



## Succession of major insect pest and their natural enemies in pigeon pea [*Cajanus Cajan* (L) millsp.]

Rahul Patidar<sup>1\*</sup>, Rajendra Patel<sup>2</sup>, Sumit Kakde<sup>3</sup>

<sup>1-3</sup> Department of Entomology, College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh, India

### Abstract

A field experiment was conducted at experimental field during Kharif season 2018-2019. Thirteen different species of insects and four natural enemies' species belonging to seven orders and fourteen families were associated with the pigeon pea crop at Jabalpur during 2018-2019. i.e. jassid, Thrips, Cow bug, Pod bug, Red cotton bug, Green stink bug, Grasshopper, Red pumpkin beetle, Pod fly, Leaf webber, Gram pod borer, Tur plume moth, Spider, Lady bird beetle, Blister beetle, Green lace wing and wasp. Data collected revealed that six major insect are Gram pod borer *Helicoverpa armigera*, Tur plume moth *Exelastis atomosa*, Pod fly *Melanagromyza obtusa*, Pod bug *Clavigralla gibbosa* Spinola, Blister beetle, *Mylabris pustulata* Thunberg, Thrips *Megalurothrips usitatus* and 2 natural enemies Lady bird beetle and Green lace wing.

**Keywords:** experiment, *Exelastis atomosa*, *Megalurothrips usitatus*, Succession

### Introduction

Pigeon pea [*Cajanus cajan* (L.) Millspaugh] known as redgram, tur or arhar, is the second most important grain legume of India, after chickpea. Pigeon pea is grown world over, mostly in tropical and sub-tropical countries for grains, fodder and feed for livestock (Rao *et al.*, 2002) [18]. Pigeon pea (*Cajanus cajan* (L) Millsp.) is an important multi-use shrub legume of the tropics and subtropics. Pigeon pea is a tropical grain legume mainly grown in India and ranks second in area and production and contribute about 90% of the world's pulse production. In India pigeon pea is cultivated in an area of 4.04 million ha and production of about 2.65 million tonnes, with a productivity of 656 kg/ha. In Madhya Pradesh pigeon pea occupies 13.50% (0.53 million ha) area with 12.60% (0.33 million tonnes) production of India and productivity of 656 kg/ha (DES, 2012) [4]. In the country, the crop is extensively grown in Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Gujarat. Pigeon pea is a rich source of protein (21.71%) and supplies a major share of protein requirement of the vegetarian population of the country, besides it is also a rich source of iron, iodine and essential amino acids like arginine, cysteine and lysine (Singh *et al.*, 2007) [19].

Insect pest complex is the most limiting factor in pigeon pea production. These pests cause adequate economic damage leading to very low yield levels of 500 - 800 kg/ha as against the potential yield of 1800 - 2000 kg/ha (Lal *et al.*, 1997 and Upadhyay *et al.*, 1998) [6]. Pod infesting insect pests recorded at Jabalpur are gram pod borer (*H. armigera* Hubner), pod bug (*C. gibbosa* Spinola), pod fly (*M. obtusa* Malloch) and plume moth (*E. atomosa* Walsingham). Out of the four pests, *M. obtusa* has established as the most important pest on the basis of pod and grain damage which range from about 55 to 85 and 29 to 63 per cent, respectively (Landge, 2009) [18]. Pod fly, *Melanagromyza obtusa* (Malloch) is a key pest of pigeon pea (*Cajanus*

*cajan*) throughout South-east Asia. It attacks the crop from pod filling to pod maturity. The oviposition of pod fly takes place on the inner surface of the pod walls. Females deposit the eggs singly under the epidermis in the green pods and the larvae after hatching mines into the pods and feeds on the soft seed thus making it unfit for human consumption as well as seed purposes (Lal and Yadav, 1993) [7]. The estimates of avoidable losses due to pod borer complex, mainly pod fly and *Helicoverpa armigera* were 43.5 and 30.2%, respectively (NCIPM 2012) [12]. Pigeon pea has a wide range of products, including the dried seed, pods and immature seeds used as green vegetables, leaves and stems used for fodder and the dry stems as fuel. It also improves soil fertility through nitrogen fixation as well as from the leaf fall and recycling of the nutrients (Mapfumes, 1993; Snapp *et al.*, 2002) [10, 24]

### Material and Methods

The present investigation entitled, "Succession of major Insect Pest and Their Natural Enemies in Pigeon pea [*Cajanus cajan* (L) Millsp.]" was Succession of insect pests and their natural enemies were studied on pigeon pea cv. TJT - 501 by raising crop following all recommended agronomic practices. Regular observations were initiated immediately after germination and continued upto harvest of the crop. Observation of major insect pest pod bug, pod fly, pod borer, plume moth were recorded on per plant were recorded on randomly 20 pods per 5 plants. The sequence in which the pests and natural enemies appeared was noted on plants, once in a standard week.

