Insect pest of chickpea and their Management-A Review

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Abstract: Chickpea (*Cicer arietinum* L.) is known in India by different names: Bengal gram, gram and chana. India is the largest producer of chickpea accounting for 64% of the global production. But in recent years chickpea production is constrained by diseases and insect-pests. Among the insect-pests, pod borer is the most severe yield reducer throughout India, while the bruchids cause severe damage in storage. Other major insect pests of chickpea are termite and cutworm and their managements through new generation insecticides and botanicals extracts.

Introduction

Chickpea (*Cicer arietinum* L.) is one of the world's most valuable food grain legumes, with 14.78 million tons of production from an area of 14.56 million hectares and 1014.60 kg / ha of productivity in 2017. (FAOSTAT,2019) It is also referred to as "Chana" or "Bengal gram" as a leguminous pulse crop. It is a very important component of dry, rain fed cropping systems since it can repair nitrogen fixation of eighty to one hundred and twenty kilogram (Golding & Dong,2010) It is an essential energy, protein and soluble and insoluble fiber are supply. There are60-65 percent carbohydrate, 6 percent fat and about 12 to 31 percent in old seed, which is better than any other pulses. Chickpea are also a good source of vitamins (vitamin B in particular) and minerals such as K, P2o5, Su, Fe, Mg, Zn by increasing atmospheric nitrogen, chickpea plays an important function in improving soil fertility and the crop satisfies up to eighty percent of soil nitrogen.

There are many reasons responsible for the poor production of this crop. In field condition and storage condition insect pest and diseases are plays a very important role against crop production (Bentley & Clements,1989) About sixty insect species are known to feed on chickpea (Parsai,2005) Among the many arthropods sap sucking pests, particularly Aphids, Jassids,

Thrips, Whitefly are the most destructive chickpea pests in Asia, Africa and Australia (Balikai et al.,2001; Devendra &Binay 2002).

On chickpea the number of sucking pests are observed by scientist such as Aphids – Aphis craccivora Koch,1854, its belongs to order Hemiptera, Aphididae which cause the suck the juice from flower, newly emergence leaves; another pest is jassids – *Empoasca kerri* Pruthi,1940;Pea aphids- *Acrythosiphum pisum* Harris ,1776;Thrips – *Megalurothrips usitatus* Bugnall,1913;Whitefly , *Bemisia tabaci* Gennadius,1889 (Mosier et al.,2004; Anandhi et al.,2011;Sachan&Katti,1994).The region's main biotic stresses are Gram pod borer (Hubner), gram semiloper (*Autographa nigrisigna*), termites (*Odontotermes obesus* Ramb. and *Microtermes obesi* Heomgr), cutworm (*Agrotis ipsilon* Rott), aphid (*Aphis craccivora* Koch). Gram pod borer is a major insect, accounting for twenty one percent of crop yield losses and 50-60 per cent of crop pod losses.(Kambrekar,2012). The different pest control practices are used and their effectiveness compared by population assessment of each pest (Pradhan,1964). Chemical, biological, botanical pesticides and IPM are the techniques of pest management used compared with farmers' practice and untreated control (Satpute,1999; Weigand etal.,1992; Nene & Readdy,1997; Reed et al.,1987).

Due to rapid and efficient pest control, the application of chemical insecticides is widespread among the farming population. Conventional insecticides do not have satisfactory monitoring, resulting in successive rounds of application of insecticides, control failures, resistance etc. growth which cause the environmental pollution. The quest for appropriate and healthy chemicals for the atmosphere is thus a need of the day. Various novel insecticides have also been developed recently. available in the market, hence the efficiency and suitability of these items in the management of this significant pest should be assessed.

Insect pest of chickpea

- **Assessment of economic threshold level of *Helicoverpa armigera*: -**

Odak and Thakur (1975) recorded that at flowering and early podding stages and economic injury level of larvae is greater than four larvae per meter square, which cause the reducing the grain yield.

Sharma (1985) recorded that the ETL and EIL level of larva of *Helicoverpa armigera* is one per meter square in chickpea.

- **Different insect pests of chickpea: -**

Attiqueet al.,2000; Sarwar,2012 *Helicoverpa armigera* (Hubner) (Lepidopetera: Noctuidae) is an extremely polyphagous nuisance that infests several host plants, but chickpea is invaded by 57 insect species.

