EFFECT OF INTERCROPPING ON *Helicoverpa armigera* (HUBNER) AND ITS LARVAL PARASITOID IN CHICKPEA CROP

Thesis

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CERTIFICATE

This is to certify that the thesis entitled **"Effect of intercropping on *Helicoverpa armigera* (Hubner) and its larval parasitoid in chickpea crop"** submitted in partial fulfillment of the requirements for the degree of **Master of Science in Agriculture** with major in **Entomology** of the college of Post-Graduate Studies, G.B. Pant University of Agriculture and Technology, Pantnagar, is a record of bonafide research carried out by **Miss. Renu Pandey, Id. No. 26238**, under my supervision, and no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation and source of literature have been duly acknowledged.

(Ram Ujagir)
Chairman
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CERTIFICATE

We, the undersigned, members of the Advisory Committee of, **Miss.Renu Pandey, Id. No. 26238,** a candidate for the degree of **Master of Science in Agriculture** with major in **Entomology,** agree that the thesis entitled **"Effect of intercropping on *Helicoverpa armigera* (Hubner)"** may be submitted in partial fulfillment of the requirements for the degree.

(Ram Ujagir)
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Chapter1 INTRODUCTION

In India, chickpea is the most important winter legume, which occupies an area of 6.25m ha with production of 5.77 mt. Its national average yield is 923Kg/ha **(Hindu Survey, 2003-04).** Chickpea is grown either as a sole or mixed crop. Among the major constraint for low production and productivity of pulses, the insect pest alone are responsible for significant yield loss. Among its major insect pests, *Agrotis ipsilon, Agrotis segetum, A. spinifera* and *Mythimna separata* in certain areas appear during seedling stage while *Helicoverpa armigera* appear in great number during active vegetative growth at pod formation stage **(Lal, 1996).**

Helicoverpa armigera has become a pest of national importance in India causing economic losses to several crops. This pest accounts for 40-95% of total damage **(Sachan and Katti, 1994;Sitanathan *et al.*1983).**

A single larva of *Helicoverpa armigera* can damage 25-30 pods of gram in its life time **(Sharma, 1978).** Female of *H.armigera* lays spherical yellowish eggs singly on tender parts of plants. The egg, larval and pupal periods respectively are 2-4, 18-25, 6-21 days and it pupate in earthen cocoons in soil **(David, 2001).**

Now a day's higher amounts of chemicals or toxic mixtures are used to achieve desired kill. The indiscriminate and injudicious use of pesticide have eroded sustainability of agro ecosystem and resulted in residues, resistance, resurgence and secondary outbreak of pest and development of new pest problem. It is in this context the relevance of integrated pest management has come to be appreciated which aim to integrate all the approaches like cultural, mechanical, biological and chemical method in a compatible, ecofriendly manner to keep the pest at manageable level below economic injury level.

Ali ,1997 also emphasized that IPM for *Helicoverpa armigera* with more reliance in biological component; botanical pesticides and cultural practices should be the priority research agenda in all the zones. Among the cultural practices, Intercropping/mixed cropping provides an insurance against pests and aberrant weather, besides other advantage over sole cropping under this circumstances, intercropping aim to reduce pressure away from main crop or increasing abundance of beneficial insects. Its main larval parasitoid *Campoletis chlorideae* can be helpful in keeping pest population at low level. *Campoletis chlorideae* was recorded as the most important natural enemy of *H. armigera.* The percentage of parasitization ranged from 0.18 - 23.81% from March-May**. (Singh *et al.*, 2002).**

Keeping above in mind following objectives have been proposed for present study.

1. To estimate the egg and larval population of *H. armigera*.
2. To check influence of intercrops on build up and incidence of major insect *H. armigera.*
3. To study influence of intercrop on natural enemies.
4. Estimation of grain yield in different cropping system.
5. To correlate insect population and larval parasitization with weather variables.

Chapter 2 REVIEW OF LITERATURE

2.1. Economic Importance of the crop

Chickpea, *Cicer arietinum* is the third most important grain legume in the world, but India being the largest producer. Insect pest are a major constraint to chickpea production. Chickpea like any other legume crop, fixes atmospheric nitrogen symbiotically and it benefits the succeeding crop. Chickpea is valued for its nutritive seeds with high protein content, 25.3-28.9% after dehulling. Chickpea seed has 38-59% carbohydrates, 3% fiber, 4.8-5.5% oil, 3% ash, 0.2% calcium and 0.3% phosphorus. Digestibility of protein varies from 76-78% and its carbohydrate from 57-60% **(Hulse, 1991; Husiman and Vander Poel, 1994).**

2.2 Insect pest of chickpea

Though several species of insects has been recorded on chickpea but *Helicoverpa armigera* (Hubner) is the most important pest of this crop.

Reed *et al*., 1987 recorded 54 species of insect pest on chickpea, out of these 31 major insect pests are given in Table 1.

Chickpea at seedling stage may be damaged by cutworms, *Agrotis ipsilon, A.segetum, A.spinifera* along with *A.flammatra* **(Saxena and**

Table 1. Insect pests of chickpea

Pest group	Scientific name	Common name	Nature of damage
Lepidoptera (Noctuidae)	*Agrotis ipsilon (*Hfn.*) A. segetum* (Dennis & Shchiff) *A. spinifera (*Hb.) *Agrotis sp. Spodoptera exigua*	Cutworm	Seedlings are cut at or below ground level.
Lepidoptera (Noctuidae)	*Autographa nigrisigna (*wlk.*) chrosodeixis chalcites (*Esp.*) Trichoplusia ni, Plusia sp. Trichoplusia orichalcea, Plusia signata (*F.*)Thysanommpusia spp.)*	Semilooper	Larvae feed upon leaflets and pods.
	*H. armigera (*Hb.)	Gram pod borer	Larvae defoliate young crop and cut round holes in pod wall and devour the seed inside.
	H. assulta (Guenee), *H. peltigera* (Denis & Schiff), *H. punctigera* (wllgr.), *H. virescens* (Fabricius), *H. viriplaca* (Hufnagel)	Pod borer	
Diptera (Agromyzidae)	*Ophiomiya cirervicola, chromatomiya horticola, Liriomyza cocerina (*Rond*), Agromyza sp. Phytomyza atricornis*	Stem miner Leaf miner	Make tunnel in stem Make tunnel in leaf
Hemiptera (Aphididae)	*Acyrthosiphon pisum* (Harris) *Aphis fabae* (Scop.) *A. craccivora*	Pod aphid Bean aphid peanut aphid	Suck the cell sap suck the cell sap Suck the cell sap
Coleptera (Curculionidae)	*Tanymacus indicus, Sitona maculicornis, Subcoccilla vigintioctopuntata*	Leaf weevil	Make tunnel in stem
Coleoptera (Scarabaeidae)	*Holotrichia consanguinea (*Blanch*)*	White grub	Cut the plant at ground level
Isoptera (Termitideae)	*Odontotermes sp*	Termites	Root and stem are tunneled

Phokela, 1983). Nair, 1986 reported that *Spodoptera litura* defoliate the crop at vegetative stage, *Helicoverpa armigera* (Hb.) attacked during podding stage.

Lal, 1996 reported that the major pests of chickpea such as *A. separata* during seedling stage and *H. armigera* (Hb.) during active vegetative growth and at pod formation stage were found damaging leaves, tender shoots , apical tips, flower buds and pods.

Sharma, 2004 reported the legume pod borer *H. armigera* is the major insect pest of chickpeas. However, sap-sucking insects like aphids that act as vectors for viral diseases and bruchid beetles in storage are also considered important pest.

Gram pod borer, *H. armigera* (hubner) is a major pest of chickpea in most part of the country. **(Rai and Singh, 1976;Rawat *et al.*, 1979; Subramanium *et al.*, 1976).** Studies revealed that Chickpea was the preferred host of *H armigera* causing 72.65% infestation **(Verma *et al.*, 1994).**

2.3 Studies on Gram Pod borer, *H. armigera* (Hb.)

2.3.1 Taxonomy

Hardwick (1965) proposed a new genus. *Helicoverpa*, to include many of the important pest species of *Heliothis*. Under his revised nomenclature *H. zea, H. armigera*, *H.punctigera* and H. *viriplaca* remained in *Heliothis* . **Mathews (1987)** has completed a cladistic analysis of the world fauna of heliothinae moths and concludes that the suggested distinction of *Helicoverpa* and *Heliothis* is valid.