### Results and Discussion

Result revealed that 17 insects were recorded in pigeon pea but data collected major insect pest. The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads.

**Table 1:** Succession of insect pests and natural enemies on pigeon pea at Jabalpur during 2018-2019

Date of obs.	SW	Common Name	Scientific name	Order	Family	CAD	CGS
19 Aug. 2018	33	Jassid Leaf webber Spider	<i>Empoasca fabae</i> (Harris) <i>Grapholita critica</i> Meyr. <i>Telamonia dimediata</i>	Cicadellidae Tortricidae Salticidae	Hemiptera Lepidoptera Araneae	28	VS
26 Aug. 2018	34	Jassid Leaf webber Spider	<i>Empoasca fabae</i> (Harris) <i>Grapholita critica</i> Meyr. <i>Telamonia dimediata</i>	Cicadellidae Tortricidae Salticidae	Hemiptera Lepidoptera Araneae	35	
2 Sept 2018	35	Jassid Leaf webber Spider Cow bug	<i>Empoasca fabae</i> (Harris) <i>Grapholita critica</i> Meyr. <i>Telamonia dimediata</i> <i>Otinotus oneratus</i> W.	Cicadellidae Tortricidae Salticidae Membracidae	Hemiptera Lepidoptera Araneae Hemiptera	42	
9 Sept 2018	36	Jassid Leaf webber Spider Cow bug Red pumpkin Beetle	<i>Empoasca fabae</i> (Harris) <i>Grapholita critica</i> Meyr. <i>Telamonia dimediata</i> <i>Otinotus oneratus</i> W. <i>Raphidopalpa foveicollis</i> (Lucas)	Cicadellidae Tortricidae Salticidae Membracidae Chrysomelidae	Hemiptera Lepidoptera Araneae Hemiptera Coleoptera	49	
16 Sept 2018	37	Jassid Leaf webber Spider Cow bug Lady bird beetle Red pumpkin Beetle	<i>Empoasca fabae</i> (Harris) <i>Grapholita critica</i> Meyr. <i>Telamonia dimediata</i> <i>Otinotus oneratus</i> W. <i>Cheilomenes sexmaculatus</i> Fab <i>Raphidopalpa foveicollis</i> (Lucas)	Cicadellidae Tortricidae Salticidae Membracidae Coleoptera Chrysomelidae	Hemiptera Lepidoptera Araneae Hemiptera Coccinellidae Coleoptera	56	
23 Sept 2018	38	Jassid Spider Cow bug Lady bird beetle Red pumpkin Beetle Red cotton bug	<i>Empoasca fabae</i> (Harris) <i>Telamonia dimediata</i> <i>Otinotus oneratus</i> W. <i>Cheilomenes sexmaculatus</i> Fab <i>Raphidopalpa foveicollis</i> (Lucas) <i>Dysdercus koengii Fabriciu</i>	Cicadellidae Salticidae Membracidae Coleoptera Chrysomelidae Hemiptera	Hemiptera Araneae Hemiptera Coccinellidae Coleoptera Pyrrhocoreidae	63	
30 Sept 2018	39	Jassid Lady bird beetle Red pumpkin Beetle Red cotton bug Grasshopper	<i>Empoasca fabae</i> (Harris). <i>Cheilomenes sexmaculatus</i> Fab <i>Raphidopalpa foveicollis</i> (Lucas) <i>Dysdercus koengii Fabriciu</i> <i>Cyrtacanthacris</i> sp.	Cicadellidae Coleoptera Chrysomelidae Hemiptera Orthoptera	Hemiptera Coccinellidae Coleoptera Pyrrhocoreidae Acrididae	70	
