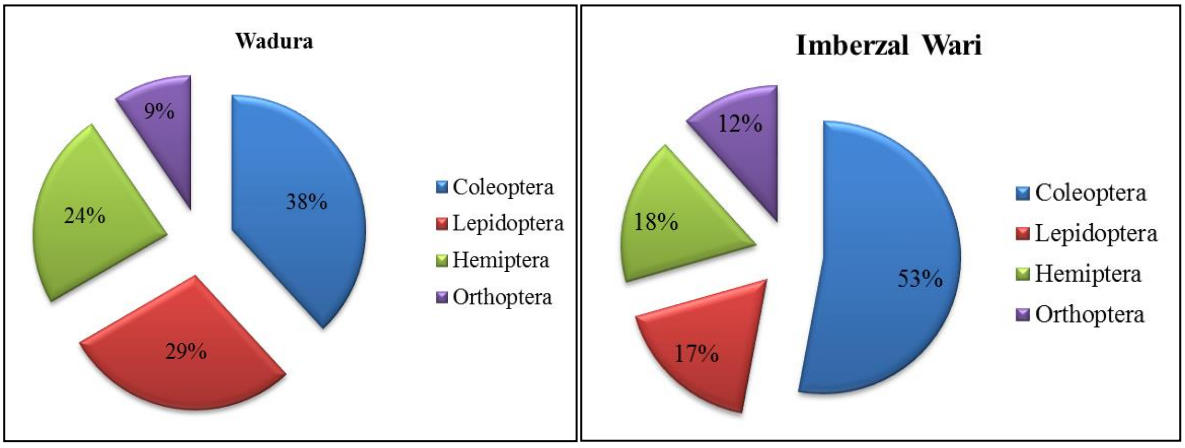

Fig 1 (a, b): Distribution of insect pests of maize at Wadura and Imberzal Wari.

The major insect pests were *Chilo partellus*, *Agrotis* spp. and *Mythimna separata*. Similar findings have been reported by Puttarudriah [24], Ahad *et al.* [2] and Erhan *et al.* [15] who reported cutworm as major crop pest of maize. The other workers such as Butani [10], Rajagopal and Channabasavanna [25], Jalali and Singh [19], Naz *et al.* [21], Shukla and Ashok [30], Biradar *et al.* [8], Ahad *et al.* [2], Patra *et al.* [23] and Kumar *et al.* [20] also reported *C. partellus* as major pest of maize, whereas Rajagopal and Channabasavanna [25] and Biradar *et al.* [8] reported *M. separata* as predominant pest infesting maize.
The minor insect pests were *Holotrichia longipennis*, *Brahmina* spp., *Melolontha furcicauda*, *Oryctes* spp., *Helicoverpa armigera*, *Carpocoris* spp., *Agriotes* spp., *Rhopalosiphum maidis*, *Aloa lactinea*, *Chrotogonus trachypterus*, *Chaetocnema pulicaria*, *Macrosteles quadrilineatus*, *Oulema melanopa*, *Cicadulina mbila*, *Spilosoma obliqua*, *Oxya japonica* and *Mylabris pustulata*. 1 insect pest specie *viz. Protaetia speciosa*, and other 2 *viz. Aphis fabae* and *Altica himensis* were recorded as secondary and stray insect pests respectively. Similar results have been found by Puttarudriah [24], Rajagopal and Channabasavanna [25], Boupha *et al.* [9], Biradar *et al.* [8], Ahad *et al.* [2] and Deole *et al.* [13] who have reported *H. armigera* as minor pest on maize. Though, Ahad *et al.* [1] also reported *H. consanguinea*, *M. pustulata* and *Protatia alboquotatta* infesting maize;

whereas, Erhan *et al.* [15] reported common European cockchafer (*M. melolontha*) and steppe cockchafer (*A. villosa*) as minor pest on maize; and Butani [10] reported hairy caterpillars infesting maize at different phenological stages. The results are also corroborated with findings of Rajagopal and Channabasavanna [25], Naz *et al.* [21], Boupha *et al.* [9], Biradar *et al.* [8], Ahad *et al.* [2], Beres [6] and Kumar *et al.* [20] who reported *R. maidis* as a minor pest infesting maize crop. Rice grasshopper as an insect pest of maize has been reported by Butani [10]. Another pest, *C. bipunctella bipunctella* has also been reported by Rajagopal and Channabasavanna [25] as minor pest infesting maize.