The moth currently called *H.armigera* has most commonly been referred to in the past as: *Bombyx obsoleta* F., *H. obsoleta* F. and *Noctua barbara*. It has also been reported as *Heliothis armigera* **(Zalucki *et al*.,1986).**

2.3.2 Geographical distribution

The geographical range of *H. armigera* extends from the cape verde Island in the Atlantic through Africa, Asia and Australia to South pacific Island in the and from Germany in the North to New Zealand in the South. **(Reed and Pawar, 1981). Sachan (1992),** reported that Gram pod borer, *H. armigera* have wide range of geographical distribution in India like states of Punjab, Haryana, some part of Rajasthan and Uttar Pradesh, eastern Bihar, Maharashtra, Karnataka are more sensitive and Madhya

pradesh, Gujrat, Tamilnadu, Andhra Pradesh and West Bengal are less sensitive against *H.armigera* in chickpea.

2.3.3. Range of host plants of *H.armigera (Hb.)*

H.armigera is a widely distributed polyphagous pest and in India, it has been recorded from 182 plant species (170dicots and 12 monocots) belonging to 45 families **(Pawar *et al*, 1986)**

H.armigera is a major pest of cotton, pigeonpea, chickpea, peas, cowpea, sunflower, tomato, sorghum, pearl millet etc.Other important crop hosts include groundnut, okra, field beans and other leguminosae, tobacco, potato, maize, linseed. A number of fruits (prunes, citrus, etc.), forest trees, and a range of vegetable crops. A wide range of wild plant species support larval development: important species in India include *Hibiscus* sp., *Acanthospermum* sp., *Datura* sp. *Gamphrena celosioides*; and in Africa: *Amaranthus* sp., *clome* sp. and *Acalypha* sp.**(Mathews, 1991; Majunath *et al*., 1989).**

Host species for *H. armigera* come from a broad spectrum of families and include important agricultural crops such as cotton, maize, chickpea, pigeon pea, sorghum, sunflower, soybean and ground nuts **(Fitt, 1989)**

2.3.4 Seasonal incidence of *Helicoverpa armigera* (Hb.)

Tripathi and Sharma (1985) studied the effect of seasonal changes in the larval populations of *H. armigera* on chickpea from 1981-84 in Tarai belt, Uttar Pradesh, India and found that large number of larvae were present during the pod formation.

Parihar and Singh (1992) showed that *H. armigera* was active throughout the year in the field. *H.armigera* was most active during March and April and its activity decreased remarkably during May and June at Meerut.

Verma et *al*., (1994) studied the incidence, biology and population fluctuations of *H. armigera*. Studies revealed that temperature played an important role in regulating adult activity.

Two distinct peaks, the first during mid-march to the 1st week of June and the second during the 2nd week of June to the last week of July were recorded in Himachal Pradesh.

2.3.5. Biology of *Helicoverpa armigera*(Hubner)

2.3.5.1 Oviposition

It is well documented that ***H.armigera*** oviposition is particularly prevalent during the flowering stages of its hosts. **(Parsons, 1940, Room, 1975; Broadley, 1978; Wardhaugh *et al*; 1980, Topper, 1987; Nyambo, 1988)**

Davies and Lateef (1975) reported that female moths are generally extremely prolific and over 1000 eggs are laid. The eggs are small and sub spherical in shape. Eggs are usually laid singly, making detection difficult near buds, flowers, and fruits or on leafy plant parts. They are initially pale green, sometimes with black dots and they later change to cream and then

Brown **(Zalucki *et al.*, 1986; Deueter *et al*., 2000; CPC 2002).**

2.3.5.2.Incubation Period

The incubation period may vary according to climatic conditions. The incubation period of eggs is longer in cold weather and shorter in hot weather, being 2 to 8 days in S.Africa and 2.5 to 17 days in United States **(Pearson and Darling, 1958)**

Saoud,A.H., (1989) reported incubation period ranged from 3-7 days with a hatching rate of 55-85% and 2-5days were reported in india.

Srivastava and Saxena, 1958; Singh and Singh, (1975). However, **Jallow and Zalucki (1998)** reported that to be 3-4 days only.

2.3.5.3 Larvae and nature of damage

The larvae of *H.armigera* had six instars but in extreme condition,i.e.cold weather, the seven instars can be ruled out**(Pearson and Darling,1958**)

The newly hatched larvae are translucent and yellowish orange with longitudinal lines**. (Neuzing, 1964; Singh and Singh, 1975).** The full-grown larvae are of medium size and of variable colors with marked strips on the body surface. The newly hatched larvae fed exclusively on the buds of foliage parts. The medium sized full grown larvae with variable colors and marked strips on the body surface and feed on preferably selected seeds of immature pods **(Pawar and Bhalla, 1975)**

Dhandapani and Bhalasubramanium (1980) under laboratory studies observed that larval period might range from 17-20 days.

Davies and Lateef (1975) reported that there might be difference between feeding habit of young larvae .The young larvae ate away the empty shell before feeding on plants. Young larvae feed mostly on flowers, buds and foliage but rarely on pods. Neonate larvae of *H.armigera* feed extensively on leaves and flowering buds and older one feed on the grains of immature pods **(Pawar and Bhalla, 1975)**.

During feeding, the larva thrusts its head into the pod while keeping body outside the pod. The larvae made clear and round hole on the pods.

Jayraj (1982) reported that older larvae prefer pods of chickpea. The full-grown larvae of *H.armigera* habitually feed on seeds with only front portion of its body inside the hole it had made.

Singh (1987) studied pattern of boring in pods of chickpea by larvae of *H.armigera* .He found most of entry hole (42.5%) were recorded in apical region followed by the basal region and least (4.5%) on the dorsal sutures of the pods.

2.3.5.4 Pupation

Saoud *et al*; 1989 reported that pupal stage lasted for 12-19 days in soil at a depth of 5-12 cm.The length of pupa reached 17-19mm.

Jayraj (1982) reported that full grown larvae of *H.armigera* leaves the plant, sometimes by dropping to the ground and burrows into soil to a depth of 2.5-17.5 cm. The pupa is 14-20mm long, pale brown in color with a tinge of green, turning darker brown as the adult develops within, smooth surfaced and rounded both anterior and posteriorly, with two tapering parallel spines at the posterior and pupal stage normally occupies 10-12 days **(Zalucki *et al*, 1986;Deuten *et al*, 2000 and CPC 2002)**

2.3.5.5 Adult Longevity

The length of adult life was found dependent on the availability of pod, initial pupal weight and temperature. (**Pearson, 1958 and Armes,1989)**

2.3.5.6 Extent of damage by *H. armigera* (Hb.)

A single larvae of *H.armigera* can damage 25-30 pods of gram in its life time **(Sharma, 1978)**

Bhatnagar *et al*., (1981) reported that **c**hickpea has a relatively small number of insect pests of which *Heliothis* sp. are dominant in all the major production areas of the world. ICRISAT scientists collected pod samples from 610 farmers fields situated in various parts of India and found an average of 7.5% of pod damaged by *H. armigera* . In another survey carried out by Directorate of Pulses Research, Kanpur during 1978-81 have revealed that crop damage in chickpea due to *Helicoverpa* was 15% **(Lal *et al*., 1985)**.

Prasad *et al.* (1990) screened different genotypes against pod borer from ICRISAT and AICPIP. The pod damage in ICRISAT genotypes ranged from 13.1% in ICC-5810 to 33.6 in ILC-1931. Pest infestation in AICPIP ranged from 23.1 (BG-275) to 52.5% (BG 276).

Olla and Saini (2000) reported that crops losses, were around 50, 65 and 75% after 10, 20 and 30 days respectively after release of larvae of *H. armigera* on the chickpea plants at Hissar, Haryana.

