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Impact of Chickpea Varieties and Sowing Dates on Pod Borer *Helicoverpa armigera* (Hubner)

H.S. Randhawa[1], Charanjeet Kaur[2], Guriqbal Singh[3], G.K. Taggar[3]

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ABSTRACT

Background: Global warming and climate change will have a major bearing on population and incidence of insect-pests and their associated yield and quality losses in different crops. In chickpea, a number of insect-pests are observed which mainly limit its production and productivity. Among these, gram pod borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is a major and prominent pest in different chickpea growing areas of the country. The increased demand of residue free crop produce will definitely motivate farmers to select alternative management strategies instead of insecticides for management of insect-pests. Therefore, the current study aimed to determine the effect of different chickpea varieties at different dates of sowing on the population and incidence of gram pod borer.

Methods: The present study was conducted at Regional Research Station, PAU-Gurdaspur during *Rabi* seasons of 2019-20 and 2020-21 to determine the effect of chickpea varieties (PBG 7 and PBG 8) and different sowing dates *viz*. 25thOctober, 05, 15 and 25thNovember on the larval population and per cent pod borer infestation of *Helicoverpa armigera*.

Result: It was concluded that both the tested chickpea varieties had non-significant effect on population of pod borer, pod damage and gram yield. However, the pod borer's larval population and pod infestation decreased across sowing dates from last week of October to last week of November. The mean larval population and incidence of *H. armigera* decreased with a delay in time of sowing *i.e.* 7.88 and 5.29 larvae/3 rows and 62.96 and 42.27% pod damage in the 25thOctober and 25thNovember sown crop, respectively. The maximum grain yield (17.45 q/ha) was obtained from 15th November sown crop.

Key words: Chickpea, Global warming, Impact, Infestation, Non-significant, Pod borer, *Rabi*, Sowing dates, Varieties.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the most important *Rabi* pulse crop of India and occupies first position among the pulses crops. Although all the pulses occupy a unique position in Indian agriculture as well as throughout the world, chickpea is considered as "King of Pulses". It is a rich source of calcium, iron, niacin, vitamin B and C; and provides the valuable protein supplement to the diet of the predominately-vegetarian human population-besides-contributing to the national income. It is also considered to have medicinal value for blood purification and beneficial for diabetic patients. It is also widely used as fodder and green manure. It is one of the most important food legume crops in sustainable agriculture systems because of its low production cost, wider adaptation, ability to fix atmospheric nitrogen and fit in various crop rotations (Singh, 1997). It can be grown profitably on residual moisture in heavy soils, in rainfed rice fallow lands (RRFL) without or with minimum irrigation. In India, the main chickpea growing states are Madhya Pradesh, Uttar Pradesh, Rajasthan, Bihar, Haryana, Maharashtra and Punjab.

Several biotic and abiotic constraints limit the production and productivity of chickpea. But, insect-pests are a major constraint to decrease the production and productivity of chickpea (Sharma *et al*., 2007; Yadav *et al*., 2006). Losses due to insect pest damage are likely to increase as a result of changes in cropping patterns and global warming. On chickpea, a number of insect-pests are observed such as aphid (*Aphis craccivora* Koch), jassids (*Empoasca kerri* Pruthi), pea aphids (*Acrythosiphum pisum* Harris), thrips (*Megalurothrips usitatus (*Bugnall), whitefly (*Bemisia tabaci* Gennadius), gram pod borer (*Helicoverpa armigera* Hubner), gram semilooper (Autographa nigrisigna (Walker)), termites (*Odontotermes obesus* Ramb. and *Microtermes obesi* Heomgr), cutworm (*Agrotis ipsilon* Rott), budworm (*H. punctigera*), leaf miner (*Liriomyzaci trifolli* Burgess) and pulse beetle (*Callosobruchus chinensis* Linnaeus) (Mosier *et al*., 2004; Anandhi *et al*., 2011;

[1]Punjab Agricultural University, Regional Research Station, Gurdaspur-143 521, Punjab, India.
[2]Farm Advisory Service Centre Gangian, Hoshiarpur-144 205, Punjab, India.
[3]Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana-141 004, Punjab, India.