7 Oct. 2018	40	Lady bird beetle Red pumpkin Beetle Red cotton bu	<i>Cheilomenes sexmaculatus</i> Fab <i>Raphidopalpa foveicollis</i> (Lucas) <i>Dysdercus koengii Fabriciu</i>	Coleoptera Chrysomelidae Hemiptera	Coccinellidae Coleoptera Pyrrhocoreidae	77	
14 Oct. 2018	41	Lady bird beetle Red pumpkin Beetle Red cotton bug Blister beetle Green lace wing	<i>Cheilomenes sexmaculatus</i> Fab <i>Raphidopalpa foveicollis</i> (Lucas) <i>Dysdercus koengii Fabriciu</i> <i>Mylabris pustulata Thunberg</i> <i>Chrysoperla</i> sp.	Coleoptera Chrysomelidae Hemiptera Coleoptera Neuroptera	Coccinellidae Coleoptera Pyrrhocoreidae Meloidae Chrysopidae	84	
21 Oct. 2018	42	Lady bird beetle Red pumpkin Beetle Red cotton bug Blister beetle Thrips	<i>Cheilomenes sexmaculatus</i> Fab <i>Raphidopalpa foveicollis</i> (Lucas) <i>Dysdercus koengii Fabriciu</i> <i>Mylabris pustulata Thunberg</i> <i>Megalurothrips usitatus Bagnall</i>	Coleoptera Chrysomelidae Hemiptera Coleoptera Thysanoptera	Coccinellidae Coleoptera Pyrrhocoreidae Meloidae Thripidae	91	
28 Oct. 2018	43	Lady bird beetle Red pumpkin Beetle Red cotton bug Blister beetle Pod bug Plume moth	<i>Cheilomenes sexmaculatus</i> Fab <i>Raphidopalpa foveicollis</i> (Lucas) <i>Dysdercus koengii Fabriciu</i> <i>Mylabris pustulata Thunberg</i> <i>Clavigralla gibbosa Spinola</i> <i>Exelastis atomosa</i>	Coleoptera Chrysomelidae Hemiptera Coleoptera Hemiptera Lepidoptera	Coccinellidae Coleoptera Pyrrhocoreidae Meloidae Coreidae Pterophoridae	98	
4 Nov. 2018	44	Lady bird beetle Red cotton bug Blister beetle Pod bug Plume moth Green lace wing	<i>Cheilomenes sexmaculatus</i> Fab <i>Dysdercus koengii Fabriciu</i> <i>Mylabris pustulata Thunberg</i> <i>Clavigralla gibbosa Spinola</i> <i>Exelastis atomosa</i> <i>Chrysoperla</i> sp.	Coleoptera Hemiptera Coleoptera Hemiptera Lepidoptera Neuroptera	Coccinellidae Pyrrhocoreidae Meloidae Coreidae Pterophoridae Chrysopidae	105	
11 Nov. 2018	45	Lady bird beetle Pod fly Lady bird beetle Blister beetle Pod bug Plume moth Green lace wing	<i>Cheilomenes sexmaculatus</i> Fab <i>Melanagromyza obtusa Malloch</i> <i>Coccinella septempunctata Linn.</i> <i>Mylabris pustulata Thunberg</i> <i>Clavigralla gibbosa Spinola</i> <i>Exelastis atomosa</i> <i>Chrysoperla</i> sp.	Coleoptera Diptera Coleoptera Coleoptera Hemiptera Lepidoptera Neuroptera	Coccinellidae Agromyzidae Coccinellidae Meloidae Coreidae Pterophoridae Chrysopidae	112	
18 Nov. 2018	46	Gram pod borer Lady bird beetle Pod fly Lady bird beetle	<i>Helicoverpa armigera</i> Hub <i>Cheilomenes sexmaculatus</i> Fab <i>Melanagromyza obtusa Malloch</i> <i>Coccinella septempunctata Linn.</i>	Lepidoptera Coleoptera Diptera Coleoptera	Noctuidae Coccinellidae Agromyzidae Coccinellidae	119	RS

