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CONTENTS

Monitoring of insect pests infesting cowpea, *Vigna unguiculata* at Pantnagar

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ABSTRACT: Studies were conducted to record the insect-pest species in the cowpea ecosystem during the *Zaid* and *Kharif* seasons of crop growth. A total of nineteen insect-pest species, belonging to seven orders and fourteen families, were recorded at different stages of crop growth, five of which belonged to Lepidoptera, seven to Hemiptera, three to Coleoptera, and one each to Orthoptera, Diptera, Thysanoptera and Isoptera. All the major parts of the cowpea crop *viz.*, pod/seed, flower, flower bud, leaves and root were found to be infested by these insect species. Out of nineteen species, spotted pod borer, *Maruca vitrata* F., tur pod bug, *Clavigralla gibbosa* Spinola, pod sucking bug, *Riptortus pedestris* F. and bean flower thrips, *Megalurothrips sjostedti* Trybom were observed as the major insect-pests in cowpea ecosystem. Studies highlight insect-pest complex infesting cowpea crop, allowing farmers to plan in advance to reduce infestations of these pest species.

Key words: Insect infestations, *Maruca vitrata*, *Megalurothrips sjostedti*, pod bugs, *Vigna unguiculata*

Cowpea, *Vigna unguiculata* (L.) is one of the important legume crops. In India, cowpea is cultivated at approximately 3.9 MH with a production of 2.21 MT and the national productivity is 683 kg/ha (Singh *et al*., 2012). Cowpea is usually preferred by farmers owing to its role in maintaining soil fertility through nitrogen-fixing (Asiwe *et al*., 2009) and production of nutritious fodder for livestock. However, yield is very low for various reasons, including numerous diseases, insect pests, parasitic weeds, drought, low soil fertility and lack of inputs and infrastructure (Ahlawat and Shivakumar, 2005). Sometimes total yield losses and crop failure occur due to the spectrum of insect pests, which destroy the crop at different growth stages. More than twenty insect pests have been recorded to cause damage to the cowpea crop (Anusha *et al*., 2016). In India, several insect pests *viz.,* pod borer, *Helicoverpa armigera* Hub.*;* spotted pod borer, *Maruca vitrata* F.; spiny pod borer, *Etiella zinckenella* Treitschke; pod fly, *Melanagromyza obtuse* Malloch; stem fly, *Ophiomyia phaseoli* Tryon*;* pea and bean weevil, *Stiona* spp.; aphids, *Aphis craccivora* Koch. and *Aphis fabae* Scopoli*;* white fly, *Bemisia tabaci* Genn.*;* defoliators, *Spodoptera litura* F.*, S. exigua* Hub. and *Amsacta* spp.; leafhoppers, *Empoasca* spp., thrips, *Scirtothrips dorsalis* Hood and *Caliothrips indicus* Bagnall; blister beetles, *Mylabris* spp.; and the bruchids, *Callosobruchus chinensis* L. and *Bruchus pisorum* L. have been recorded, which cause extensive losses (Sharma and Kaushik, 2010). Therefore, there is a great scope for studying the insect-pest complex of cowpea in the Pantnagar region.

MATERIALS AND METHODS

The field experiments were conducted at Breeder Seed Production Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) India, during the *Zaid* season from March to June and during the *Kharif* season from August to October of 2013 on cowpea varieties PGCP-12 and Pant Lobia -1, respectively. The seeds were sown in plots (4×3 m^2) with spacing of 60 cm between two rows and 20 cm between two plants. The fields were monitored regularly at weekly intervals to record and identify the insect fauna at various stages of crop growth. Sweep nets are used to collect flying and saltatorial insects at ground level. The collected insects were transferred to a bucket, containing a minimum amount of ethyl acetate to kill them. The killed insects were sorted