Corresponding Author: H.S. Randhawa, Punjab Agricultural University, Regional Research Station, Gurdaspur-143 521, Punjab, India. Email: harpals_randhawa@pau.edu

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Sachanand Katti, 1994, Sharma *et al*., 2007; Ram *et al*., 2021). Among these gram pod borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is a major and prominent pest in different chickpea growing areas of the country, accounting for 21% of crop yield losses and 50-60% of crop pod losses (Kambrekar, 2012). The adult of pod borer is a light reddish-brown moth with a prominent dot near the middle of the forewing. The caterpillars have variable colours ranging from green, brown or yellow. The caterpillars feed on the leaves, floral parts, pods and developing grains in pods (Begum *et al*., 1992; Anonymous, 2021). It assumed a major pest status across number of crops because of its high fecundity, migratory behavior, high adaptation to various climatic conditions and development of resistance to a range of insecticides (Rheenen and Rheenen, 1991; Srivastava, 2003). Currently, the insect-pests control is dominated by synthetic chemical use based on pest scouting and pre-determined action levels. This has resulted in the overuse of these pesticides, leading to the killing of natural enemies and development of resistance (Magallona, 1989; Forget, 1993; Tudi *et al*., 2021).

A number of cultural practices like sowing dates, crop rotation, selection of resistant cultivars, judicious use of fertilizers and proper plant spacing (Matthews and Turnstall, 1994) can be used in place of synthetic pesticides. Many of these practices were overlooked in preference to the effective and easy-to-use pesticides. Now the Indian population is being more aware about health, which has opened doors for production of organic food and these points towards bright future for resistant varieties. The increased demand of residue free products will definitely motivate farmers to select resistant varieties for management of insect-pests. Host plant resistance is a relationship between the plant feeding insects and their hosts. The resistance enables plants to avoid, tolerate or recover from the effects of insect-pests attack and has proved to be a successful tool against insects in many crops (Felkl *et al*., 2005). Plant genotypes, either due to environmental stress or genetic makeup, possess physiological and biochemical differences which alter the nutritional value (primary metabolites) for plant feeding insects (Alvim *et al*., 2004). Secondly management of the pest through agronomic manipulation was considered as a possible way, as most of the insects infest the plant/crop at particular growth stage under certain environmental conditions which may be manipulated by sowing the crop on different dates (Singh *et al*., 2002). Several researchers have studied the effect of different dates of sowing and the seasonal abundance of gram pod borer with the corresponding yield of chickpea in different parts of India. It is learnt from the past studies of Deka *et al*. (1989), Yadava *et al*. (1991) and Cumming and Jenkins (2011) where they stated that the date of sowing has a great impact on the incidence of the insect-pests which may be attributed to the difference in weather conditions. The objectives of present study hence were to: (1) establish optimum sowing dates for new gram varieties (PBG 7 and PBG 8) and (2) test the new varieties for susceptibility to infestation by gram pod borer. Therefore, the present investigation was formulated to determine the effect of different dates of sowing on the incidence of *H. armigera* with different varieties of chickpea.

MATERIALS AND METHODS

Field experiments were carried out during *Rabi* seasons of 2019-20 and 2020-21 at the PAU Regional Research Station, Gurdaspur located in North-West Province of Punjab. The station is located at 75.24°E and 32.02°N and 265 metres above sea level. It is in sub-mountainous region of Punjab and receives an average 1000 mm annual rainfall. In summer, average temperatures over 32°C (max.) and 24°C (min.) and a relative humidity of 92.5% and 83.5% in October and April, respectively. The soil at, Gurdaspur (Punjab) India has been classified as fine loamy, non-calcareous, developed under hyperthermic regime (USDA: Typic Haplustalfs) (Soil Survey Staff, 2003) with silt loam texture-(41.0% sand, 39.0% silt, 20.0% clay). The experiments were laid out in a factorial randomized block design with two factors *i.e*. varieties and dates of sowing with four replications. Two chickpea varieties i.e. PBG 7 and PBG 8 were sown across four sowing dates *viz*. 25th Oct, 05th, 15th and 25th November in *Rabi* seasons during 2019-20 and 2020-21. The plot size of each treatment was kept as 10.0 m^2 and the buffers were maintained with 1.5 and 1.0 meter between replication and treatment plots, respectively. The seeds were sown in furrows in a depth of 3-4 cm with space of 30 × 15 cm. The experimental plots were maintained with margins at a large distance from the surrounding fields to make sure that the insecticides sprayed to other fields do not affect the study plots. The crop was raised by following all recommended package of practices for *Rabi* crops of Punjab Agricultural University, Ludhiana except plant protection measures which enabled the buildup of insect-pests in a pesticide free environment.