		Blister beetle Pod bug Plume moth Green lace wing	<i>Mylabris pustulata</i> Thunberg <i>Clavigralla gibbosa</i> Spinola <i>Exelastis atomosa</i> <i>Chrysoperla</i> sp.	Coleoptera Hemiptera Lepidoptera Neuroptera	Meloidae Coreidae Pterophoridae Chrysopidae		
25 Nov. 2018	47	Gram pod borer Lady bird beetle Pod fly Lady bird beetle Pod bug Plume moth Green lace wing Green stink bug	<i>Helicoverpa armigera</i> Hub <i>Cheilomenes sexmaculatus</i> Fab <i>Melanagromyza obtusa</i> Malloch <i>Coccinella septempunctata</i> Linn. <i>Clavigralla gibbosa</i> Spinola <i>Exelastis atomosa</i> <i>Chrysoperla</i> sp. <i>Nezara viridula</i> Linn.	Lepidoptera Coleoptera Diptera Coleoptera Hemiptera Lepidoptera Neuroptera Hemiptera	Noctuidae Coccinellidae Agromyzidae Coccinellidae Coreidae Pterophoridae Chrysopidae Pentatomidae	126	
2 Dec. 2018	48	Gram pod borer Pod fly Lady bird beetle Pod bug Plume moth Jassid Thrips Green lace wing Green stink bug	<i>Helicoverpa armigera</i> Hub <i>Melanagromyza obtusa</i> Malloch <i>Coccinella septempunctata</i> Linn. <i>Clavigralla gibbosa</i> Spinola <i>Exelastis atomosa</i> <i>E. fabae</i> (Harris) <i>M. usitatus</i> Bagnall <i>Chrysoperla</i> sp. <i>Nezara viridula</i> Linn.	Lepidoptera Diptera Coleoptera Hemiptera Lepidoptera Hemiptera Thysanoptera Neuroptera Hemiptera	Noctuidae Agromyzidae Coccinellidae Coreidae Pterophoridae Cicadellidae Thripidae Chrysopidae Pentatomidae	133	
9 Dec. 2018	49	Pod bug Gram pod borer Pod fly Green stink bug Green lace wing plume moth	<i>C. gibbosa</i> Spinola <i>H. armigera</i> Hub. <i>M. obtusa</i> Malloch <i>N. viridula</i> Linn. <i>Chrysoperla</i> sp. <i>E. atomosa</i> Walsingham	Hemiptera Lepidoptera Diptera Hemiptera Neuroptera Lepidoptera	Coreidae Noctuidae Agromyzidae Pentatomidae Chrysopidae Pterophoridae	140	
16 Dec. 2018	50	Pod bug Gram pod borer Pod fly Green stink bug Green lace wing plume moth Wasp	<i>C. gibbosa</i> Spinola <i>H. armigera</i> Hub. <i>M. obtusa</i> Malloch <i>N. viridula</i> Linn. <i>Chrysoperla</i> sp. <i>E. atomosa</i> Walsingham <i>Cotessia (Apanteles)</i> sp.	Hemiptera Lepidoptera Diptera Hemiptera Neuroptera Lepidoptera Hymenoptera	Coreidae Noctuidae Agromyzidae Pentatomidae Chrysopidae Pterophoridae Braconidae	147	
23 Dec. 2018	51	Gram pod borer Pod fly Lady bird beetle Pod bug Plume moth Thrips Green lace wing Green stink bug	<i>Helicoverpa armigera</i> Hub <i>Melanagromyza obtusa</i> Malloch <i>Coccinella septempunctata</i> Linn. <i>Clavigralla gibbosa</i> Spinola <i>Exelastis atomosa</i> <i>M. usitatus</i> Bagnall <i>Chrysoperla</i> sp. <i>Nezara viridula</i> Linn.	Lepidoptera Diptera Coleoptera Hemiptera Lepidoptera Thysanoptera Neuroptera Hemiptera	Noctuidae Agromyzidae Coccinellidae Coreidae Pterophoridae Thripidae Chrysopidae Pentatomidae	154	
30 Dec. 2018	52	Jassid Thrips Pod bug Gram pod borer Pod fly Green stink bug plume moth Spider	<i>E. fabae</i> (Harris) <i>M. usitatus</i> Bagnall <i>C. gibbosa</i> Spinola <i>H. armigera</i> Hub. <i>M. obtusa</i> Malloch <i>N. viridula</i> Linn. <i>E. atomosa</i> Walsingham <i>Telamonia dimediata</i>	Hemiptera Thysanoptera Hemiptera Lepidoptera Diptera Hemiptera Lepidoptera Araneae	Cicadellidae Thripidae Coreidae Noctuidae Agromyzidae Pentatomidae Pterophoridae Salticidae	161	
6 Jan. 2019	1	Pod fly Wasp Gram pod borer	<i>M. obtusa</i> Malloch <i>Cotessia (Apanteles)</i> sp. <i>H. armigera</i> Hub.	Diptera Hymenoptera Lepidoptera	Agromyzidae Braconidae Noctuidae	168	MS

Obs. = Observation, SW = Standard week CAD = Crop age in days, CGS = Crop growth stage, VS = Vegetative stage, RS=Reproductive stage, MS = Maturity stage.