Talekaretal., 2006.The *H. armigera* is a major polyphagous noctuid insect in Asia, widely known as cotton bollworm or American bollworm, causing significant damage to agricultural, horticultural and ornamental crops.

Patankeretal., (2001)It has been stated that *H. armigera* is the world's most significant nuisance of chickpea and other crops. In extreme cases, it causes seed yield losses of around seventy-five to ninety percent, and it was noted that gram pod borer affected leaves, tender shoots, apical tips, floral buds and pods.

J. Kumar, J.B. Smithson.,1980; Khan S, S Faizullah, 1999.In all the chickpea growing areas, it is the most severe chickpea pest. Extreme declines in productivity have been recorded by numerous workers, such as 21 per cent and 37.50 per cent, owing to more insect infestation.

Infestation of chickpeas, *H. armigera* continues with 2-3 peaks from the vegetative stage to the maturity. Even so, maximum infestation is in month of the 3rd week of December to the 3rd week of January at the flowering and podding stage (Nema and Verma, 2000).

Hussain (2003) It was noted that the infestation of pod borer in chickpeas was very extreme due to high rainfall during 1999-2000, but average during the normal rainfall year in 2000-2001 In both years, both the intercrops and insecticide spraying showed a substantial decline in pod borer infestation in chickpeas.

In USA also some pest problems related to the Chickpea (Miller et al., 2002; Margheim et al., 2004; Glogoza, 2005). Infrequent nuisance in the Pacific Northwest are the western yellow striped armyworm, *S. praefica* (Grote) (Clement, 1999), pea leaf weevil, Sitonalineatus (L.) (Williams et al., 1991), pea aphid, *A. pisum* and cowpea aphid, *A. craccivora* (Clement et al., 2000).

Knights and Siddique, 2002. In Australia, the major pests of chickpea are the two species of pod borers such as, *H. armigera* and *H. punctigera.*

Miller et al., 2002; Margheim et al., 2004. The possible nuisance attack on chickpea which is in the early season i.e. cutworm, wireworm, grasshopper, leafminer, aphids, corn earworm and out of that leaf miner larvae has mine the chickpea leaves but not huge lose are observed.

Dabhi and Patel (2004) Population peaks occurred between the first and fourth weeks of February and the second week of May, respectively (2.1, 2.8 and 1.2 larvae /m). In morning period high temperature and relative humidity which effect on positive and negative impact on increase population of *Helicoverpa armigera* on chickpea.

Fifty samples of chickpea fields were observed at different locations (each 1.0 m crop plant) to record *H. armigera* larval population at four per site. Separately, records of early and late instar larvae were kept. The pest appeared until the seed maturity in 20 days old crop. Three overlapping generations of the pest on the crop were suggested by studies. In the first-generation peak activity *Helicoverpa armigera* of the second and third instar larvae are observed in the month of last week of December on chickpea was observed i.e.16 larvae per meter square. In the first week of February, a second generation was detected other peak activity of the pest are recorded i.e. (12.5 larvae/m^2). In the first week of March, the third generation of the pest population was detected in the third instar larvae i.e. (10.5 larvae/m2). The most damaged by this pest is on podding stage i.e.90%. The second and third peaks in the larval population coincided with the flowering and podding periods of the crop and were considered to be the most damaging. Maximum larvae population was noted to be 20.4 larvae per meter square in the month of the December.

Ali and Shazad (2005) The seasonal changes in the *Helicoverpa armigera* pod borer chickpea pest population have been observed during the 49^{th} to 6*th* standard weeks, the nuisance population gradually low but it is high from the 7^{th} standard week onwards and again decreased during the 14th standard week. There was a strong association between larvae, larval instars, and total density of *H armigera* and the mean and low and normal temperatures. There was however a negative association between eggs, larval instars, and total density. *H armigera* and the mean level of relative humidity in the morning. The eggs, the larval instar and the total density of this pest were not related to relative humidity at night.

Singh et al. (2005) The larval population of *H. armigera* was observed to occur after 15 days of sowing (0.2 to 0.8 caterpillar /m^2) and steadily increased up to the 1st week of December (3.00 to 3.40 caterpillars/m^2) and subsequently decreased at the end of January in the caterpillar population. Once again from mid-February, the population began to increase (1.0 to 1.8 caterpillar/m2) and hit its peak in the second week of April (8.0 to 10.8 larvae/m^2), then decreased abruptly. The first period of the caterpillar population (3.26 larvae/m^2) was reported in the 1st week of December and the 2nd peak (9.40 larvae/m) was reported in the second week of April. The highest temperature reported in the 1st week of December (3.26 larvae/m^2 and the 2nd high of 9.40 larvae/m^2) was recorded in the second week of April there was a strong positive association between the mean and minimum temperature to the caterpillar population. Only during 1998-99 did rainfall have a positive association with the caterpillar population. The overall relative humidity was adversely associated with the population of larvae.