The loss in yield of gram (*Cicer arietinum*) due to the noctuid, *Heliothis armigera* **(***Helicoverpa armigera*) was studied in Punjab, India, in 1982-83 by comparing chemically protected and unprotected crops. The crop in the protected plots was sprayed once with endosulfan at flower-bud formation. The mean reduction in the pest population in the protected crop ranged from 61.1 to 81.1% at different locations. The avoidable loss in grain yield by applying endosulfan was 60.0 to 87.5%. Every unit increase in the larval population per 0.5 m^2 crop area resulted in an increase in damage to both pods and grains by 8%. The economic injury level was estimated at 1.5% pod damages **(Singla *et al.*, 1989).**

Sachan and Katti (1994) advocated that *H.armigera* was responsible for causing sometimes as high as 90-95% damage in chickpea. The gram pod damage due to *H.armigera* on chickpea crop varied upto100% in India**(Lal *et al.*, 1985; Sachan 1987; Ujagir and Khare,1987; Joginder Singh *et al.*, 1990 and Sehgal, 1990)**

At Pantnagar in Northen India, pod damage due to *H. armigera* varied from 42.6-90% with an average of 65.5% in unprotected crops. Grain yield was 0.02-1.36t/ha.during the rabi winter season of 1979-80 to1987-88 **(Sehgal and Ujagir, 1990)**

2.4 Management options

There are various control measures by which we can reduce the extent of damage caused by *H.armigera*.Out of these control measures most effective are cultural, biological and chemical control.

2.4.1. Cultural Control

Cultural control by the way of habitat diversification has received considerable attention as an alternative pest management strategy **(Bohlen and Barrett, *et al.*, 1999).** Habitat diversification by way of companion or intercropping aim to reduce the pest population on the target crop by diverting pressure away from the main crop or increasing the abundance of beneficial insects.

Role of cultural practices such as time of sowing, crop rotation, tillage, plant spacing, fertilizer management, field sanitation, removal of alternate host plants and intercropping in the management of borers is reviewed**. (Verma and Singh , 1989). Naresh *et al*. (1986)** studied the damage caused by larval population of *H. armigera* on chickpea at three plant densities in Haryana, India . The larval population was least on the plot at a density of 10 plants per square meter and highest in the plots at a density of 30 plants per square meter. The pod damage was greatest at a plant density of 30 plants per square meter.

Studies carried out under AICPIP for several years have revealed that mixed or intercrop with barley, wheat , mustard and linseed has lead to the reduced damage of *Helicoverpa armigera* in chickpea crop resulting higher yield compared to sole crop of chickpea **(Sachan,1992)**

Chaudhary and Sachan (1995) Studied the influence of sowing dates (i.e. 4^{th}, 11^{th}, 18^{th} October and 20^{th} November) on the incidence of *H. armigera* on chickpea at Modipurum, U.P., India . Early sowing can be used to minimize pod borer *H.armigera* (Hb) damage to chickpea on Northern India .

Garg and Verma (1995) reported that in Tarai (Uttaranchal) October sown crop had the smallest larval population and greatest grain yield and 22^{nd} November sown crop had greatest number of larval population and lowest grain yield.

Sehgal and Ram Ujagir (1997) reported that early planting in October and intercropping with non hosts like coriander ,barley,mustard,linseed and trap cropping with marigold and field sanitation summer ploughing reduce the incidence of *H.armigera.* **Nikan and Tendulkar, (1987)** reported when chickpea (75%)and safflower (25%) grown in 3:1 ratio, the intercropping gave the maximum monetary returns (Rs.8.26/hac) hence produced extra monetary returns of Rs. 2,766 and Rs.1,209/ha over the sole chickpea and safflower.

Gupta *et al.*, 1999 reported that when one row of coriander was intercropped between all rows of chickpea , there was significantly high parasitoid (6.4 cocoons per five meter row) and low pest activity(2.6 larvae /five meter row)resulting in minimum pod damage (9.6 %) and highest seed yield (16qt./hac) compared to chickpea sole crop .

Hossain and Rahman, 1999 observed that intercropping of chickpea with wheat or Indian mustard reduced the infestation level and yield loss. The highest level of pod borer infestation (18.56%) was observed in sole chickpea crop.

Prasad and Chand, 1989 noticed that intercropping of chickpea with barley, mustard and wheat suppressed the number of *H. armigera* by 59,56 and 47% respectively. It was concluded that barley, mustard and wheat are compatible as intercrop with chickpea crop. Lower incidence of *H. armigera* were recorded on chickpea intercropped with linseed, barley, wheat, mustard, safflower and sorghum as compared to sole crop **(Ghosh *et al.*, 1986; Mehto *et al.*, 1988; Yadav *et al.*, 1989; Das *et al.*, 1997).**

Sharma *et al.*, 1992 reported that intercropping with *Brassica juncea* was as beneficial to chickpea in yield terms as spraying with monocrotophos against pod borer (*H. armigera*). Chickpea intercropped with safflower produced the highest net return.

Cowgill, 1995 reported that intercrops like groundnut in pigeonpea and coriander in chickpea were found to be beneficial in reducing the incidence of pest besides the additional income obtained through intercrop achieved by habitat manipulation.

Effect of intercropping, chickpea with coriander or linseed on *Helicoverpa armigera* egg and larval population and on the rate of larval parasitism was examined. There were significantly more *Helicoverpa armigera* larvae per plot in sole chickpea treatment than in intercropped treatment. The result suggested that chickpea is more suitable host for *Helicoverpa armigera* than coriander or linseed **(Shekhar *et al.*, 1995).**

Prasad *et al.*, 2002 reported that all intercrops like barley linseed, coriander and mustard were found to be effective in suppressing the larval population ranging from 39.43-58.62%, 26.0-46.56%, 35.72-60.25%, 32.86-32.72% respectively as compared to sole crop of chickpea.

Das, (1998) showed that chickpea intercropped with wheat, mustard or safflower was less susceptible to *H. armigera* and had higher yields when intercropped with linseed, lentil or pea and chickpea grown alone was most susceptible to the pest.

Sekhar and Patel, 1995 reported that certain intercrop like groundnut in pigeon pea and coriander in chickpea were found to be

beneficial in reducing the incidence of the pest besides the additional income obtained through intercrops achieved by habitat manipulation.

Mehto, *et al*., (1988) observed the effect of intercropping mustard, wheat, barley, lentil and linseed with chickpea on various insect pest of chickpea and reported that intercropping generally delayed the appearance of the major pest of chickpea.

Rao and Reddy, (2003) reported that pigeonpea intercropping with castor and sorghum reduced pod damage by *H. armigera*.

Patnaik,et al., (1989) reported that severest attack by *H. armigera* was on sole cropped pigeon peas followed by pigeon peas intercropped with groundnut, mungbean, blackgram and finger millet.

Wang, *et al.*, 1993 reported the interplanted fields (cotton in wheat) the number of eggs of the 2nd generation of noctuid *Heliothis armigera* decreased by 37.8%.

Karel, (1993) reported *H. armigera* larvae were significantly lower in *Phaseolus vulgaris* + maize intercropping and higher plant population than in pure stands.

Patel and Yadav (1992), observed the impact of intercropping marigold on *H. armigera* and found that *H. armigera* preferred marigold over tobacco for egg laying.

Patil *et al*., (1997) reported that lowest infestation (3.4%) was observed in tomatoes intercropped with radishes. Tomato fruit borer infestation levels in tomatoes grown alone, tomato intercropped with coriander and onion was 4.5%, 4.2% and 4.7% respectively.

Umeh, *et al*., (2002) reported that intercropping tomato with crops such as cereals, tubers and other vegetable reduced infestation in some areas.

Murugan, (2001) reported that tomato intercropped with Indian mustard had lowest incidence of *H. armigera* at 60,75,90,105 and 120 DAT

Karel, *et al*., (1982)made an attempt to study the insect pest complex of cowpea when intercropped with maize under different plant population resulted higher pests damage in pure stands than in mixture and that maize acted as a barrier to the dispersal and entry of many pests in mixture.

It was found that population density of developmental stages was significantly lower on tomato planted with pepper or cucumber compared with that recorded on tomato seedling planted alone. **Serwiy *et al*., (1987)** An experiment involving plots of sole cowpeas and sorghum/cowpea intercrop were carried out and it was found that intercropping reduced the number of flower thrips and pod sucking bugs. **Alghali ,1993**

Wiech and Wnuk, (1991) reported that Aphid as well as cabbage moth population were reduced drastically on cabbage intercropped with clover and bean in comparison with monoculture.

Varun *et al*, 1994 reported that growing of odouriferous crop such as garlic, coriander and mentha etc. reduced the incidence of early shoot borer from 8% in sole crop.

Misra and Hora, 1982 reported that the reduction in incidence of top borer in coriander intercropped with sugarcane.