**Pod bug, *Clavigralla gibbosa* Spinola (Hemiptera: Coreidae)**

First appearance of the pod bug was observed when the crop age was about 98 days, 43th SW (Table 1). It is evident that the pest was present on the crop during the reproductive stage and remained available upto the first week of January, 1st SW i.e. maturity stage of the crop (168 CAD). Both nymph and adult stages of the bug suck sap of developing seeds through the pod wall. Singh *et al.* (1989) [19] also reported that pest appeared during the first fortnight of the November, while Rana *et al.* (2008) [16] reported that the pest appeared on the crop from December to February. Other findings are Srilaxmi and Paul (2010) [25], Vikram

(2015) [29], Pandey *et al.*, (2016) [13], Bijewar *et al* (2019) [3].

**Pod borer, *Helicoverpa armigera* Hub. (Lepidoptera: Noctuidae)**

First appearance of the pod borer larva was observed when the crop age was about 119 days, 46th SW (Table 1). It is evident that the pest was present on the crop during the reproductive stage and remained available upto the first week of January, i.e. maturity stage of the crop (168 CAD). These findings are observations of Reddy *et al.* (1998) [19], Balikai and Yelshetty (2008) [2], Rathore (2011), Pandey (2013) [14], Pawar *et al.*, (2014) [15] and Shinde and Patel (2014) [20], They also reported that pod borer infested

pigeonpea from the flowering stage and remained active upto the maturity stage of the crop.

**Pod fly, *Melanagromyza obtusa* Malloch (Diptera: Agromyzidae)**

First appearance of the pod fly was observed when the crop age was about 105 days, 44th SW (Table 1). It is evident that the pest was present on the crop during the reproductive stage and remained available upto the first week of January, i.e. maturity stage of the crop (168 CAD). Maggot was the damaging stage. Fullygrown maggot makes a hole in the pod walls leaving a “window” through which the adult flies emerge after pupation. Similarly results findings of Sirohi (1990) [23] and Minja *et al.* (1999) [11], Srilaxmi and Paul (2010) [26], Pawar *et al.*, (2014) [15], Vikram (2015) [29], Pandey *et al.*, (2016) [13] and Bijewar *et al* (2019) [3] they also reported pod fly to infest pigeonpea crop from pod filling stage to maturity stage of the crop.

**Red gram plume moth, *Exelastis atomosa* Walsingham (Lepidoptera: Pterophoridae)**

First appearance of the red gram plume moth larva was observed when the crop age was about 98 days, 43th SW (Table 1). It is evident that the pest was present on the crop during the reproductive stage and remained available upto the first week of January, 1st SW i.e. maturity stage of the crop (168 CAD). Small spiny caterpillars and pupae seen on the pods The larva was the damaging stage, which feeds on buds, flowers and young pods and as a result of feeding, small holes are seen on the buds and tender pods. These findings are reported Srilaxmi and Ravinda (2010) [25]; Subharani and Singh (2004) and Yadav *et al.* (2009) [13], Pandey *et al.*, (2016) [13] and Bijewar *et al* (2019) [3].

**Blister beetle, *Mylabris pustulata* Thunberg (Coleoptera: Meloidae)**

First appearance of the adult blister beetles was observed when the crop age was about 84 days, 41<sup>st</sup> SW (Table 1). It is evident that the pest was present on the crop during the reproductive stage However, Mahalle (2008) [9] and Pawar *et al.*, (2014) [15] reported that blister beetle infested the vegetative stage and remained active upto the reproductive stage of the crop. Adult beetles were the damaging stage they feed on buds and flowers of pigeonpea to lead heavy shedding of buds and flowers.