Table 1: Insect pests of maize crop at Wadura Sopore (1590 m AMSL).

S. no.	Common name	Scientific name	Family; Order	Nature of damage	Crop stage infested	Period of prevalence	Period of peak incidence	Status
1	Cut worm	*Agrotis* spp.	Noctuidae; Lepidoptera	Larvae cut the seedling horizontally at the ground surface.	VE-V6	Last week of March – 3rd week of June	2nd week of April – Ist week of June	Major
2	Maize stem borer	*Chilo partellus*	Pyralidae; Lepidoptera	Larvae feed on growing point inside central whorl and result in dead hearts.	VE-R1	1st week of April – 2nd week of August	3rd week of April – last week of May	Major
3	White grub and chafer beetle	*Holotrichia longipennis; Brahmina* sp.; *Melolontha furcicauda.*	Scarabaeidae; Coleoptera	Grubs feed on root system of seedlings and adults feed on foliage of plants.	VE-R0	Ist week of April - last week of September	2nd week of May – last week of May (Grubs) 2nd week of June – 1st week of July (Adults)	Minor
4	Army worm	*Mythimna separata*	Noctuidae; Lepidoptera	Larvae feed on foliage of plant.	V2-V10	Last week of April – last week of July.	2nd week of May – 2nd week of July.	Major
5	Gram pod borer	*Helicoverpa armigera*	Noctuidae; Lepidoptera	Larvae feed on foliage of plant.	V8-R0	1st week of June – 3rd week of July	Last week of June	Minor
6	Shield bug	*Carpocoris* sp.	Pentatomidae; Hemiptera	Nymph and adults infesting foliage, leaves, ears and grain.	V8-R0	June-August	1st fort night of June	Minor
7	Wire worm	*Agriotes* spp.	Elateridae; Coleoptera	Grubs feed on root system of seedlings and weaken the whole plant.	VE-V4	1st week of April – last week of June	Last week of April – 2nd week of May	Minor
8	Maize leaf aphid	*Rhopalosiphum maidis*	Aphididae; Hemiptera	Nymphs and adults suck sap from leaves, tassel and cobs.	V8-R5	3rd week of June – 1st week of October	1st week of August – 3rd week of September	Minor
9	Hairy caterpillar	*Aloa lactinea*	Eribidae; Lepidoptera	Larvae feed on foliage of plants.	V2-V8	1st week of May – 3rd week of June	3rd week of May- 2nd week June	Minor
10	Surface grasshopper	*Chrotogonus trachypterus*	Acrididae; Orthoptera	Nymphs and adults nibble at the leaves giving irregular lateral cuts.	V8-R1	1st week of June – 1st week of September	2nd week of July	Minor
12	Flea beetle	*Chaetocnema pulicaria*	Chrysomelidae ; Coleoptera	Adults feed on the chlorophyllous tissue of leaves leaving only leaf lamina intact.	V8-R4	3rd week of July – 3rd week of August	2nd week of July	Minor
13	Flower eating beetle	*Protaetia speciosa*	Cetonidae; Coleoptera	Feed on grains of cob that have been damaged earlier by birds.	R1-R5	1st week of August – 3rd week of August	2nd week of August	Secondary pest/ Minor
14	Aster Leaf hopper	*Macrosteles quadrilineatus*	Cicadellidae; Hemiptera	Nymphs and adults suck sap from the plant.	V4-R0	Last week of May – 2nd week of July	Last week of June	Minor
15	Cereal leaf beetle	*Oulema melanopa*	Chrysomelidae ; Coleoptera	Adults feed on the chlorophyllous tissue leaving leaf lamina only intact.	V8-R2	Last week of June – 1st week of September	3rd week of August	Minor
16	Maize leaf hopper	*Cicadulina mbila*	Cicadellidae; Hemiptera	Nymphs and adults suck sap from the plant.	V8-R0	1st week of June – last week of August	2nd week of July	Minor
17	Bihar hairy caterpillar	*Spilosoma obliqua*	Eribidae; Lepidoptera	Larvae defoliate the seedlings.	V8-R0	2nd week of May – 1st week of June	Last week of May	Minor
18	Rice grasshopper	*Oxya japonica*	Acrididae; Orthoptera	Nymphs and adults nibble at the foliage in a zig-zag fashion laterally.	V8-R1	3rd week of July – 2nd week of September	1st week of August	Minor
19	Black bean aphid	*Aphis fabae*	Aphididae; Hemiptera	Adults and nymphs suck sap from foliage.	V8-R2	3rd week of July – 3rd week of August	1st week of August	Stray pest
20	Flea beetle	*Altica himensis*	Chrysomelidae ; Coleoptera	Adults scrap chlorophyllous tissues and leave behind epidermis.	V8-R1	2nd week of July – last week of September	Last week of July – 2nd week of August	Stray pest