Singh and Ali (2006) Stated that the behaviour of the larva *H. armigera* persisted with two peaks in both years during the crop season, i.e. the first from 45 to 49 regular weeks and the second from 5 to 13 regular weeks. At 45 and 12 standard weeks, the highest mean larval populations of 6.3 and 6.4 larvae/m^2 were observed respectively. Low and maximum temperatures were correlated favourably with the larval and adult *H. armigera* populations. While relative humidity showed a negative association.

Population fluctuation data obtained from 1983-84 to 2006-07 revealed that the larval population of *H. armigera* was above ETL with 2 larval row lengths from 46 standard week to 7 standard weeks, with a maximum load between the 2nd week of December and the 3 rd week of January coinciding with the reproductive stage of the crop (Anonymous, 2007).

Singh et al. (2008 a) The survey to determine the status of *Helicoverpa armigera* on chickpea and larvae observed in Jhansi district was conducted from the last week of December to the first week of January with an average damage to the pod of 37.07 percent. In both years, the maximum moth population was recorded in February. Under high temperatures and relative humidity conditions, an improved larval population was detected. Losses on yield attributable to *H. armigera* in multiple areas ranged from 36.88 to 50 %.

Reddy et al. (2009) observed that the occurrence of the pod borer, *Helicoverpa armigera* in chickpea resumed from second week of February, i.e., in the early part of 1st fortnight of February, with 0.05 mean larval population/ plant. During the fourth week of March (12th regular week the larval population began to increase and reached its limit of 12.97 average larval population/plant.

Yadav and Jat (2009) On the chickpea infestation of *H armigera* began in the second quarter of November and peaked at the end of February. Throughout the growth cycle of the plant, the larval population of the pest occurred and was maximal at the stage of pod forming and grain production. Highest and lowest temperatures showed a significant positive correlation with the larval population and minimum temperatures showed a significant positive correlation with the larval population, while relative humidity and precipitation were significant which were no effect on fluctuation of population of larvae.

Bajya et al. (2010) documented that the larval population of *H. armigera* larvae began during the third week of November. During the second week of March, the highest population (9.2 larvae/10 plants) was reported and decreased steadily. The pest was prevalent in this crop from November until March. Normal temperature, precipitation, vapor pressure and humidity were positively associated with the increase the population of *H. armigera* in the morning and evening period in chickpeas. In cotton, population variations were inversely related with the morning and evening higher and lower temperature & vapor pressure. The reduction in these variables resulted in higher in the community.

The population dynamics of chickpea pod borer, *Helicoverpa armigera* (Hubner) on chickpea were investigated and reported that the pest emerged from the second week of December to the second week of January reached a maximum of 3.12 larvae /plant. During the last week of December to the third week of January, the nuisance was active. Later, towards the maturity of the harvest, the population of pests decreased steadily. The association between *H armigera* and various environmental parameters revealed that the maximal temperature showed a very relevant negative correlation (r= 0.751) with the larval population of *H.armigera* Whereas the low temperature (r= 0.577) and average temperature (r= 0.683) showed a substantial negative association, the pest population showed a significantly substantial and favourable correlation between morning relative humidity (r= 0.709), night relative humidity (r= 0.729) and mean relative humidity (r= 0.729) Chatar et al.,(2010)

Among biotic causes, chickpea is infested by almost 60 species of insects of which the most important pests are cutworm, *Agrotis ipsilon* (Ratt.), gram pod borer, *Helicoverpa armigera* (Hub.), semilooper, *Autographa nigrisigna* (Walk.), and aphid, *Aphis craccivora* (Koch.) (Acharjee and Sharma, 2013). Among others, the gram pod borer, which is polyphagous in nature, causes considerable damage. *Helicoverpa armigera* is one of most extreme chickpea pests, feeding more than one hundreads and fifty crops worldwide. (Vinutha et al., 2013).