**Thrips, *Megalurothrips usitatus* Bagnall (Thysanoptera: Thripidae):**

First appearances of the thrips were observed when the crop age was about 91 days, 42 SW (Table 1). It is evident that the pest was present on the crop during the reproductive stage and remained available upto. Maturity stage of the crop 161 days, 51 SW. The present findings corroborates the findings of Kumar and Nath (2003) [5] Balikai and Yelshetty (2008) [2], Mahalle (2008) [9], Landge (2009) [8] Ambhure (2012) [1], Pandey (2013) [14] and Pawar *et al.*, (2014) [15], Bijewar *et al* (2019) [3]. They also reported that thrips infested pigeonpea during the reproductive stage and remained available upto the maturity stage of the crop.

**Lady bird beetle, *Cheilomenes sexmaculatus* Fab. (Coleoptera: Coccinellidae)**

First appearance of the lady beetle was observed when the crop age was about 56 days, 37<sup>th</sup> SW (Table 1). It is evident

that the natural enemy was present on the crop from the vegetative stage and remained available upto the first week of December crop age was 133days, 48<sup>th</sup> SW i.e. reproductive stage of the crop. The natural enemy, lady bird beetle grub and adults were the predators, which devour eggs of some lepidopteran insect pests, nymph and adult stages of soft bodied insect species viz., aphids, jassids etc. the present finding are Ambhure (2012) [1] and Pandey (2013) [14], Pandey *et al.*, (2016) [13] and Bijewar *et al* (2019) [3].

**Greenlace wing, *Chrysoperla* sp. (Neuroptera: Chrysopidae)**

First appearance of the greenlace wing was observed when the crop age was about 84 days 41 SW (Table 1) i.e vegetative stage. It is evident that the natural enemy was present on the crop during the vegetative stage and remained available reproductive stage of the crop 105 days 44<sup>th</sup> SW. The present findings are in conformity with the findings Kumar and Nath (2007) [5] and Ambhure (2012) [1], Bijewar *et al* (2019) [3].

**References**

1. Ambhure Ganpatrao Krishna. Influence of crop biodiversity on pigeonpea insect pests and their natural enemies. M. Sc. (Ag) thesis submitted to JNKVV Jabalpur, 2012.
2. Balikai RA, Yelshetty S. Insect pest scenario of pigeonpea in Northern Karnataka. Legume Res. 2008; 31(2):149-151.
3. Bijewar AK, Das SB, Saxena AK. Succession of Insect Pest Complex and their Natural Enemies in Pigeonpea [*Cajanus cajan* (L) Millsp.] Int. J Curr. Microbiol. App. Sci. 2019; 8(7):619-628.
4. DES www.agricoop.nic.in. Agriculture Statistics at a Glance Directorate of Economics and Statistics, Department of Agriculture and Co-operation, 2012.
5. Kumar Akhilesh, Nath Paras. Influence of weather factors on population of insect pests in pigeonpea at vegetative and flowering stage. Presented in the “5th Nat. symp. on bio-control agents for sustainable management of pests” held at G.B. Pant Univ. of Agric. & Tech., Pantnagar, from, 2003, 137 pp.
6. Lal SS, Yadava CP. Ovipositional response of pod fly (*Melanagromyza obtusa*) on resistant pigeonpea (*Cajanus cajan*) selections. Indian Journal of Agricultural Sciences. 1993; 64(9):658-660.
7. Lal SS, Yadav CP, Ahmad R. Insect pests of short duration pigeonpea - A review. Pl. Prot. Bull. 1997; 49(5):32.
8. Landge Kumar S. Studies on pest complex of pigeonpea *Cajanus cajan* (L.) and their management under late sown condition. M.Sc. (Ag). thesis submitted to JNKVV Jabalpur, 2009, pp: 1-164.
9. Mahalle Sagar C. Studies on pest complex of pigeonpea *Cajanus cajan* and management of pod borer complex. M.Sc. (Ag.) Thesis, Jawaharlal Nehru Krishi Vishwavidyala, Jabalpur, 2008, pp.1-133.
10. Mapfumes P. Pigeonpea in Zimbabwe: A new crop with potential in soil fertility research for maize based farming systems in Malawi and Zimbabwe. International Pigeonpea Newsletter. 1993; (7):12.
11. Minja EM, Ongaro Shanower TG, Deritu JMN, Songa JM. Natural enemies associated with arthropod pests of