The data on larvae population were recorded at weekly interval from three central rows of each treatment of the field. The outermost rows were left as border rows and excluded from sampling. The crop monitoring was started and terminated at 30 and 140 days after sowing, respectively as suggested by Saini and Jaglan (1998) and Ahmed and Rai (2005). One day before harvesting, the healthy and infested pods from 10 randomly selected plants were counted and per cent infestation of pod borer was determined. The per cent pod damage was calculated by using formula given below,

$$\text{Pod damage (\%)} = \frac{\text{No. of damaged pods}}{\text{No. of total pods}} \times 100$$

Harvesting and threshing was done separately of each plot and grain yield data recorded from each treatment for assessment of yield losses. Cumulative yield of each treatment was converted into quintal per hectare. Thus, the data recorded during the course of investigation were

subjected to statistical analysis by using square root transformation (Sheoran, 1998).

RESULTS AND DISCUSSION

Effect of chickpea varieties and sowing dates on

Larval population of pod borer, *H. armigera*

The data regarding mean larval population per three central rows for each treatment of gram pod borer were recorded during the year 2019-20 and 2020-21 and presented in Table 1. The results indicated that mean larval population had a significant and non-significant interaction between dates of sowing and varieties of chickpea, respectively during both the years. However, the larval population of *H. armigera* decreased with delay in sowing of chickpea crop. The significantly maximum (av. of two varieties) larval population per three rows was recorded 8.06 and 7.69 (Table 1) from chickpea crop that was sown at 25th October and it was followed by the 05th November sown crop with (mean of two vars.) larval population 7.42 and 7.19 during year 2019-20 and 2020-21, respectively while mean minimum larval population 5.29 and 5.28 recorded on the crop sown on 25th November during year 2019-20 and 2020-21, respectively. The data on pooled mean larval population for two years was demonstrated in decreasing order with respect to date of sowing of both cultivars (PBG 7 and PBG 8) as 25th October>5th November>15th November>25th November with mean larval population 7.88>7.31>6.60>5.29 per three central rows. The more larval population at the early dates of sowing can be attributed to the fact that, during this period the vegetative growth of crop was more which resulted in higher larval population of pod borer.

Pod damage due to gram pod borer, *H. armigera*

The data pertaining to per cent pod damage due to *H. armigera* at different sowing dates and varieties during the year 2019-20 and 2020-21 are presented in Table 2. The data showed that the pod borer's incidence did not differ significantly between tested chickpea varieties during both years. The data further revealed that per cent pod infestation (av. both cultivars) due to pod borer varied 42.29-64.44 and 42.25-61.49 during the year 2019-20 and 2020-21, respectively. The first date of sowing (25th October), recorded highest pod borer's incidence (64.44 and 61.49 %) and followed by second and third dates of sowing (05th and 15th November) which recorded mean infestation 59.32 and 57.50% during the year 2019-20 and 2020-21, respectively. The significantly lowest pod damage 42.29 and 42.25% was recorded from 04th dates (25th November) of sowing of year 2019-20 and 2020-21, respectively. The pooled mean data on pod infestation for two years was demonstrated in decreasing order with respect to date of sowing of both chickpea varieties (PBG 7 and PBG 8) as 25th October>5th November>15th November>25th November with pod incidence 62.96>58.41>52.44>42.27 per cent. The higher pod infestation (%) at the early dates of sowing can be attributed to the fact that, advance sowing of crop has more vegetative growth which resulted in more larval population and more pod infestation. However, per cent pod incidence varied non-significantly between two tested varieties.