Mari et al., 2013 stated that the three arthropods (*Helicoverpa armigera*, *Spodoptera litura* and *Agrotis ipsilon*) were documented from the research site and reports indicate that larval instars of these pests are attack on the newly emergence leaves forming buds and pods. The larval population of pests was reported during January to March. The data showed that was present among three pests in the entire average population. The population of *H. armigera* was slightly higher (74.25) relative to *S. Litura* (55.25) as well as *A. ipsilon* (42.12)

Pandey et al. (2014) confirmed seasonal occurrence of *Helicoverpa armigera* on chickpeas at Azamgarh region in UP and reported that during the 11th standard week, the larval population varied with ecological factors i.e. High and low temperature, humidity and sunshine hours) and reached a maximum of 14.55 larvae/10 plants. The positive association between minimum and maximum temperatures was important.

Ramteke et al. (2014) recorded that *Helicoverpa armigera* larval activities on chickpeas were observed at Allahabad (U.P.) with a maximum during tenth standard week from fourth standard week to fourteen standard weeks. With summer temperatures ranging between 28.6 °C and 32.4 °C, the larval population abruptly increased.

Farhat et al. (2014) documented the occurrence of various insects on chickpeas, i.e. Observed is cutworm, whitefly, aphid, grasshopper & butterfly. The occurrence of insect pests in the vegetative and reproductive periods alone.

Patel et al (2015) The population dynamics of the chickpea pod borer *Helicoverpa armigera* (Hubner) were reported in relation to environmental variables and found that the nuisance began from the second week of November which is until in the month of the February and maximum activity of nuisance is in the first and second week of December. The correlation study shows that significant and negative association between larval population of *Helicoverpa armigera* and evaporation (-0.551). In the larval population of *H. armigera* is a non-significant impact was found, high temperature, relative humidity at night, vapor pressure and speed of wind.

Kumar et al. (2015) found that on 15 April (15th standard weeks) the larval population of *H. armigera* on chickpea peaked in all control plots when the maximum and minimum temperatures of 34 ° C and 17.67 ° C respectively, 57.57 percent humidity and 0.00 mm rainfall were noted. However, in the first standard week the lowest larval population of 1.21 was recorded, with a maximum and minimum temperature of 13.35 and 4 °C, humidity of 77.78 percent and rainfall of 0.00 mm respectively. During rabies season 2010-11, the larval population of *H.armigera* was found to be positive with a maximum (r=0.858) and minimum (r=0.886) temperature. The correlation was found to be negative between the larval population and humidity (r=0.569). During the crop season, rainfall had a positive association (r=0.158) with the larval population.

Sunitha N et al. (2018) recorded that *Spodoptera exigua* (Cut Worm) is a developing chickpea nuisance.

Singh et al.,2018 confirmed that 4 arthropods i.e. Pod borer, leaf miner, cutworm and termite, and the results show that chickpea pests, gram pod borer, have been identified as the major pest in the region. During mid-December, it first emerged in the fifty-one Standard Week with its initial strength of 0.25 larvae /m row, which rise up to eighth standard week over subsequent months and impacted the maximum population of 13.00 larvae /m row during 9th standard week.

❖ **Different management practices of the insect pest of chickpea: -**

➢ **To know efficacy of safer insecticides against major insect of chickpea: -**

Sharma et al. (1997) have recorded a 70.9 percent decline in the larvae population resulting in 11.2 percent pod damage and 1.86 t/ ha grain yield, triggering chemical insecticide Endosulfan 35 EC @ 1,200 ml /ha.

In a field study, Shah et al. (2003) conducted cypermethrin's 10 EC, 35 EC, lambda cyhalothrin 2.5 EC and chlorpyrifos 40 EC, against *Helicoverpa armigera* larvae on chickpea in 2001-2002 for the management of larval population of gram pod borers in winter season. Increasing biomass and grain output in comparison with control through all insecticides significantly reduced the larval population density of the plant. The effective insecticide led by endosulfan, lambda cyhalothrin and cypermethrin has shown to be chlorpyrifos.

Helicoverpa armigera on chickpea was studied in the field and laboratory by Ahmed et al. (2004). Results suggest that the Spinosad treatment with Indoxacarb and Methomyl and spinosad was the most effective way to reduce nuisance infestation. Cypermethrin was not able to do acting as spinosad. In the laboratory bioassays, Spinosad 1 ppm was found to be toxic to the second instar larva and cypermethrin 216 ppm was minimum effect to the larva.