Table 1:Diversity of insect fauna associated with cowpea crop

Order	Family	Insect pest	Status	Plant part infested	Crop stage	Activity period	Number of individuals collected
Lepidoptera	Noctuidae	Tobacco caterpillar	Minor	Leaf	Vegetative	Apr-June (*Zaid*)	37
		Spodoptera litura F.				Aug-Sep (*Kharif*)	34
		Pod borer	Minor	Pod	Flowering-pod	May (*Zaid*)	23
		Helicoverpa armigera Hub.			maturity	Sep (*Kharif*)	31
		Semilooper	Minor	Leaf	Vegetative	Mar-Apr (*Zaid*)	32
		Trichoplusia ni Hub.				Aug-Sep (*Kharif*)	28
	Pyralidae	Spotted pod borer	Major	Flower	Flowering-	Apr-May (*Zaid*)	43
		Maruca vitrata F.		bud, pod	pod maturity	Sep-Oct (*Kharif*)	86
	Arctiidae	Bihar hairy caterpillar	Minor	Leaf	Vegetative-	-	-
		Spilarctia obliqua Walk.			flowering	Aug (*Kharif*)	112
Hemiptera	Aphididae	Cowpea aphid	Minor	Leaf,	Vegetative	Mar (*Zaid*)	46
		Aphis craccivora Koch.		Flower, pod		Aug-Oct (*Kharif*)	114
	Cicadellidae	Leaf hopper	Minor	Leaf	Vegetative	Mar-May (*Zaid*)	34
		Empoasca kerri Pruthi			-pod filling	Aug-Oct (*Kharif*)	53
	Aleyrodidae	Whitefly	Minor	Leaf	Vegetative-	-	-
		Bemisia tabaci Genn.			pod filling	Aug-Sep (*Kharif*)	68
	Pentatomidae	Green stink bug	Minor	Leaf, pod	Pod formation-	Mar-May (*Zaid*)	19
		Nezara viridula L.			maturity	Aug-Oct (*Kharif*)	24
		Jewel bug	Minor	Leaf	Pod formation-	-	-
		Chrysocoris stollii Wolff			maturity	Sep (*Kharif*)	17
	Coreidae	Tur pod bug	Major	Leaf, pod	Pod filling –	May (*Zaid*)	41
		Clavigralla gibbosa Spinola			pod maturity	Sep-Oct (*Kharif*)	72
		Pod sucking bug	Major	Leaf, pod	Pod filling –	May (*Zaid*)	34
		Riptortus pedestris F.			pod maturity	Sep-Oct (*Kharif*)	83
Coleoptera	Meloidae	Blister beetle	Minor	Flower	Flowering	-Sep (*Kharif*)	-14
		Mylabris phalerata Pallas					
		Mylabris pustulata Thunberg					
	Chrysomelidae	Flea beetle	Minor	Leaf	Vegetative-	Mar-May (*Zaid*)	13
		Phyllotreta sp.			pod filling	Aug-Sep (*Kharif*)	16
		Red pumpkin beetle	Minor	Leaf	Vegetative	Apr (*Zaid*)	13
		Aulacophora foveicollis Lucas				Aug (*Kharif*)	15
Orthoptera	Acrididae	Short horn grasshopper	Minor	Leaf	Vegetative-	Mar-May (*Zaid*)	03
		Hieroglyphus banian F.			pod filling	Aug-Oct (*Kharif*)	12
Diptera	Agromyzidae	Leaf miner	Minor	Leaf	Vegetative	Mar-Apr (*Zaid*)	24
		Liriomyza spp.				Aug-Sep (*Kharif*)	36
Thysanoptera	Thripidae	Bean flower thrips	Major	Leaf,	Vegetative-	Mar-May (*Zaid*)	56
		Megalurothrips sjostedti Trybom		Flower, Bud	pod filling	Aug-Sep (*Kharif*)	110
Isoptera	Termitidae	Termites	Minor	Root	Seedling-	Mar-May (*Zaid*)	62
					crop maturity	Aug-Oct (*Kharif*)	48

into different taxa and preserved by pinning or card mounting for further study. The soft-bodied insects were sorted and preserved in plastic vials, containing 70% alcohol. The active search method is used to collect immature and adult stages of the pests during morning and evening hours and brought them to the laboratory. Immature stages were reared in the laboratory until adult emergence. Field collected and emerged adults were killed in killing bottle, mounted on either insect pins or paper points depending on their size and properly labeled for further study. Soil samples were taken from the root zone of the crop to record soil-dwelling insects. The soil was washed out with water in a sieve and the insects (termites) were preserved in plastic vials containing 70% alcohol. Insects were classified as major or minor based on their abundance and damaging potential. All specimens were identified by experts from the University's Department of Entomology.

RESULTS AND DISCUSSION

The biodiversity of insect-pest fauna associated with cowpea crop has been enlisted in Table 1. A total of nineteen insect species, belonging to seven orders and fourteen families, were recorded at different stages, five of which belonged to Lepidoptera, seven to Hemiptera, three to Coleoptera and one each to Orthoptera, Diptera, Thysanoptera, and Isoptera. Out of nineteen insect pests, *M. vitrata*, *Megalurothrips sjostedti*, *Clavigralla gibbosa* and *Riptortus pedestris* were recorded as the pests of major importance on cowpea.