Grain yield of chickpea

The data on grain yield of chickpea was recorded after harvesting of the crop and it was significantly varied to the different sowing dates and varieties (Table 3). During both years (2019-20 and 2020-21), the maximum yield (16.97 and 17.93 q/ha) was recorded on third date of sowing *i.e.*, 15th November followed by 25th November (15.86 and 17.01 q/ha), whereas minimum grain yield (15.09 and 14.74 q/ha) was obtained from crop sown on first date of sowing *i.e.*, 25th October (Table 3). Pooled data on grain yield per hectare (Table 3) showed non-significant interaction between sowing dates and gram varieties. But grain yield was increased as the crop sowing delayed up to 15th November during study period.

Regarding the impact of chickpea varieties and dates of sowing for multiplication of pod borer, *Helicoverpa armigera*, the results are in accordance with Kumar *et al*. (1983), Borah (1998) and Patnaik (2004) who reported that sowing dates had a greater effect on pest population, their incidence and grain yield when sown in first week of November than second week of December. Kabir *et al*. (2009) were also observed maximum yield in November 22 sown chickpea crop followed by December 2 and December 12 sown crop. Singh *et al*. (2008) also recorded yield losses from different locations varied from 37 to 50% due to *H. armigera*. Present finding was corroborated with the results of Prasad

Table 1: Effect of sowing dates and varieties on larval population of *Helicoverpa armigera.*

Date of sowing	Larval population per three rows								
	2019-20			2020-21			Pooled mean		
	PBG 7	PBG 8	Mean	PBG 7	PBG 8	Mean	PBG 7	PBG 8	Mean
D1 (25 Oct)	8.14 (3.02)	7.97 (2.99)	8.06 (3.00)	7.94 (2.99)	7.44 (2.90)	7.69 (2.94)	8.04 (3.01)	7.71 (2.95)	7.88 (2.99)
D2 (05 Nov)	7.60 (2.93)	7.24 (2.86)	7.42 (2.90)	7.38 (2.89)	7.00 (2.82)	7.19 (2.86)	7.49 (2.91)	7.12 (2.84)	7.31 (2.88)
D3 (15 Nov)	6.78 (2.78)	6.62 (2.75)	6.70 (2.76)	6.44 (2.72)	6.38 (2.70)	6.41 (2.71)	6.61 (2.76)	6.58 (2.75)	6.60 (2.76)
D4 (25 Nov)	5.59 (2.55)	4.98 (2.40)	5.29 (2.50)	5.44 (2.52)	5.13 (2.42)	5.28 (2.47)	5.52 (2.55)	5.06 (2.44)	5.29 (2.51)
Mean	6.99 (2.81)	6.74 (2.76)	6.87 (2.81)	6.80 (2.78)	6.48 (2.71)	6.64 (2.76)	6.92 (2.81)	6.62 (2.74)	6.77 (2.79)
CD	Varieties: NS and dates: (0.30)			Varieties: NS and dates: (0.33)			Varieties: NS and dates: (0.23)		

NS- Non-significant.

Table 2: Effect of sowing dates and varieties on percent pod damage due to *Helicoverpa armigera.*

Date of sowing	Pod damage (%)								
	2019-20			2020-21			Pooled mean		
	PBG 7	PBG 8	Mean	PBG 7	PBG 8	Mean	PBG 7	PBG 8	Mean
D1 (25 Oct)	65.12 (8.12)	63.76 (8.04)	64.44 (8.08)	63.50 (8.02)	59.48 (7.76)	61.49 (7.89)	64.31 (7.29)	61.62 (7.91)	62.96 (7.60)
D2 (05 Nov)	60.76 (7.84)	57.88 (7.65)	59.32 (7.75)	59.00 (7.73)	56.00 (7.53)	57.50 (7.63)	59.88 (7.03)	56.94 (7.59)	58.41 (7.32)
D3 (15 Nov)	54.26 (7.38)	52.98 (7.31)	53.62 (7.35)	52.50 (7.81)	51.00 (7.16)	51.95 (7.18)	52.24 (7.60)	52.63 (7.31)	52.44 (7.01)
D4 (25 Nov)	44.72 (6.71)	39.86 (6.23)	42.29 (6.47)	43.50 (6.62)	41.00 (6.28)	42.25 (6.45)	44.11 (6.17)	40.43 (6.35)	42.27 (6.26)
Mean	55.89 (7.50)	53.94 (7.33)	54.92 (7.48)	54.38 (7.39)	52.87 (7.18)	53.30 (7.37	55.13 (6.77)	52.90 (7.29)	54.02 (7.42)
CD	Varieties: NS and dates: (0.92)			Varieties: NS and dates: (1.01)			Varieties: NS and dates: (0.71)		