Ingale et al., (2008) doing experiment on effect of entomogenous fungus *Nomurea Rileyi* (Farlow) in the form of oil on *Helicoverpa armigera* (Hubner) in Chickpea. The results showed that after spraying in the field, larval reduction increased. In reducing population of larvae, pod damage and increasing grain yield of chickpea, two sprays of DC-Tron, soybeans and sunflower oil were found very effective. However, the maximum damage by the larvae in the endosulfan 35 EC 0.06% treated plot and maximum grain yield than process. According to ICBR, endosulfan was first in was first in number i.e. 1:21,14 ICBR, and soybean (1:18.40), DC Tron Oil (1:16.57) and Sunflower Oil formulation (1:16.38).

The field trial of bio effectiveness of various insecticides on *Helicoverpa armigera* infesting chickpea (CVJ315) was carried out. The most reduction in pod and seed damage was detected by Indoxacarb & cypermethrin, whereas the smallest was seen in quinalphos sprayed plants. Singh et al.,(2008 b)

Proclaim, Radiant and Jatara against *H armigera* have been tested by Sahito et al. (2012). At the 15- and 20-day time of second and third application on *H. armigera* applied three times respectively hence the prove that the three insecticides have found to be effective in reducing the population of the pests. Proclaim, however, produced best results for gram pod borer, *Helicoverpa armigera* total average population is 0.36,0.40.0.49 was reported on each plant in the per plot where the spray was doing with the above insecticides respectively where the untreated plot was 1.23 larva per plant. The entire mean population of pod borer during the second sprayed. The plots handled with Proclaim, Radiant and Jatara were 0.33, 0.51 and 0.56 per plant, respectively compared to the untreated plot (2.21 larvae/plant). In the third application, the entire average population of pod borer is 0.29,0.44,0.48. In the Proclaim, Radiant, and Jatara plots, respectively compared to the untreated plot (2.68 larvae / plant).

The insecticide emamectin benzoates (proclaim 5 WG) 0.025%, novaluron (Remon 10 EC) 0.01%, lufenuron (Match 5 EC), 0.005%, flubendiamide(Fame 480 SC) 0.01%, rynaxypyr(Coragen 20 SC) 0.006% and endosulfan (Thiodan 35 EC) 0.07,spinosad (Spintor 45 SC) 0.0135%, Thiodicarb (Larvin 75 WP) 0.075,Indoxycarb (Fego 15.5 SC) 0.007 % etc were evaluated by Babar et al (2012), study was carried both in invitro and in vivo condition during rabi season in 2009-10 The findings of the laboratory experiment showed upwards of 70% egg mortality by flubendiamide and thiodicarb , shows as ovicidal in nature In the laboratory experiment, flubendiamide, emamectin, rynaxypyr, and spinosad reported more than 90% larval death and found it most effective as larvicide.

Kumar et al. (2012) observed seasonal behaviour pod borer during Rabi 2007-08 in farmers' fields. Its activity starts from vegetative stage till harvesting stage of crop. In the 10th standard weeks at a minimum temperature of 13.8° C and at a maximum temperature of 30.1°C with relative humidity 68 percent without reported precipitation during entire crop season. The average population of the pest at the sidhauna village was 3 larvae/10 plants and at pandepurwa, pithia & jorium village were 2 larvae/10 plant. Sidhauna village had a significant link between the larval population with low temperature, high temperature and relative humidity. In the Padepurwa and Pithla larval population with the temperature, relative humidity and the minimum temperature were positively associated. In the Nerium, larval population & relative humidity had positive association & Maximum and minimum temperature had Negative association. In the pod borer management analysis, likewise. Spinosad 45 SC @ 90 g a.i./ha was followed by Indoxacarb 14.5 EC @ 50 g a.i./ha, Novaluron 10 EC @ 100 g a. i/ha and Spinosad 45 SC @ 90 ga.i./ha became more successful treatment. Based on larval reduction and seed yield, Endosulfan 35 EC @ 700 g a.i/ha was less effective. From Indoxycarb 14.5 EC @ 50 g /ha treatment maximum cost benefit ratio is obtained maximum C:B ratio from 14.5 EC @ 50 g per hectare Indoxacarb.

The Karate 2.5 EC @750ml/ha recommended by Ahmed and Awan in 2013 mixed with 200 liter of water when the crop is infested with more than two instar larvae per m row length.