VE- Emergence; V1- Collar of first leaf visible; V2-Collar of 2nd leaf visible; V4-Collarof 4th leaf visible; V6- Collar of 6th leaf visible; V8-Collar of 8th leaf visible; V10-Collar of 10th leaf visible; R0- Tasselling; R1- Silking; R2-Blister stage; R4-Dough stage; R5-Dent stage.

Table 2: Insect pests of maize at Imberzal Wari (2120 m AMSL).

S. no.	Common name	Scientific name	Family; Order	Nature of damage	Crop stage infested	Period of prevalence	Period of peak prevalence	Status
1	Cut worm	*Agrotis* spp.	Noctuidae; Lepidoptera	Larvae cut the seedling horizontally at the ground surface.	VE-V6	Last week of March – 3rd week of June	2nd week of April – 1st week of June	Major
2	Maize stem borer	*Chilo partellus*	Pyralidae; Lepidoptera	Larvae feed on growing point inside central whorl and result in dead hearts.	VE-R1	1st week of April – last week of July.	Last week of April – 1st week of June	Major
3	White grub and chafer beetle	*Holotrichia longipennis; Brahmina* sp.; *Melolontha furcicauda; Oryctes* sp.	Scarabaeidae; Coleoptera	Grubs feed on root system of seedlings and adults feed on foliage of plants.	VE-R0	Ist week of April - 2nd week of October	1st week of May – last week of May (Grubs) 2nd week of June – 1st week of July (Adults)	Minor
4	Shield bug	*Carpocoris* sp.	Pentatomidae; Hemiptera	Nymph and adults infesting foliage, leaves, ears and grain.	V8-R0	June-August	1st fort night of June	Minor
5	Wire worm	*Agriotes* spp.	Elateridae; Coleoptera	Grubs feed on root system of seedlings and weaken the whole plant.	VE-V4	1st week of April – 3rd week of May	1st week of May– 2nd week of May	Minor
6	Green leaf aphid	*Rhopalosiphum maidis*	Aphididae; Hemiptera	Nymphs and adults suck sap from leaves, tassel and cobs.	V8-R5	2nd week of June – Last week of September	2nd week of August – 2nd week of September	Minor
7	Hairy caterpillar	*Aloa lactinea*	Eribidae; Lepidoptera	Larvae feed on foliage of plants.	V2-V8	1st week of May – 3rd week of June	3rd week of May- 2nd week June	Minor
8	Surface grasshopper	*Chrotogonus trachypterus*	Acrididae; Orthoptera	Nymphs and adults nibble at the leaves giving irregular lateral cuts.	V8-R1	Last week of May – 1st week of September	1st week of July	Minor
9	Flea beetle	*Chaetocnema pulicaria*	Chrysomelidae; Coleoptera	Adults feed on the chlorophyllous tissue of leaves leaving only leaf lamina intact.	V8-R4	3rd week of July – 3rd week of August	3rd week of July	Minor
10	Blister beetle	*Mylabris pustulata*	Meloidae; Coleoptera	Adults feed on silk of cobs leading to barren cobs.	R0-R4	3rd week of July – 2nd week of September	1st week of August	Minor
11	Cereal leaf beetle	*Oulema melanopa*	Chrysomelidae: Coleoptera	Adults feed on the chlorophyllous tissue leaving leaf lamina only intact.	V8-R2	1st week of July – 2nd week of September	Last week of August	Minor
12	Maize leaf hopper	*Cicadulina mbila*	Cicadellidae; Hemiptera	Nymphs and adults suck sap from the plant.	V8-R0	Last week of June – 1st week of September	3rd week of July	Minor
13	Rice grasshopper	*Oxya japonica*	Acrididae; Orthoptera	Nymphs and adults nibble at the foliage in a zig-zag fashion laterally.	V8-R1	2nd week of July – 3rd week of September	1st week of August	Minor
14	Flower eating beetle	*Protaetia speciosa*	Cetonidae; Coleoptera	Feed on grains of cob that have been damaged earlier by birds.	R1-R5	1st week of August – 3rd week of August	2nd week of August	Secondary pest/ Minor