NS- Non-significant.

Table 3: Effects of dates of sowing and chickpea varieties on grain yield.

Date of sowing	Yield (Q/ha)								
	2019-20			2020-21			Pooled Mean		
	PBG 7	PBG 8	Mean	PBG 7	PBG 8	Mean	PBG 7	PBG 8	Mean
D1 (25 Oct)	14.87 (3.98)	15.30 (4.04)	15.09 (4.01)	14.33 (3.92)	15.15 (4.02)	14.74 (3.97)	14.60 (3.95)	15.23 (4.03)	14.92 (3.99)
D2 (05 Nov)	15.25 (4.03)	16.46 (4.18)	15.86 (4.11)	15.77 (4.09)	16.66 (4.20)	16.22 (4.15)	15.51 (4.06)	16.56 (4.19)	16.04 (4.13)
D3 (15 Nov)	16.37 (4.17)	17.57 (4.31)	16.97 (4.24)	17.87 (4.34)	17.98 (4.36)	17.93 (4.35)	17.12 (4.26)	17.77 (4.33)	17.45 (4.30)
D4 (25 Nov)	14.69 (3.96)	17.02 (4.25)	15.86 (4.10)	17.23 (4.27)	16.79 (4.22)	17.01 (4.24)	15.96 (4.12)	16.90 (4.23)	16.43 (4.18)
Mean	15.30 (4.04)	16.59 (4.19)	-	16-30 (4.16)	16.25 (4.20)	-	15.80 (4.10)	16.62 (4.20)	-
CD	Varieties: NS and dates: (0.02)			Varieties: NS and dates: (0.07)			Varieties: NS and dates: (0.04)		

NS- Non-significant.

and Singh (1997) and Singh *et al*. (2002) and it has been reported that the pod filling ability in chickpea varieties also varied with sowing dates and exhibited a definite trend on pod damage. Jamor and Jamir (2015) also recorded minimum population of *H. armigera* in late sown crop of pea. The *H. armigera* larval population was high in early sown crop (October 15th to November 1st) than in delayed sowing *i.e*. after first week of November (Anwar *et al*. 1994). Similar observations were also published by Rishi *et al*. (2016), Singh *et al*. (2005), Singh and Yadav, (2006) and Pavani *et al*. (2019).

CONCLUSION

The present study concluded that very early sown crop had more population and pod infestation of pod borer, *Helicoverpa armigera*. It was further indicated that higher grain yield could be obtained by sowing the crop during 2nd week November. However, interaction between dates of sowing and varieties clearly indicated non-significant effect on larval population, pod damage and grain yield. Therefore, high quantum in grain yield losses can be lowered by the adoption of improved technologies for its cultivation, which include the sowing of pest resistant/tolerant variety at optimum time supported with recommended agronomic manipulation. Hence, for ensuring the less insect-pest infestation, chickpea should be sown in second week of November.

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REFERENCES

Ahmad, R. and Rai, A.B. (2005). Twenty-five years of research on *Helicoverpa armigera* at IIPR. Indian Institute of Pulses Research, Kanpur. pp. 54.

Alvim, G.S.J., Collevatti, R.G., Fernandes, G.W. (2004). Effects of genetic variability and habitat of *Qualea parviflora* (Vochysiaceae) on Herbivory by free feeding and Gall-forming Insects. Annals of Botany. 94: 259-268.