Choudhary (2013) claimed that the on-chickpea pod borer recommended as a rynaxypyr 20 SC or lufenuron 5.4 EC flubendiamide 48 SC.

The effect of different chemicals is tested by Yogeeswarudu & Venkata (2014) such as indoxacarb 14.5 SC @ 0.5 ml/l, profenophos 50 EC @ 2.0 ml/I, imidacloprid 17.8 SL @ 1 m/l, novaluron 10 EC @ 1.5 ml/l, fipronil 5 SC @ 2.0 ml/l and lambda cyhalothrin 5 EC @ 1 ml/l against pod borer larvae. It was observed that indoxacarb 14.5 SC @ 0.5 ml/l was the better than the all treatments with a minimum larval population i.e.1.53.0.46.0.73 larvae / five plants at a first spray. With a reduction of 89.45.97.01.95.83% over untreated at 3 DAS, 5 DAS & 7 DAS the second spray with minimum larval population of 0.00, 0.26 and 0.00 larvae/five plants were decreased by 100,98.74 and 100% compared to untreated at 3 DAS, 5 DAYS, and 7 DAYS respectively. Five insecticides (i.e., Emamectin 1,9 EC®) have been tested for their efficacy by Iqbal et al. (2014). On chickpea variety "BRC390" ,Lannate 40 SP (Methomyl) , Coragen 20 SP (rynaxypyr)., Match of 50 EC® (Lufenuron), Profenofos 50 EC® (Profenofos) against gram pod borer (*Helicoverpa armigera*).In Profenofos treated plots (85%, 90% and 94%) and Coragen treated (85%, 90% and 90%) at 3, 5 and 7 DAT., respectively the highest mortality rate of gram pod borer was reported. In control plots of 3rd to 7th day no plant mortality has been reported. These insecticides have therefore proven extremely efficient in controlling chickpea gram pod borer under invitro conditions

Sharma et al. (2014) announced that the most successful application for the reduction of larval instar, pod damage and the higher yield was Rynaxypyr 20 SC @ 75 ml/hectare. While rynaxypyr had the highest gross profit, but higher than rynaxpyr is ICBR of flubendiamide 48 SC @ 50 ml/ha. The successful economic control of *Helicoverpa armigera* in Chickpea could be an efficient Rynaxypyr 20 SC @ 75 ml/ha or the flubendiamide 48 SC @ 50 ml/ha.

Vikrant et al., 2018. The research was conducted in the Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, for a study to determine the bio- efficacy of certain insecticides against *Helicoverpa armigera* (Hubner) in chickpea during the 2014to15 and 2015to16 rabi. The Treatment 5 (Spinosad 45 EC @ 166 ml/ha) has a minimum survivor and maximum reduced larval population percentage while on 3rd, 7th and 10th days after spray a maximum survival and minimal decrease in larval populations has been reported in T1 (haNPV@250 LE/ha).

- **To know efficacy of Bacillus thuringenesis against major insect pest of chickpea:**

Khalique and Ahmed, 2001a, b). Ahmed et al., 1990 1990, 1994, 1998. Extensive assessments of the Bioefficacy of some indigenous and exotic strains of *B Thuringensis* and commercial preparation have been carried out in Pakistan. The development of a package of Bacillus thuringenesis application technologies to handle the pod borer population on chickpea resulted.

The preparations for Btbased insecticides, Biobit, Dulfin and DiPel with NPV showed a minimum of (4.2 to 16.7 percent) pod damage, compared with untreated (12.2 to 38.6 %) in Pantnagar, Durgapur, Sehore, Rahuri, Bangalore and Dulbarga, India (Anonymous,1997).

Application of Bt formulations at evening contribute to greater control than application of other times of day. Mahapatro and Gupta et al.,1999.

Naranjo, 2005 The use of Bt plants and the resulting decline in the use of insecticides enhance the importance and role of natural enemies to minimizing the secondary pest population.

Mahmudunnabi et al.,2013 *Bacillus thuringiensis* (Bt) application @ 0.4 g/litre of water; IPM practices 2 (P2) consists of the trapping of pheromone in addition to the release of sequential biocontrol agents and spraying (HNPV). These results show that the best performance of the IPM practice (P2) was reducing the 68.20% pod damage and which is important to increase grain yield i.e. (1832.20 kg/ha).