Ojha and Singh, 2003 reported that intercropping of cauliflower with marigold registered the minimum population of aphid and Diamond back moth followed by garlic, mustard, tobacco, radish and coriander.

(Begum and Khan, 2000) reported that squash and bitter gourd intercropping significantly reduced the attack of fruit fly on bitter gourd as compared to control.

It was reported that *Plutella Xylostella* could be effectively controlled when cabbage is intercropped with onion, spearmint and tomato. **(Timbilla, J.A.; Nyako, 2001)**

Saha, *et al.*, 2000 reported that there was a general downward trend in infestation level of black Aphid, tomato fruit borer in intercrop combination i.e.Indian mustard and linseed compared to their number in sole crops of preferred host.

(Satyanarayana and Singh, 1997) reported that intercropping rice bean with sorghum had suppressing effect on most of insect pest.

2.4.1.1 resistant varieties

Kolade and Sharma, (1993) reported that ICC 506, ICCV7, ICC 6663, PDE2, G645, Dulia, ICC 10667, ICC 5264 varieties of chickpea are resistant against *H. armigera.*

Rembold *et al.*,(1990) correlated resistance of chickpea lines to high concentration of malic and oxalic acids in trichome exudate of chickpea.

2.4.2 Biological Control

A number of biological features of *Heliothis* spp affect the prospects of biological control and need to be kept in mind considering the likely effectiveness of biotic control agent.

2.4.2.1 Natural Biocontrol agent

Biotic agent of this pest have been studied in great deal 4 egg, 23 larval

parasitoids, 1 mermithid nematode, 21 species of insect predators and 5 sp.

of spider predators have been recorded around Hyderabad **.(Pawar *et al.*,1986 b)**

At Anad, Gujrat five species of birds- cattle egret *Bubulcus ibis I* (linn.), rosy pastor or rose coloured starling, *Sturnus roseus* (Linn.) ,common

myna *Acridotheres tristis* (Linn.),racket tailed drongo *Dicrurus paradiseus* (Linn.),

And house sparrow *Passor domesticus* (Linn.) were recorded predating on large larvae of *H. armigera* on chickpea. The birds take toll of about 84% larvae **(Anonymous,1987).**

Apart from ichneumonid *C. chloridae* Uchida, house sparrow *P. domesticus* and bank myna *A.ginginianus* (Lotham) are important biotic agent of *H.armigera* in Punjab **(Singh *et al*.,1990).**

The ichneumonid *C. chloridae* is probably the most important larval parasite in India,but parasitism is affected by the host plant,and varies from

46% on sorghum to 3% in pigeonpea **(Pawar *et al*.,1986).**

Devi and Singh *et al.*, 2002. reported that five parasitoids were found associated with *H. armigera* and among the parasitoids, *C. chloridae* was recorded as most important natural enemy of this pest. The percentage of parasitism ranged from 0.18-23.81% from March to May.

Extent of natural larval parasitization by *C. chloridae* on *H. armigera* varied from 5-41% during 1999-2000 ,3-40% during 2000-2001**(Rai ,*et al*., 2003).**

Gupta *et al.*, 1999 reported that when one row of coriander was intercropped between all rows of chickpea, there was significantly high parasitoid (6.4 cocoons per five meter row) and low pest activity (2.6 larvae /five meter row) resulting in minimum pod damage (9.6 %) and highest seed yield (16qt./ha) compared to chickpea sole crop.

Sachan and Bhaumik(1998) reported the extent of natural parasitization by *C. chloridae* of *H. armigera*. It varied between 12.69-56.28%.

Kaur and Singh (2000) in their studies the larval parasitoid *C. chloridae* has been recored as the most important mortality factor, parasitism due to *C. chloridae* ranged from 0.98-68.50% throughout crop season.

Sriniwas, P.R. (1989) determined the seasonal incidence of *C. chloridae* and *Eriborus* spp. the maximum parasitazation of *H. armigera* larvae (43.9 %) was recorded for *C. chloridae* during the first two weeks of December compared with 18 % for Eriborus spp.

Patnayak and Behera. (1991) reported that ichneumonid *C. chloridae* and tachinid *Carccelia illota* played a key role in suppressing the larval population during podding stage.

C. chloridae was reported as potential parasitoid of *H. armigera* infesting chickpea and other pulses **(Gangrade, 1964 ; Mehto *et al*,. 1986 ; Pawar *et al*,. 1989).**

Odak *et al.*, (1986) reported that *C. chloridae* transmitted the virus to *H. armigera* larvae directly by oviposition. The parasitism of *H. armigera* was higher attacked from chickpea planted near the coriander **(Pimbert and Srivastava, 1989)**

Nagarkatti (1981) reported that *C. chloridae* has been found more active on chickpea crop and parasitization ranging from 20-80% and maximum parasitization recorded in December and January.

2.4.2.2 Applied Biocontrol agents

Anonymous (1985) reported that during field tests using *T. chilonis* against bollworm in Gujarat state, in 1982 *T. chilonis* (20,000) were released against *H. armigera* and egg parasitism was 40% in the field where biocontrol agent were released, while parasitism was 0% in the insecticide treated field. In 1983, *T. chilonis* (2,50,000) were released, where the level of egg parasitism averaged 64%. Finally it was concluded that insecticide treated field had less bollworm damage than the biocontrol field in the both

year. The net profit was greater form the insecticide treated field in 1982, but in 1983 the profit form the biocontrol field was about the same as that from the insecticide treated field.

Romies *et al.* (1999) reported various reasons for the failure of *Trichogramma* egg parasitoids of *H. armigera* on chickpea. They found that residence time of female *T. chilonis* on chickpea leaves was affected by trichome and the acidic trichome exudates secreted by all green parts of the plant. Parasitoids spent longer time on parts where the acidic trichome exudates had been washed off than on unwashed leaves. When placed on unwashed chickpea leaves, 6.8% of parasitoids were trapped and killed by the exudates. Female of *T. chilonis* were deterred by high concentration of malic and oxalic acids, the major components of the trichome exudates. They also reported that no parasitized eggs of *H. armigera* were collected from chickpea field in India in which *T. chilonis* were released 5 times at a weekly interval and at a rate of >1,37,000 female/ha. Sticky trap catches showed that no parasitoid population was sustained in the release field.

Madhu *et al.*, (2000) conducted the bioassay of the aqueous extracts of eight plants, to observe their synomonal effects on parasitism by *T. brasiliensis* (Ashmead) and *T. japonicum* (Ashmead). Chickpea extract recorded least response from either of the parasitoid species with mean percent parasitism of 1.58 and 1.51 by *T. brasiliensis* and *T. japonicum.* respectively in comparison to that of in pigeon pea extract where it showed 2.48 and 2.46% parasitism, respectively.

Reddy and Manjunatha (1999) reported that *Trichogramma chilonis* and *T.achaea* are most important egg parasitoids of *H. armigera* in India.

2.4.3 Microbial Control

Some of the microbial organism which are amenable for mass multiplication have proved quite effective against several pests of pulses. On chickpea, the efficacy of HaNPV has been demonstrated in Gujrat, where high mortality of *Helicoverpa* larvae is obtained. In the preliminary trials, a 47% increase in grain yield has been indicated over controls **(Anonymous,1987).**

HaNPV at the rate of 1.5×10^{12} polyhedral occlusion bodies (POB)/ha sprayed three to four times in the evening hours at an interval of 7-10

days. When the pest is in the very early stages, effectively controls the pest on chickpea.**(Jayraj *et al.*, 1987, Rabindra and Jayraj, 1988)**

B. bassiana has been found highly pathogenic to 2nd instar larvae of *H.armigera*. **(Prasad *et al.*,1990).**

Sarode *et al.*, (1999) compared the virulence of HaNPV propagated in field collected and laboratory reared insects. The larval mortality was invariable higher ranging form 7.25 to 84.17% in the treatment of inoculum form field collected insects, which showed 5.18 to 83.33% mortality of *H. armigera*.

Longanathan *et al.* (2000) spicturin (Bt.) with HaNPV proved to be effective as compared to chemical pesticides against gram pod borer, *H. armigera*.

Sehgal and Ram Ujagir (1997) reported that *Helicoverpa* nuclear polyhedrosis virus (HaNPV) @ 250-400 LE per hectare. 2-3 applications are more effective against the gram pod borer. Bacterium *Bacillus thuringiensis* have been effective against *H. armigera.*

Ali *et al.*, (1993) evaluated Edar (HaNPV) and Dipel spores of *Bacillus thuringiensis* sub sp. *thuringienesis* against *H. armigera* in chickpea at Gajipur and Bangladesh. There were significant reduction in

number of larvae and greater yield in plots treated with biopesticides compared to untreated control plots.