Anandhi, D.M.P., Elamathi, S.,Sobita, S. (2011). Evaluation of bio-rational insecticides for management of *Helicoverpa armigera* in chickpea. Annals of Plant Protection Sciences. 19: 207-209.

Anonymous, (2021). Package of Practices for *Rabi* Crops. Punjab Agricultural University, Ludhiana: 68-70.

Anwar, M., Shafique, M., Ahmad, M., Shaloori, A.P. (1994). Incidence of attack and population fluctuation of *Heliothis* armigera in relation to chickpea phenology and environmental factors. Proceedings of Pakistan Congress of Zoology. 12.

Begum, N., Hussain, M., Chowdhury, S.I. (1992). Effect of sowing date and plant density of pod borer incidence and grain yield of chickpea in Bangladesh. International Chickpea Newsletter. 27: 19-21.

Borah, R.K. (1998). Influence of sowing dates on the infestation of *Helicoverpa armigera* and grain yield of chickpea in the hill zone of Assam. Indian Journal of Entomology. 60: 416-417.

Cumming, G. and Jenkins, L. (2011). Chickpea: Effective crop establishment, sowing window, row spacing, seeding depth and rate. Australian Pulse Bulletin. 7: 1-4.

Deka,N. K., Prasad, D., Chand, P. (1989). Plant growth, *Heliothis* incidence and grain yield of chickpea as affected by date of sowing. Journal Research Birsa Agricultural University. 1: 161-168.

Felkl, G., Jensen, E.B., Kristiansen, K. andersen, S.B. (2005). Tolerance and antibiosis resistance to cabbage root fly in vegetable *Brassica* species. Entomologia Experimentalis et Applicata. 116: 65-71.

Forget, G. (1993). Balancing the need for pesticides with the risk to human health. In: Impact of Pesticide Use on Health in Developing Countries. [(Eds.) Forget, G., Goodman, T. and Villiers, A.] IDRC, Ottawa, p. 2.

Jamoh, R. and Jamir, I.T. (2015). Effect of dates of sowing and varieties on pest complex of garden pea (*Pisum sativum* Linn). National Academy of Agricultural Science. 33: 1825-1830.

Kabir, H.M.F., Bari, M.N., Abdul, K.M.D., Khaliq, Q.A., Ahmed, J.U. (2009). Effect of sowing time and cultivars on the growth and yield of chickpea under rainfed condition. Bangladesh Journal of Agricultural Research. 34: 335-342.

Kambrekar, D.N. (2012). Management of pod borer in chickpea. The Hindu, http://www. thehindu.com/scitech/agriculture/ management-of-pod-borer in chickpea/article4143687.ece.

Kumar, R., Yadav, H.L., Yadav, D.S. (1983). Comparative performance of promising gram varieties under different dates of sowing. Indian Journal of Agronomy. 28: 87-88.

Magallona, E. (1989). Effects of insecticides in rice ecosystems in Southeast Asia. Ecotoxicology and climate: With special reference to hot and cold climates. Wiley, Chichester. Pp. 265-297.

Matthews, G.A. and Turnstall, J.P. (1994). Insect-pests of cotton (eds). CAB International, Wallingford.

Mosier, A.R., Syers, J.K., Freney, J.R. (2004). Nitrogen Fertilizer: An essential component of increased food, feed and fibre production. In [A.R. (eds.)] Agriculture and the Nitrogen Cycle. Washington, DC, Island Press. pp. 291.

Patnaik, H.P. (2004). Influence of sowing dates, spacing and varieties on the incidence of *Helicoverpa armigera* (Hubner) in chickpea in northern Orissa. Legume Research. 27: 129-133.

Pavani, T.R., Babu, T., Sridevi, D, Radhika, K., Sharma, H.C. (2019). Effect of different sowing dates on pest incidence in chickpea. International Journal of Current Microbiology Applied Science. 8: 627-637.

Prasad, C.S. and Singh, V.P. (1997). Impact of variety, sowing date and control measures on incidence of pod borer, *Helicoverpa armigera* (Hub.) and yield of chickpea. Annals of Plant Protection Science. 5: 26-28.