VE- Emergence; V1- Collar of first leaf visible; V2-Collar of 2nd leaf visible; V4-Collarof 4th leaf visible; V6- Collar of 6th leaf visible; V8-Collar of 8th leaf visible; V10-Collar of 10th leaf visible; R0- Tasselling; R1- Silking; R2-Blister stage; R4-Dough stage; R5-Dent stage.

3.1 Major insect pests

3.1.1 *Chilo partellus*: Also known as maize stem borer in vernacular, the larvae were seen feeding inside the central whorl resulting in characteristic linear pin-hole symptoms on leaves. The feeding on the growing point by the larvae also resulted in dead hearts in the crop.

3.1.2 *Agrotis* spp: The soil dwelling caterpillar comes out during wee hours and clips the seedling close to ground surface, with the result that crop stand was reduced drastically.

Mythimna separata: Commonly known as army worm, the larvae of the insect feed on foliage, resulting in tattered lamina of the leaves, sometimes leaving veins intact. The central whorl of the infested plant is filled with frass and a careful examination of the inner whorls revealed the presence of the larvae. It was recorded in Wadura only.

3.1.3 Minor insect pests: These include *Holotrichia longipennis, Brahmina spp, Melolontha furcicauda* and *Oryctes* spp*:* Commonly known as Chafer beetles, May-June beetles and the immature ones are collectively called as 'white grubs'. The grubs feed on the roots of the seedlings causing damage to the root system while the adult beetles feed on the leaves, cutting leaves from the margins inwards.

3.1.4 *Helicoverpa armigera*: Also known as gram pod borer, the insect has wide host range. The larvae feed on foliage of

the plant and on central whorl and the leaves that unfold later bear diamond shaped holes.
Sucking pests: The insect pests with plant sap sucking nature of damage were observed on maize crop were Shield bug,

3.1.4.1 *Carpocoris* spp.; Maize leaf aphid, *Rhopalosiphum maidis*; Aster leaf hopper, *Macrosteles quadrilineatus* and Maize leafhopper, *Cicadulina mbila.*

3.1.4.2 *Oxya japonica*: Commonly known as rice grasshopper.

3.1.4.3 *Chrotogonus trachypterus*: Commonly known as surface grasshoppers.

3.1.4.4 *Agriotes* spp: The grubs of wireworms were seen infesting root system of maize plants.
Other minor insect pests belonging to lepidoptera observed were Bihar hairy caterpillar, *Spilosoma obliqua* and hairy caterpillar, *Aloa lactinea* which were found to feed occasionally on the lower leaves of plant. However, they were associated mainly with the weed flora of the area.
Similarly other coleopteran minor insect pests infesting maize crop at Wadura were cereal leaf beetle, *Oulema melanopa*; Flower eating beetle, *Protaetia speciosa* and Flea beetle, *Chaetocnema pulicaria.* Flea beetle and cereal leaf beetle were found to be feeding on chlorophyllous tissue of leaf lamina, the blister beetle fed on the silk of maize crops, hence hindering pollination while as flower eating beetle was found to be feeding on grains of cobs that were already damaged by birds (secondary pest).

3.2 Stray insect pests
The insect pests of other crops that were occasionally noticed on maize crop are Flea beetle, *Altica himensis* and black bean aphid, *Aphis fabae*. These were observed at Wadura only.

4. Conclusion
From the present study it can be concluded that a larger number of insect pests infests maize crop in plains (21) than at higher altitude (17) of the Kashmir valley out of which 3 insect pests infest the crop severely that need effective management strategies. Also the status of insect pests infesting maize crop must be reviewed from time to time to ascertain the changing pattern of incidence, if any.

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