- pigeonpea in eastern Africa. Internat. Chickpea & Pigeonpea Newsletter. 1999; 6:47-50.
12. NCIPM. National Centre for Integrated Pest Management LBS Building Pusa Campus, New Delhi-110012; ipmnet@bol.net.in: www.ncipm.org.in, 2012.
  13. Pandey AK, Keval R, Yadav A, Srivastava CP. Seasonal incidence of pod fly (*Melanagromyza obtusa* Malloch) and pod bug (*Clavigralla gibbosa* Spinola) in short duration pigeonpea. Journal of Applied and Natural Science. 2016; 8(1):28-30.
  14. Pandey SA. Studies on pod infesting insect pest complex of pigeonpea *Cajanus cajan* L. (Millsp.) and their control with insecticides and biopesticides. M.Sc. (Ag) thesis submitted to JNKVV Jabalpur, 2013.
  15. Pawar UA, Chintkuntalawar PS, Ugale TB. Studies on succession of insect pest complex and their natural enemies in pigeonpea [*Cajanus cajan* (L.) Millsp.]. International Journal of Plant Protection. 2014; 7(2):318-324.
  16. Rana NS, Rana DK, Gupta A, Shukla BC, Sharma RN. Study of population dynamics of insect pests of pigeonpea. Presented in "Nat. Conf. on pest mgmt. strategies for food security" held at College of Agriculture, I.G.K.V., RAIPUR, C.G. (INDIA), from, 2008, pp. 33.
  17. Rana NS, Rana DK, Gupta A, Shukla BC, Sharma RN. Study of population dynamics of insect pests of pigeonpea. Presented in "Nat. Conf. on pest mgmt. strategies for food security" held at College of Agriculture, I.G.K.V., RAIPUR, C.G. (INDIA), from, 2008, pp. 33.
  18. Rao SC, Coleman SW, Mayeux HS, Crop Sci. 2002; 42:1259-1263.
  19. Reddy NC, Singh Y, Singh VS. Pest complex and their succession on pigeonpea variety P-33. Indian J Ent. 1998; 60(4):334-335.
  20. Shinde YA, Patel BR. Succession of insect pests and their natural enemies on pigeonpea. Insect Environment. 2014; 19(4):253-256.
  21. Singh C, Singh P, Singh R. Modern techniques of raising field crops. (2nd Edn.) Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi, 2007, pp. 229-230.
  22. Singh KJ, Singh OP, Thakur RC. Seasonal and off-season activity of tur-pod bug (*Clavigralla gibbosa*). Indian J Agric. Sci. 1989; 59(3):187-188.
  23. Sirohi RS. Studies on insect pest complex of pigeonpea [*Cajanus cajan* (L.) Mill.] species. M.Sc. (Ag.) Thesis, Jawaharlal Nehru Krishi Vishwavidyala, Jabalpur, 1990, pp. 1-66.
  24. Snapp SS, Rohrbach DD, Simtowe F, Freeman HA. Sustainable soil management options for Malawi: Can smallholder farmers grow more legumes? Agriculture, Ecosystems and Environment. 2002; 91:159-174.
  25. Srilaxmi K, Paul R. Diversity of insect pests of pigeonpea (*Cajanus cajan* (L.) Millsp) and their succession in relation to crop phenology in Gulbarga, Karnataka. International Journal of Environmental Sciences. 2010; 4(4):273-276.
  26. Srilaxmi K, Ravinda P. Diversity of insect pests of pigeonpea [*Cajanus cajan* (L.) Millsp.] and their succession in relation to crop phenology in Gulbarga, Karnataka. The Ecoscan. 2010; 4(4):273-276.
  27. Subharani S, Singh TK. Insect pest complex of pigeonpea (*Cajanus cajan* ) in agro-ecosystem of Manipur. Indian J. Entomol. 2004; 66(3):222-224.
  28. Upadhyay RK, Mukherji KG, Rajak RI. IPM system in agriculture 4: pulses, New Delhi, 1998, 99 pp.
  29. Vikram A, Keval R, Srivastava CP, Yadav A. Seasonal incidence of pod fly, *Melanagromyza obtusa* (Malloch) and pod bug, *Clavigralla gibbosa* (Spinola) in long duration pigeonpea. Journal of Experimental Zoology. 2015; 18:795-797.
  30. Yadav RS, Rai SN, Prasad S, Sing J. Diversity of insect pests in pigeonpea, *Cajanus cajan* (L.) Millsp, in eastern Uttar Pradesh. Appl. Zool. Res. 2009; 20(1):127-131.