Several studies have been done on cowpea abroad and in India, showing the infestations of various insect pests at different stages of crop growth. Okoronkwo (1999) reported *A. craccivora* on seedlings, while *Megalurothrips sjostedti, M. vitrata* and *Clavigralla tomentosicollis* Stal on the reproductive organs to be major pests of cowpea in Nigeria. In Africa, Adetonah *et al.* (2004) reported three principal pests on cowpea *viz., A. craccivora*, *M. vitrata* and *Ootheaca* spp. Whereas, Adipala *et al.* (2000) found four major insect pests on cowpea namely *A. craccivora*, *Megalurothrips sjostedti*, *M. vitrata* and pod sucking bugs. In India, Thejaswi *et al.* (2008) recorded 22 species of insect pests on pulse crops, among which *M. vitrata*, *A. craccivora*, leaf hoppers, thrips, *Riptortus pedestris*, *Riptortus strennus* Horvarth, *Coptosoma cribraria* F., *Anoplocnemis phasiana* F. and *Nezara viridula* L. were more predominant. Sharma and Kaushik (2010) also recorded several insect pests causing damage to cowpea crop, of which *Helicoverpa armigera*, *M. vitrata*, *Etiella zinckenella*, *Melanagromyza obtuse*, *Ophiomyia phaseoli*, *Stiona* spp., *A. craccivora*, *Aphis fabae, Bemisia tabaci*, *Spodoptera litura, S. exigua*, *Amsacta* spp., *Empoasca* spp., *Megalurothrips dorsalis*, *Caliothrips indicus*, *Mylabris* spp., *Callosobruchus chinensis* and *Bruchus pisorum* cause extensive losses.

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Studies on flower morphological characters of different oilseed *Brassica* species and their effect on the abundance of bee species

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ABSTRACT: Oilseed *Brassica* is an important source of oil for people worldwide. Oilseed *Brassica* crops largely attract hymenopterans because *Brassica* flowers are well adapted to generalist insect pollinators; they produce large amounts of pollen and nectar throughout the entire flowering period, which draws the attention of most of the insects. In the current study, we studied flower morphological characters of different oilseed *Brassica* species in relation to floral visitors along with their abundance rate at Norman E. Borlaug Crop Research Centre in Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) during the *rabi* season 2020-21. Results revealed that *Apis mellifera* had the highest relative abundance (42.11%) in oilseed *Brassica*, whereas, among oilseed *Brassica* cultivars, *B. nigra* reported the highest bee abundance (19.05%). However, among bee species and different *Brassica* cultivars, *A. mellifera* (5.06 bees/m^2/5min) showed the highest abundance in *B. carinata* followed by *Halictus* spp. (3.78 bees /m^2/5min) in *B. nigra*. Large size flower structures were found in *B. napus* (variety- GSC-6) and *B. carinata* while small flowers were found in *B. nigra*, therefore *A. mellifera* showed positive significant correlation with flower morphological characters *viz*., petal length (r = 0.791*) and outer stamen (r = 0.732*) and *Halictus* spp. reported negative significant correlation with flower morphological characters viz. sepal length (r = -0.823*) and inner stamen (r = -0.799*). The results suggested *A. mellifera* species could be effective pollinators of large flower sized *Brassica* cultivar, and *Halictus* spp. could be effective pollinators of small flowers sized *Brassica* cultivar. This association also occurs between other bee species and *Brassica* variety, except in case of *A. florea*. On the other hand, the activity of *A. florea* in oilseed *Brassica* is independent of floral morphological characteristics and may be influenced by other factors like as weather conditions, nectar availability of pollen etc.

Key words: *Apis mellifera, Brassica* species*, Halictus* spp., nectar, pollen

Floral biology refers to the understanding of the structure, sexual system and morphological adaptations of the flowers in relation to the breeding system and pollination ecology. Thus, a careful study of the floral biology of a plant is important for discerning the mode of pollination (self or cross), types of pollinators and mechanisms of pollination involved (Belavadi and Ganeshaiah, 2013). The Brassicaceae family can be differentiated by the appearance of conduplicate cotyledons (i.e., cotyledons that are longitudinally folded around the radical) and two-segmented fruits (siliquae) with seeds in one or both divisions. In India, *B. campestris*, *B. juncea*, *B. rapa* syn., *B. napus, B. carinata*, *B. nigra* and *B. oleracea* are the important and widely cultivated oilseed *Brassica* species. *B. juncea* (L.) Czern and Coss, commonly referred to as "Indian mustard" (Jat *et al.*, 2019). *Brassica* species is an ideal research crop for analyzing patterns relay heavily on insects for pollination (Stewart, 2002). Different *Brassica* flowers have a different flower shape that is well suited to generalist insect pollinators these flowers, with colorful petals, large volumes of pollen, fragrance production, and nectar production throughout the flowering period makes them attractive to pollinators for feed (Free, 1970). *B. juncea* was considered as self-compatible, but also an insect-pollinated crop. *B. napus* flowers are bisexual, with four sepals and four petals, four longer stamens and two shorter stamens (Kunjwal *et al.,* 2014). *Apis florea, A. dorsata, A. mellifera, Andrena ilerda,* and *A. leaena* are the dominant visitors while wasps, solitary bees, Dipterans and Lepidopterans are non-dominant visitors of *Brassica* crops (Abrol, 2012). *B. compestris* flowers are visited by *A. cerana indica* F., *A. florea* F., *A. dorsata* F. (Naim and Bisht, 1993). Pollinators like honeybee visited on Indian mustard