2.4.4 Botanical pesticides

Sahgal and Ram Ujagir, (1990) tested that efficiency of synthetic pyrethroids, NSKE, and other insecticides for the control of pod damage by the pest on chickpea and observed that NSKE at 5% like other insecticide was significantly better than control.

Bajpai and Sehgal (1999) reported among the botanical insecticide Karanj oil resulted in highest grain yield (12.9 qt/ha.) with 44% pod damage while neem oil resulted in highest yield (16.5 qt/ha.) with 59% pod damage

Sinha, (1993) evaluated various derivatives of neem against *H.armigera* on chickpea in Haryana . Neem seed kernel extract 5% gave 40% reduction in infestation and was comparable to endosulfan 0.07%. There were no significant differences in the seed the seed yield of plots treated with neem emulsion (0.125%) neem seed kernel (5%) Flufenoxuron and endosulfan.

2.4.5 Chemical control

The use of chemical insecticide has traditionally been the primary management option for *Helicoverpa* control on chickpea **(Lateef , 1985 and Reed *et al.*, 1987).** The development of insecticide resistance in *H.*

armigera has been reported by **Gunning *et al.*, (1984); Forrester *et al.*, (1993).**

Ram Ujagir *et al.*, (1997) tested profenofos (Curacron 50 EC)*Bacillus thuringiensis* sub sp *kurstaki* (Dipel 8L), endosulfan (Thiodon 35 EC), *Helicoverpa* Nuclear Poly hydrosis Virus (HaNPV), HNPV+ endosulfan, lindane (Kanodane) 1.3% D and 20 EC , Azadirachtin (Nimbecidine 0.03%) and cypermethrin +Profenofos (Ploythrin C) for the control of *H.armigera* on chickpea. All treatments except Nimbecidine and Dipel resulted in increased grain yield with lower pod damage.

Sehgal and Ram Ujagir, (1997) reported that many insecticides like endosulfan @ 0.07% conc. Methomyl @ 0.03% conc. deltaphos @ 450 gm a.i., cypermethrin @ 0.006 conc., fenvalerate @ 0.02% conc., monocrotophos @ 0.04% conc., Polythrin –C44 @ 440 gm a.i..,profenofos @ 1000 gm a.i., methyl parathion @ 20-25 kg in combination with NSKE and biopesticides is very effective against *H. armigera* in chickpea.

Singh *et al.*, (1999) evaluated the microbial pesticides viz., Dipel 8L(1 lit/ha), Delfin WG (1 kg/ha) and NPV (250 LE/ha) alone and in combination with endosulfan (35 EC) for their effectiveness against gram pod borer , *H. armigera* in chickpea. These biopesticides when used

alone on the combination with endosulfan proved superior to untreated control by significantly reducing pod damage and enhancing gain yield.

2.4.6 Integrated management of gram pod borer*, H., armigera* (Hb).

In multilocation testing 3 applications of endosulfan gave least pod damage 11.5%. It was closely followed by endosulfan + NSKE (11.6%), NSKE+ endosulfan (12.8%), NPV+ endosulfan (12.9%) and NSKE+NPV (12.9%) as against 25.99% damage in control **(Anonymous, 1994).**

The effectiveness of various treatments may vary from place to place. The NSKE at coimbatore and NSKE+ endosulfan at Dholi, NPV+ endosulfan at Rahuri showed better combination for control of gram pod borer **(Anonymous, 1995).** During 2000 the application of NSKE 5% followed by NPV 250 LE and endosulfan 0.07% had minimum pod damage under multiplication trial **(Anonymous, 2000).**

The efficacy of four Integrated pest management (IPM) module along with two control i.e.one standard state recommendation and an untreated control was evaluated. Pooled data revealed that minimum pod damage (5.6%) were observed in *Helicoverpa armigera* NPV followed by *B t* subs *kurstaki* module.The standard control (2sprays of endosulfan) was more effective than HaNPV followed by Nimbecidine and two sprays of HaNPV+endosulfan with regard to chickpea protection and production.**Singh and Mathur, (2000)**

Bt formulations, Dipel 8 L and Delfin WG, and HaNPV have been found to be effective for controlling *H. armigera* on chickpea. **(Singh *et al.*, 1999).**

Chapter 3 MATERIAL AND METHODS

3.1. SITE OF EXPERIMENT:

The field experiments were conducted during rabi season of 2003-04 and 2004-05 to study the influence of intercrops on *Helicoverpa armigera* population dynamics, incidence and its natural enemy *Campoletis chloridae* at Crop Research Centre of G.B. Pant University of Agriculture and Technology Pantnagar, Distt. U.S.Nagar, Uttranchal, India. Geographically, Pantnagar is situated at latitude 29^0 North and 79.290 East and altitude 243.8 meter above mean seal level. The soil of experimental field was slightly clay loam.

3.2. METEROLOGICAL OBSERVATIONS

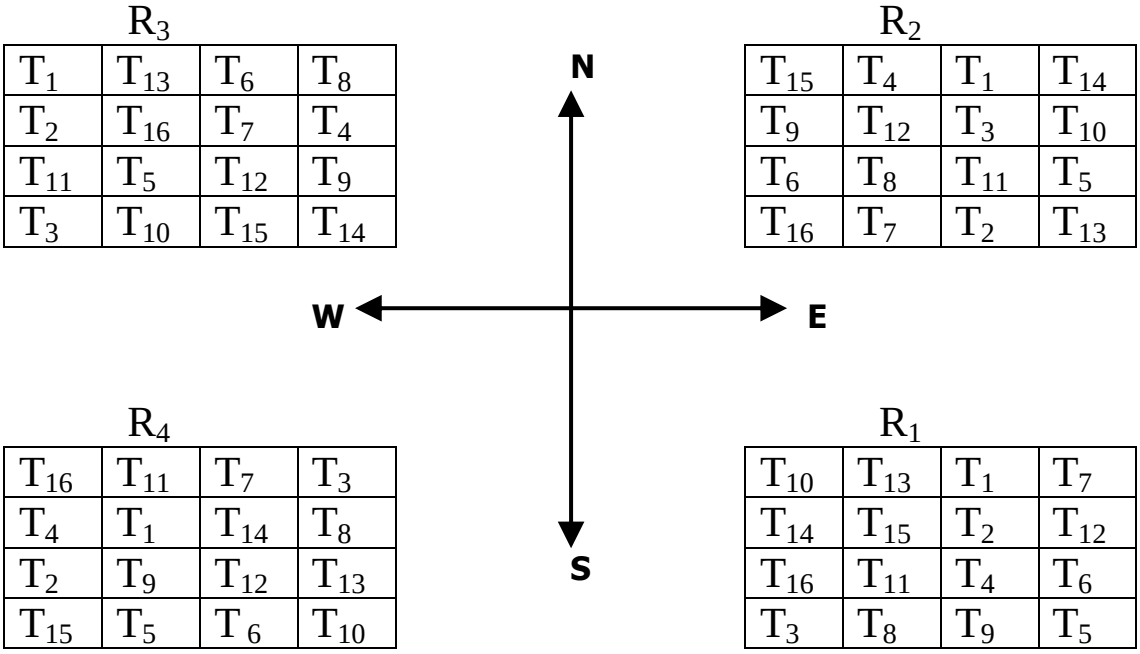
Pantnagar has humid subtropical climate with hot dry summer, hot and wet rainy season and cold winters. It is situated near the foothills of Sivalik range of Central Kumaon Himalayas. It is part of Tarai regions. The temperature may go down to 4^0c during winter whereas summer temperature may reach 43 ^{0}C. The mean annual rainfall is 1340 mm nearly 80-90% of which is received from end of June to September.

However, the total rainfall and its distribution are subjected to large variations. The mean relative humidity (R.H.) remains nearly constant about 80-90% (7 AM) from mid July till the end of February and afterwards steadily decreases to 50% by first week of May and remains at this level till June. The minimum and maximum temperature, R.H. and rainfall during the period of experimentation from December to May 2003-04 and 2004-05 at University meteorological observatory are depicted in Appendix.