Ahmed et al. announced in 2012 that the use of microbial insecticide preparations i.e. *Bacillus thuringiensis* (Bt) offers an environmentally safe solution to the broad specturm insecticides

Worldwide focus was on the entomopathogens (EPFs) and *Bacillus thuringiensis* (Bt) as biological insect control agents (Jarrahi & Safavi, 2016; Kalvnadi et al., 2018; Legwaila et al., 2015). Several trials have tested EPF and Bt biopesticides as options to conventional pesticides in IPM techniques (Bayissa et coll., 2017; Erler & Ates, 2015; Lacey et al., 2015; Opisa et al., 2018).

(Da Silva et al.2018,) The Soil Bacterium *Bt* Berliner subsp. Kurstaki (Btk) is the beneficial biocontrol agent for number of pests including pod borer and Lepidopteran pests.

- **To know efficacy of HaNPV against major insect pest of chickpea:**

The NPV was reduced significantly larval population of pod bore and recorded by Jayaraj & et.al., (1987); Pawar et al., (1987); Narayana, (1980) and Chandra, (1987). thus, less risk to the chickpea than chemical insecticides and untreated. High larval mortality of pod borer reported by Sharma et al. (1997). Mortality of larval mortality in bioagents and chemical insecticide application. The NPV @ 300 LE /ha decreased the larval density by 78.7 percent, consisting in 10.0 percent pod losses and a high yield of grain (1.86 t/ha) Several natural populations of pod borer as well as other lepidopteran species, have at least some extent of infection with species specific NPV.If the extent of NPV contamination can be raised, then the pod borer population can be demolished without harmful impacts on beneficial species. HaNPV has been identified as a better option to minimizing the pod borer on chickpea (Rabindra & Jayaraj,1998; Butani et al.,1997; Ahmed etal.,1999; Cherry et al.,2000).

Thakur (1998) used a *nuclear polyhydrosis virus* treatment at 1.5 ml /l and produced a higher yield of grain, not substantially different from that of a chemical insecticide (Deltamethrin 2.8 EC applied at 1.0 ml l/ha), but significantly more than a untreated.

In addition, a NPV that is selective to pod borer (HaNPV) has been isolated. (HaNPV) is a natural and selective replacement to insecticides (Cherry et al., 2000). Prior study has shown HaNPV can be efficiently used to monitor *H. armigera* on various varieties, including citrus (Moore et al., 2004) and chickpea (Moshtaghi, Maleki et al., 2014; Ojha et al., 2017).

Arora and Padmanaban,2002, recorded that *Helicoverpa Armigera*, in repeated field trials at two doses, including a 250 LE / ha and a 370 LE / ha, was assessed at the efficacy of 2 weekly sprays of HaNPV Native Isolate (PAUI) against sunflower head borer. In minimizing the larval population and percent harm to the pest, the lower doses were unsuccessful. In comparison to the normal insecticides (carbaryl 10 kg/ha) treatments of 1.16 larva/10 plants, the highest dose of HaNPV with a larval population of 10 larva/10 plants was equivalent.

- **To know efficacy of Neem Seed Kernel Extract against major insect pest of chickpea:**

Roy and Dureja, (1998) Azadirachtin has antifood and developmental retardant functions, and is likely to result to mortality in one phase or the other of the lifespan by impinging on neuroendocrine metamorphosis regulation in an insect

Tesfahun et al. 2000 Azadirachtin have anti-sustaining and development delaying properties and may result in mortality by impairing neuroendocrinal metamorphosis in insects at any stage of life.

The integration of different IPM components was seen to minimize the pod harm (10.4%) with the maximum yield of grain (1264.4kg/ha, or 58.5% yield over untreated (797.9kg/ha), when the numerous IPM component such as neem, HaNPV were efficiently to the minimize the larval population of pod borer and out of that neem act as on the decreased effectively the oviposition of *H.armigera* in cropping season .

The capability of the neem extracts produced from the seed from Melka Woreda in Ethiopia, Tebkew et al., 2002 reported that the percentage of pod damage was reduced significantly, as were the loss of pod damage on treated chickpea lower than untreated plots (Gossa, 2007).

The most efficient IPM module consisting of pheromone trap + sequential release of the biocontrol agent + spraying of the NSKE, out of that NSKE was the best results against larval population of pod borer, accompanied by pheromone trap + sequential releases of biocontrol agent, (*T. chilonis* + *B. hebetor*) (Anonymous 2008).). The best utility is to control the sequence and the efficiency of the IPM module.