Ram, V., Chandra, U., Gautam, C.P.N., Yadav, S.K., Sharma, S., Kumar, S., Kumar, A. (2021). Study on incidence of insect pests in chickpea. Journal of Entomology and Zoology Studies. 9: 146-150.

Rheenen, H.A.V. and Rheenen, H.A.V. (1991). Chickpea breeding progress and prospects. Plant Breeding. 61: 997-1009.

Rishi, P., Singh, R., Malik, Y.P., Kumar, A. (2016). Seasonal incidence of gram pod borer *Helicoverpa armiger*a (Hubner) on prominent variety of sown different dates on chickpea. South Asian Journal Food Technology Environment. 2: 399-407.

Sachan, J.N. and Katti, G. (1994). Integrated pest management. Proceeding of International Symposium on Pulses Research, IARI, New Delhi, India. pp. 23-30.

Saini, P.K. and Jaglan, R.S. (1998). Incidence of *Helicoverpa armigera* Hubner in chickpea during different months. Annals of Agriculture Biosphere Research. 3: 101-103.

Sharma, H.C., Gowda, C.L.L., Stevenson, P.C., Ridsdill-Smith, T.J., Clement, S.L., Rao, G.V.R., Romeis, J., Miles, M., El-Bouhssini, M. (2007). Host plant resistance and insect management in chickpea chapter published in Chickpea. Breeding and Pest Management. pp. 520-37.

Sheoran, O.P., Tonk, D.S., Kaushik, L.S., Hasija, R.C., Pannu, R.S. (1998). Statistical Software Package for Agricultural Research Workers. In: Recent Advances in Information Theory, Statistics and Computer Applications by [Hooda, D.S. and Hasija, R.C.] Department of Mathematics Statistics, CCS HAU, Hisa. pp. 139-143.

Singh, K.B. (1997). Chickpea (*Cicer arietinum* L.). Field Crops Research. 53: 161-170.

Singh, S.S. and Yadav, S.K. (2006). Evaluation of chickpea varieties for their resistance against gram pod borer, *Helicoverpa armigera*. Indian Journal of Entomology. 68: 321-324.

Singh, C.B., Shrivastava, A.K., Rai, M.K. (2008). Survey and assessment of status of *Helicoverpa armigera* in district Jhansi on chickpea. Indian Journal of Entomology. 70: 113-117.

Singh, V., Siag, R.K., Vijay, P. (2005). Seasonal occurrence of larval population of *H. armigera* (Hub.) on chickpea in North-West Rajasthan. Indian Journal of Pulses Research. 18: 92-93.

Singh, H., Singh, I., Mahajan, G. (2002). Effect of different dates of sowing on the incidence of gram pod borer (*Helicoverpa armigera*) on different cultivars of chickpea (*Cicer arientinum*). Agriculture Science Digest. 22: 295-296.

Soil Survey Staff. (2003). Keys to Soil Taxonomy, 9th edition. United States Department of Agriculture, Natural Resources Conservation Service. Available online.

Srivastava, S. K. (2003). Relative performaFig urence of varies chickpea genotypes by *Helicoverpa armigera* (Hubner) and estimation of yield losses under late sown condition. Indian Journal of Pulses Research. 16: 144-146.

Tudi, M., Ruan, H. D., Wang, L., Lyu, J. (2021). Agriculture development, pesticide application and its impact on the environment. International Journal of Environmental Research and Public Health. 18(3): 1112. doi: 10.3390/ijerph18031112.

Yadav, S.S., Kumar, J., Yadav, S.K., Singh, S., Yadav, V.S., Turner, N.C., Redden, R. (2006). Evaluation of *Helicoverpa* and drought resistance in desi and kabuli chickpea. Plant Genetics Resources. 4: 198-203.

Yadava C.P., Lal S.S., Ahmad, R., Sachan, J.N. (1991). Influence of abiotic factors on relative abundance of pod borers of chickpea (*Cicer arietinum*). Indian Journal of Agricultural Sciences. 61: 512-515.