3.3. FIELD LAY OUT

Sixteen treatments consisting of different row ratio of chickpea + barley (2:1, 4:1, 6:1, 4:2, 7:2), chickpea+coriander (2:1, 4:1, 6:1, 4:2, 7:2) chickpea+linseed (2:1, 4:1, 6:1, 4:2, 7:2) along with Sole chickpea crop were tested in randomized block design (RBD) with four replications. Sowing of all four crops was done on December 13th during 2003-04 and November 20th during 2004-05. These treatments were sown in plot of 5 x 6 m^2 size having 20 rows of 5-meter length. The varieties of chickpea were C-235 and PG-186. The spacing between plant-to-plant and row-to-row was 10 cm and 45 cm, respectively. The recommended agronomic practices were followed to raise the crop.

Fig. 1: Field layout of different intercropping treatments with chickpea during 2003-04 and 2004-05.



Treatment	Intercrop Combinations
T1	Chickpea+barley (2:1)
T2	Chickpea+barley (4:1)
T3	Chickpea+barley (6:1)
T4	Chickpea+barley (4:2)
T5	Chickpea+barley (7:2)
T6	Chickpea+coriander (2:1)
T7	Chickpea+coriander (4:1)
T8	Chickpea+coriander (6:1)
T9	Chickpea+coriander (4:2)
T10	Chickpea+coriander (7:2)
T11	Chickpea+linseed (2:1)
T12	Chickpea+linseed (4:1)
T13	Chickpea+linseed (6:1)
T14	Chickpea+linseed (4:2)
T15	Chickpea+linseed (7:2)
T16	Sole chickpea

3.4. STUDIES ON GRAM POD BORER *Helicoverpa armigera*

3.4.1. Sampling on population estimation in different treatments

3.4.1.1. Observation on number of eggs of *Helicoverpa armigera* during 2003-04 and 2004-05

During both the years i.e. 2003-04 and 2004-05, 2.0 m^2 area was selected randomly from each plot. Efforts were made to have equal number of plants in marked area of each plot. The number of eggs present on these plants was recorded at weekly interval from 50% flowering until the maturity of crop.

3.4.1.2. Observation on number of larvae of *Helicoverpa armigera* during 2003-04 and 2004-05

During both the years i.e. 2003-04 and 2004-05, 2.0 m^2 area was selected randomly from each plot. The number of plants in that area were counted and marked with tags. The number of larvae present on these plants was recorded at weekly interval from 50% flowering until the maturity of crop.

3.4.1.3. Observation on extent of pod damage and assessment of losses due to *H. armigera* during 2003-04

For pod damage assessment, 15 plants were randomly selected from different treatments at the time of harvest. Every pod was critically examined for the damage of pod borer, *H. armigera*. The following criteria was adopted

(i) Healthy or clear pods without any external damage symptoms

(ii) Pods attacked by *H. armigera* having big circular holes without larval exuviae on the pods.

The number of healthy and damaged pods due to pod borer were recorded separately for each sample and converted in to percentage pod damage with the help of following formula

$$\text{Percent pod damage} = \frac{\text{Number of damaged pod}}{\text{Total number of pods}} \times 100$$

3.4.1.4. Observation on grain yield

During 2003-04 and 2004-05, the sample yield of fifteen plants taken for pod damage assessment and yield of rest plants constituted plot yield. After harvesting the grains were dried in open sunlight to stabilize the moisture content. The weight was taken after this period. The yield of chickpea, coriander, barley, and linseed were recorded separately in Kg

per plots and converted in to Kg per hectare. The yields of different intercrops were converted in to chickpea equivalent based on market value of each commodity.

$$\text{Equivalent yield} = \frac{\text{Yield of intercrop per hactare} \times \text{Price of intercrop (Rs per quintal)}}{\text{Price of sole crop (Rs per quintal)}}$$

The prices of chickpea, coriander, barley, linseed were Rs. 20, 35, 10, 25 per Kg grain respectively.

3.4.2. Larval parasitazation of *Helicoverpa armigera* in different cropping system.

3.4.2.1. Sampling unit

The *Campoletis spp.* are main natural enemy of *Helicoverpa armigera* (Hubner). These parasitize only the young larvae. Simultaneously weekly observations were taken on the larval parasitization of *H. armigera* infesting chickpea sown separately in the field for infestation studies (4^{th} replication)

First and second instar larvae were collected from different treatments at weekly interval. The field-collected larvae were kept individuals in vials for parasitization studies under laboratory. The larvae were provided daily fresh food. Their survivals were examined till the larvae died/ parasitized/ pupated.

3.4.3. Correlation studies:

Egg and larval count as observed in different treatments were correlated with weather factors i.e. temperature, R.H., rainfall to check if these factors influence the egg or larval count. For this the data on these environmental factors were recorded from observatory at weekly interval.

3.5. Statistical analysis:

(i) The data relating to number of eggs, larvae, percent pod damage and plot yield of all the fields were subjected to analysis of variance (ANOVA). The data on above parameters were analyzed in completely randomized block design.

(ii) The data on per cent pod damage were subjected to arcs in transformation

(iii) The yield data were analyzed without applying any transformation.

(iv) The data on insect population (egg and larvae) were subjected to square root transformation with 0.5 adding factor ($\sqrt{x}+0.5$)

All the statistical analyses were carried out by UNIX and LINUX computer system of this university.

Chapter 4 RESULTS AND DISCUSSION

The field experiments were conducted during winter season of 2003-04 and 2004-05 at Crop Research Centre (CRC) of G.B. Pant University of Agriculture and Technology Pantnagar, to study the influence of chickpea intercroped with barley, linseed, coriander on build up and incidence of *Helicoverpa armigera* (Hb.) and it's natural enemies. Natural larval parasitization of *H. armigera* was also studied in laboratory condition during both years

4.1. Egg population estimation in chickpea with intercrops:

The data on the number of eggs of *H. armigera* per square metre during 2003-04 were recorded from flowering stage at 94 days after germination (DAG) till the maturity, 129 DAG. The data on the number of eggs per square metre recorded in various intercrop combinations have been presented and summarized in Table 1. The number of eggs did not vary significantly among the treatments at 94, 101, 115, 122, 129 DAG except 108 DAG. However, at 94 DAG the number of eggs ranged from minimum of 16.0 eggs/m^2 in chickpea+linseed (6:1) to maximum of 30.7 eggs/m^2 in chickpea + barley (7:2) with 18.3 eggs/m^2 in chickpea sole crop.

Table 1. Effect of intercropping on mean number of eggs of *Helicoverpa armigera* in chickpea crop during Rabi 2003-04.

Treatment	94 DAG 17-3-04	101DAG 24-3-04	108DAG 31-3-04	115DAG 07-4-04	122DAG 14-4-04	129DAG 21-4-04	Overall Mean
Chickpea+Barley(2:1)	27.7(5.2)*	3.3(1.9)	20.0(4.4)	24.6(4.7)	14.3(3.5)	2.6(1.4)	15.5
Chickpea+Barley(4:1)	21.3(4.53)	6.6(2.6)	22.3(4.6)	27.0(5.2)	12.3(3.0)	0.0(0.7)	14.9
Chickpea+Barley(6:1)	22.3(4.7)	4.3(2.1)	23.3(4.7)	26.6(4.8)	3.6(1.6)	5.0(1.7)	14.2
Chickpea+Barley(4:2)	18.3(3.9)	5.0(2.3)	8.6(2.5)	33.3(5.7)	7.0(2.5)	0.0(0.7)	12.0
Chickpea+Barley(7:2)	30.6(5.5)	4.0(2.0)	27.0(5.2)	40.6(6.2)	8.6(2.6)	2.6(1.4)	18.9
Chickpea+Coriander(2:1)	29.3(5.4)	4.0(2.0)	15.0(3.9)	33.0(5.7)	3.3(1.5)	0.0(0.7)	14.1
Chickpea+Coriander(4:1)	20.0(4.5)	6.6(2.5)	16.3(4.0)	32.6(5.7)	11.6(3.4)	0.0(0.7)	14.6
Chickpea+Coriander(6:1)	26.0(5.0)	3.6(2.0)	21.6(4.4)	58.3(7.6)	12.6(3.0)	0.0(0.7)	20.4
Chickpea+Coriander(4:2)	23.3(4.6)	6.6(2.6)	22.0(4.6)	42.6(6.5)	4.0(1.6)	0.0(0.7)	16.5
Chickpea+Coriander(7:2)	18.0(3.7)	4.3(2.1)	7.0(2.3)	31.0(5.5)	4.0(1.6)	0.6(0.9)	10.8
Chickpea+Linseed(2:1)	24.0(4.9)	5.0(2.1)	28.3(5.3)	19.3(4.2)	12.6(3.5)	6.6(1.9)	16.0
Chickpea+Linseed(4:1)	23.6(4.2)	6.33(2.5)	20.6(4.5)	49.3(7.0)	5.0(2.0)	0.0(0.7)	14.5
Chickpea+Linseed(6:1)	16.0(3.9)	7.0(2.5)	35.0(5.9)	44.6(6.5)	13.0(3.2)	4.0(1.6)	19.9
Chickpea+Linseed(4:2)	20.0(4.1)	5.3(2.1)	25.3(5.0)	24.6(5.0)	3.3(1.5)	0.0(0.7)	13.1
Chickpea+Linseed(7:2)	21.6(4.6)	4.6(2.4)	17.3(3.8)	17.6(4.2)	2.0(1.3)	0.0(0.7)	10.6
Sole Chickpea	18.3(4.2)	11.6(3.4)	48.0(6.8)	54.3(7.1)	20.3(4.3)	8.3(2.1)	26.8
F value	-	-	Sig	-	-	-	
SEM ±	-	-	0.77	-	-	-	
CD (5%)	-	-	2.23	-	-	-	
CV%	30.16	32.20	29.61	22.62	49.47	83.17	