The NSKE 5% application helps decreased the pod borer population in chickpea (Gupta 2007; Pachundkar et al. 2013; Hussain et al. 2016).

The percentage of pod damage after spraying with the neem oil and custard apple leaf extract, recorded substantial declines the larval population by Mishra et al (2013). The vermiwash combined with aqueous garlic extract, which combined animal dung and urban solid waste, caused a significant decrease in the infestation frequency of pod borers.

Bhushan et al.,2011to check the efficacy of biopesticides against pod borer in chickpea, in decreasing larval population & pod damage, results show that NSKE 5 percent was found to be most effective.

- **To know efficacy of plant- based products against major pest of chickpea:**

Mallapur and Ladji 2011. Ladji et al. 2011. Comprehensive use of vegetable and animal products such as pongamia (10.0%) + NSKE (10%) + aloe (0.5%) + cow urine (30%), GCA (2%) + GCK (0.5%), and leaf extract of vitex (20%) + clerodendrone (4%) + cow urine (17%) reduced the larval population with higher chickpea pod yield.

- **To know the efficacy of mixture of bio-based and safer insecticides:**

Cherry et al, (2000) Field assessment of formulations such as NPV, chemical insecticide, endosulfan or *B. thuringiensis* against chickpea pod borer.

Reddy et al. (2010) tested in the combination of gram pod borers on chickpeas, the effectiveness of traditional insecticides viz., NSKE, *Helicoverpa armigera* (Hubner) *Nuclear Polyhedrosis Virus* (HaNPV) and Endosulfan .It has been found that the population of larval population decreased by NSKE 1.66% + HaNPV 250LE/ha + Endosulphan 0.023%, followed by NSKE 1.66% + Endosulfan 0.023%, NSKE 2.5% + HaNPV 250LE applied twice in fifteen days periods.

Lambda Cyhalothrin and NSKE can protect chickpea from pod borer *H.armigera* (Hubner), reported by Hossain et al. (2010).

Anandhi et al. (2011) assesses a various of chemical and bio-based insecticides against pod borer on chickpea i.e. emamectin benzoate, spinosad, indoxacarb, quinalphos, pongamia, NSKE and garlic extracts)

At the time of pod borer incidence, 2 sprays were given for every insecticide in fifteen days intervals Five randomly chosen plants in each plot were counted with pod borer larvae.

One day before the first and second sprays, the pre-treatment count was completed, while after each spray, the count was done on the third and fifth days. Result revealed that the decrease in population was equivalent to untreated treatment. Indoxacarb was the most important in the 1st and 2 nd application, pursue spinosad application.

Amongst the biobased insecticides i.e. (NSKE) followed by garlic extract was the bet treatement wih the largest decrease in the pod borer population in the 1st and 2nd spray. Indoxacarb has reported a cost benefit ratio and has proven its efficacy across treatment and the second highest cost-benefit ratio of quinalphos was due to the reduced insecticide costs, followed by Proclaim, Tracer, Nimbicidine , garlic extract and leaf extract.

The combined NSKE + HaNPV + Panchagavya application caused lower pod damage and higher yields of chickpea reported by Muddukumar 2007.

Kumari et al.,2015 During the field experiment performed at Bihar Agricultural College, Sabour Farm of Bihar Agricultural University, Sabour in the years 201011 to 2012to13, it has been discovered that the *Helicoverpa armigera* on chickpea could be effectively controlled using pheromone trapping + Bt+ HaNPV and also increase the yield of crop comparison to the other treatment.

- **Conclusion: -**

From the this review it is concluded that the pod borer, *H. armigera* remained active throughout the crop season with one peak coincided with the reproductive phase of the crop.

Application of Rynaxypyr 20SC @ 75ml/ha and the new molecule BAS 45001I300SC @ 60 ml/ha were found effective in chickpea to avoid the menace of the pod borer and also minimizes the effect on natural enemies.

- **Knowledge Gap:** To develop a comprehensive and holistic understanding of the population dynamics of *H. armigera* on chickpea in relation to abiotic factors is the basic need so that effective prediction of its infestation can be made. As the botanicals and bio- insecticides have shown potential in managing this pest in combination with chemical insecticides, reduced dosages of chemical insecticides in combination with botanicals and bio - pesticides should be given priority in further research.

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