cultivars RH-30, *B. carinata* cv. Carinata, *B. compestris* variety Brown Sarson (cv. BSH-1), (Choudhary, 2001).

The pollinating abundance of anthophilous insects is intimately related to the floral biology of the many species (Menzel, 2002). Thompson (2001) quantified how the visitation rates of different pollinators to a multiple *Brassica* species vary in relation to variation in floral design and floral display. After going through aforesaid literature the current research was directed to study the impact of floral structure of different species of oilseed *Brassica* on abundance of different bee species.

MATERIALS AND METHODS

The investigations were carried out at Norman E. Borlaug Crop Research Centre in Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) during the rabi season 2020-21 with the oilseed *Brassica* cultivar *B. campestris* (var. BSH-1), *B. rapa* (var. YST-151), *B. juncea* (var. Varuna), *B-nigra, B. juncea* (var. PM-31), *B. napus* (var. GSC-6), *B. alba* and *B. carinata*.

Flower morphological characters

While observing the flower structure, it is important to record special modifications to attract flower visitors. The length and number of anthers, the length of inner and outer stamen, and the length of the style were all observed in flower structure of oilseed *Brassica* crops. Each floral character was determined using a Vernier caliper after measurements were taken from 5 fully opened flowers from an individual variety of oilseed *Brassica.*

Abundance of bee species

A total number of visiting insects/m^2 of randomly selected crop area was counted for five minutes in three replications. The relative abundance of dominant pollinator species was calculated by three-way ANOVA performed using SPSS software Version 20 and expressed as per centage (Srikanta and Shashidhar, 2010).

RESULTS AND DISCUSSION

Flower morphological characters

Flower of oilseed *Brassica* has 4 small greenish sepals, 4 yellowish petals arranged in across formation pattern. There are 6 stamens in a flower, 4 long and 2 short along with a slender pistil. The size of flower structures was significantly different in different varieties of oilseed *Brassica* presented in Table 1. Average petal length of oilseed *Brassica s*pecies was 10.53 mm whereas, *B. carinata* had maximum petal length (13.79 mm), which was statistically similar to *B. napus* var. GSC-6 (13.47 mm) but higher than other *Brassica* species. Petal breadth was significantly maximum in *B. napus* var. GSC-6 (7.92 mm) followed by *B. compestris* var. BSH-1 (6.92 mm) and minimum was observed in *B. nigra* (3.33 mm). *Brassica* flowers are bisexual, sepals are oblong with different length. Average length of sepals in oilseed *Brassica* was 6.15 mm and sepal size in *B. napus* var. GSC-6 (7.82 mm) was found to be similar with sepal length size of *B. carinata* (7.49 mm) being statistically higher than others while sepal length was minimum in *B. nigra* (3.85 mm). The length of style was maximum in *B. carinata* (9.57 mm) which was statistically at par with *B. napus* var. GSC-6 (9.56 mm) and *B. rapa* var. YST-151 (8.80 mm). Length of inner filament in *B. napus* var. GSC-6 (9.75 mm) was significantly higher than other *Brassica* species followed by *B. carinata* (8.53 mm). Whereas, the minimum size of the inner filament was found in *B. nigra* (5.86 mm). *B. napus* var. GSC-6 had higher length of outer stamen (8.17) which was statistically similar with *B. carinata* (7.86 mm) while smallest length was found in *B. juncea* var. PM-31(4.41 mm) which was statistically at par with and *B. nigra* (4.50 mm).

Abundance of different bees on different oilseed *Brassica* species

The relative abundance of insect visitor's *viz.*, *A. mellilera* L. *A. cerana indica*, *A. dorsata*, *A. florea* and *Halictus* spp. were recorded on flowers of 8 species of oilseed *Brassica* crop on day hour. The observations were recorded in Table 2. Data further indicated that mean relative abundance of *A.*