*Figures given in parentheses are square root transformed value ($\sqrt{x+0.5}$)
DAG:Date After Germination

The number of eggs at 101 DAG ranged from lowest of 3.3 eggs/m^2 in chickpea + barley (2:1) to highest of 11.7 eggs/m^2 in chickpea sole crop. A decrease in data on egg count recorded at 101 DAG could be attributed due to hatching of eggs, which were previously laid at 94 DAG.

At 108 DAG, number of eggs ranged significantly from minimum of 7.0 eggs/m^2 in chickpea+coriander (7:2) to the maximum of 48.0 eggs/m^2 in chickpea sole crop. All the combinations of chickpea and intercrop were significantly different from chickpea sole crop. This indicated that majority of intercrop treatments received low number of eggs as compared to chickpea crop. This may be due to effect of intercrop, which may hinder host selection behavior of *H.armigera*. At 115 DAG high number of eggs ranged from 17.7 eggs/m^2 in chickpea +linseed (7:2) to 58.3 eggs/m^2 in chickpea + coriander (6:1) with 54.3 eggs/m^2 in chickpea sole crop. When the crop reached in pod formation stage at 122 DAG, there was slight reduction in number of eggs, which varied from 2 eggs/m^2 in chickpea+linseed (7:2) to 20.3 eggs/m^2 in chickpea sole Crop. The low number of eggs on intercrop may be due to less appearancy of main host (chickpea) to adult females of

H. armigera. On maturity at 129DAG the intercrop did not receive eggs as compared to chickpea sole crop, this may be due to senescence of

chickpea plants in intercrop combinations. The result indicated that *H. armigera* may lay flush of eggs first at the time of flowering near 94 DAG and second between 108 DAG and 115 DAG.

The data on number of eggs/m^2 recorded during 2004-05 have been summarized in table 2. The egg population was recorded from 94 DAG to 129 DAG. During 2004-05, egg laying was low and delayed in comparison of previous years. This may be due to environmental conditions, which could not favor the build up of insect population. As a result there was no significant difference observed among the treatments at 94, 101, 108, 122, 129 DAG except 115 DAG. Initially, at 94 DAG the minimum number of eggs (0.0 /m^2) was received by chickpea + coriander (2:1), chickpea + linseed (2:1), chickpea+ barley (4:2) chickpea + linseed (4:2) and maximum number of eggs was observed in chickpea sole crop i.e. 5.7 eggs/m^2. At 101 DAG numbers of eggs ranged from minimum of 0.0 eggs/m^2 in majority of intercropping combinations to maximum of 2.67 eggs/m^2, which was observed in chickpea+barley (4:1).

At 108 DAG number of eggs ranged from minimum of 0.33 eggs/m^2 in chickpea+barley (7:2) to maximum of 6.33 eggs/m^2 in chickpea +linseed (2:1) with 5.33 eggs/m^2 in chickpea sole crop. In comparison with last year, this year all the intercrop combinations

Table 2. Effect of intercropping on mean number of eggs of *Helicoverpa armigera* in chickpea crop during Rabi 2004-05.

Treatment	94DAG 28-2-05	101DAG 7-3-05	108DAG 14-3-05	115DAG 21-3-05	122DAG 28-3-05	129DAG 4-4-05	Overall Mean
Chickpea+Barley (2:1)	1.6(1.3)*	0.0(0.7)	2.0(1.4)	10.0(3.1)	12.7(3.5)	5.0(1.7)	5.2
Chickpea+Barley (4:1)	0.3(0.8)	2.7(1.7)	1.6(1.3)	1.3(1.1)	19.6(4.4)	3.7(1.8)	4.9
Chickpea+Barley (6:1)	0.6(0.9)	0.0(0.7)	4.0(2.0)	14.3(3.7)	19.6(4.2)	10.0(2.7)	8.1
chickpea+Barley (4:2)	0.0(0.7)	1.0(1.0)	4.6(2.0)	4.6(2.2)	16.6(4.0)	2.3(1.3)	4.9
Chickpea+Barley (7:2)	3.0(1.7)	0.3(0.8)	0.3(0.8)	3.3(1.9)	16.3(3.9)	16.6(3.9)	6.7
Chickpea+Coriander(2:1)	0.0(0.7)	0.0(0.7)	1.0(1.1)	5.6(2.0)	11.0(3.3)	0.0(0.7)	3.0
Chickpea+Coriander(4:1)	1.0(1.0)	1.3(1.1)	3.0(1.8)	0.6(0.9)	15.0(3.9)	7.3(2.7)	4.7
Chickpea+Coriander(6:1)	2.3(1.6)	1.0(1.1)	2.0(1.5)	12.0(3.4)	24.6(4.8)	10.0(2.8)	8.7
Chickpea+Coriander(4:2)	1.3(1.2)	0.3(0.8)	1.0(1.0)	2.3(1.5)	25.0(4.9)	0.0(0.7)	5.0
Chickpea+Coriander(7:2)	1.3(1.2)	0.0(0.7)	5.3(2.1)	15.6(4.0)	17.6(4.1)	0.0(0.7)	6.7
Chickpea+Linseed(2:1)	0.0(0.7)	1.0(1.1)	6.3(2.6)	2.7(1.4)	13.3(3.5)	2.6(1.4)	4.3
Chickpea+Linseed(4:1)	0.6(0.9)	0.0(0.7)	6.0(2.2)	19.0(4.2)	10.0(3.0)	5.0(1.7)	6.8
Chickpea+Linseed(6:1)	2.3(1.5)	0.0(0.7)	1.6(1.3)	29.0(5.7)	15.6(3.3)	3.3(1.5)	8.7
Chickpea+Linseed(4:2)	0.0(0.7)	1.6(1.3)	3.0(1.8)	19.7(4.4)	24.3(4.2)	6.0(1.9)	9.1
Chickpea+Linseed(7:2)	3.3(1.9)	0.0(0.7)	3.6(1.9)	14.3(3.7)	23.6(4.6)	12.3(3.1)	9.6
Sole Chickpea	5.6(2.1)	0.0(0.7)	5.3(2.3)	23.6(4.7)	32.3(5.5)	14.7(3.8)	13.6
F test	-	-	-	Sig	-	-	
SEM±	-	-	-	0.54	-	-	
CD at 5%	-	-	-	1.58	-	-	
CV%	52.11	41.64	43.77	31.40	35.04	75.05	

*Figures given in parentheses are square root transformed value ($\sqrt{x+0.5}$)
DAG:Date After Germination

received less number of eggs on account of heavy incidence of root rot disease which led to weakening and poor health of chickpea plants.

At 115 DAG egg count ranged significantly from minimum of 0.67 eggs/m^2 in chickpea+coriander (4:1) to maximum of 29.0 eggs/m^2 in chickpea+linseed (6:1) with 23.67 eggs/m^2 in chickpea sole crop. All the intercropping treatments were significantly different from sole chickpea crop except chickpea+linseed (6:1) intercrop combination. This observation suggested that majority of intercrop treatments received less number of eggs as compared to chickpea sole crop which could be due to some extent of shading effect of intercrop on chickpea plants which resulted in poor growth of chickpea plants.

At 122 DAG, high number of eggs was observed almost in all cropping systems including chickpea sole crop. The number of eggs/m^2 in various intercrop combinations was found to be lower (10-25 eggs/m^2) than that of chickpea sole crop (32.33 eggs/m^2). However, these differences are nonsignificant. The number of eggs ranged from minimum of 10 eggs/m^2 in chickpea+linseed (4:1) to maximum of 32.33 eggs/m^2 in chickpea sole Crop.

At 129 DAG egg count ranged from 0.0 to 16.7and highest egg population of 16.7 was observed in case of chickpea+barley intercrop combination (7: 2) with 14.7 eggs/m^2 in chickpea sole crop. Again, except chickpea+barley all the treatments received low number of eggs as compared to sole chickpea crop.

The pooled analyzed data on egg population of two years are presented in Table 3.

The table 3 revealed that egg laying by *Helicoverpa* was continued from flowering to maturity. In initial observation the number of eggs were relatively low as compared to pod formation stage of the crop (108, 115, 122 DAG). There were no significant differences in number of eggs among the treatments at 3 initial observations. The number of eggs showed significant variation among the treatments at 115 DAG. At the last observation when crop approached the maturity, the number of eggs were very low in intercrop treatments (0-15 eggs/m^2) as compared to chickpea sole crop (23.0 eggs/m^2). It is clear that all the combination of intercrop had reduced number of eggs in comparison to pure chickpea crop. Among the cropping system chickpea+barley with 4:2 and 4:1; chickpea+coriander and chickpea with linseed with 2:1 and 7:2 row ratios gave lowest of eggs over other row ratio used in the experiment.

Table3: Pooled data of two years 2003-04 and 2004-05 showing effect of intercropping on mean number of egg count of *Helicoverpa armigera* in chickpea crop.

Treatment	94DAG	101DAG	108DAG	115DAG	122DAG	129DAG	Overall Mean
Chickpea+Barley (2:1)	29.3(5.4)*	3.3(1.9)	22.0(4.7)	34.6(5.)	27.0(4.9)	7.6(2.5)	20.7
Chickpea+Barley (4:1)	21.6(4.5)	9.3(3.1)	24.0(4.8)	28.3(5.3)	32.0(5.6)	3.6(1.8)	19.8
Chickpea+Barley (6:1)	19.0(4.4)	4.3(2.1)	27.3(5.1)	41.0(6.3)	23.3(4.5)	15.0(3.4)	21.7
chickpea+Barley (4:2)	18.3(3.9)	6.0(2.5)	13.3(3.5)	38.0(6.1)	23.6(4.8)	2.3(1.3)	16.9
Chickpea+Barley (7:2)	33.6(5.8)	4.3(2.1)	27.3(5.2)	40.0(6.5)	25.0(4.9)	19.3(4.1)	24.9
Chickpea+Coriander(2:1)	29.3(5.4)	4.0(2.0)	16.0(4.0)	38.6(6.2)	14.3(3.6)	0.0(0.7)	17.0
Chickpea+Coriander(4:1)	21.0(4.6)	8.0(2.8)	19.3(4.4)	33.3(5.7)	26.6(5.1)	7.3(2.3)	19.3
Chickpea+Coriander(6:1)	28.6(5.2)	4.6(2.2)	23.6(4.6)	70.3(8.3)	37.3(5.8)	10.0(2.8)	29.11
Chickpea+Coriander(4:2)	21.3(4.)	7.0(2.7)	26.3(5.1)	45.0(6.7)	29.0(5.3)	0.0(0.7)	21.4
Chickpea+Coriander(7:2)	18.6(3.9)	4.3(2.1)	12.3(3.3)	46.6(6.8)	21.6(4.5)	0.6(0.9)	17.4
Chickpea+Linseed(2:1)	24.0(4.9)	6.0(2.4)	34.66(5.90)	22.0(4.6)	26.0(5.1)	9.3(2.2)	20.3
Chickpea+Linseed(4:1)	24.3(4.5)	6.3(2.5)	26.66(5.18)	76.3(8.2)	15.0(3.6)	5.0(1.7)	25.6
Chickpea+Linseed(6:1)	10.3(4.3)	7.0(2.6)	36.66(6.08)	73.6(8.5)	28.7(5.3)	7.3(2.0)	27.3
Chickpea+Linseed(4:2)	20.0(4.1)	7.0(2.6)	28.33(5.36)	44.3(6.6)	27.6(4.8)	6.0(1.9)	22.2
Chickpea+Linseed(7:2)	25.0(5.0)	4.6(2.0)	21(4.28)	32.6(5.7)	25.6(4.9)	12.3(3.1)	20.2
Sole Chickpea	24.3(4.9)	11.6(3.4)	53.33(7.19)	61.3(7.8)	52.6(7.2)	23.0(4.7)	37.7
F value	-	-	-		-	-	
SEM±	-	-	-	0.59	-	-	
CD (5%)	-	-	-	1.71	-	-	
CV%	28.69	26.95	23.73	15.50	30.73	68.95	

*Figures given in parentheses are square root transformed value ($\sqrt{x+0.5}$)
DAG:Date After Germination

4.2. Population estimation of larvae in chickpea with intercrops:

Table 4 presented the data on number of larvae/m^2 recorded in various intercrop combinations during 2003-04. The number of larvae did not vary significantly among the treatments at 94, 101, 122, 129 DAG. At 94 DAG, the maximum number of larvae (14.3/m^2) was observed in chickpea +coriander (6:1) and minimum number of larvae (5.7/m^2) was observed in chickpea +linseed (6:1) with 7.0/m^2 in sole chickpea. Because of poor germination of coriander more number of larvae were recorded in the intercrop combination.

At 101DAG larval population ranged from maximum of 29/m^2 in chickpea +linseed (6:1) to minimum of 14/m^2 in chickpea+linseed (4:1) with 25.3/m^2 in chickpea sole crop.

At 108 DAG larval counts ranged significantly from minimum of 42.0/m^2 in chickpea+coriander (4:2) to maximum of 69.0/m^2 in chickpea+linseed (7:2) with 65.7/m^2 in chickpea sole crop. All the treatments having coriander and barley as a intercrop had significantly reduced number of larvae than chickpea sole crop and chickpea+linseed (2:1, 4:1, 7:2) combinations.

At 115 DAG, the abundance of larvae was observed. Larval count ranged significantly from minimum of 43.7/m^2 in chickpea+coriander (7:2) to maximum of 88.7/m^2 in chickpea sole crop. Larval count in all the intercropping system having coriander, barley, and linseed as an

Table 4. Effect of intercropping on mean number of larval populatinof *Helicoverpa armigera* in chickpea crop during Rabi 2003-04.

Treatment	94 DAG 17-3-04	101DAG 24-3-04	108DAG 31-3-04	115DAG 07-4-04	122DAG 14-4-04	129DAG 21-4-04	Overall Mean
Chickpea+Barley (2:1)	7.6(2.8)*	16.3(4.0)	42.3(6.5)	45.3(6.6)	31.0(5.5)	39.0(6.1)	30.3
Chickpea+Barley (4:1)	7.3(2.7)	17.6(4.2)	50.0(7.1)	65.0(8.0)	33.0(5.6)	43.3(6.4)	36.0
Chickpea+Barley (6:1)	6.0(2.4)	25.0(5.0)	48.3(6.9)	62.0(7.8)	33.0(5.7)	33.0(5.6)	34.6
chickpea+Barley (4:2)	9.3(3.0)	14.6(3.8)	46.3(6.8)	62.6(7.9)	29.0(5.4)	37.0(6.0)	33.2
Chickpea+Barley (7:2)	11.3(3.2)	21.3(4.6)	53.0(7.2)	79.0(8.9)	39.3(5.8)	60.3(7.7)	44.0
Chickpea+Coriander(2:1)	12.3(3.5)	17.0(4.0)	50.6(7.1)	56.3(7.5)	23.3(4.8)	27.0(5.2)	31.3
Chickpea+Coriander(4:1)	8.0(2.8)	16.3(4.0)	54.6(7.4)	66.7(8.1)	33.0(5.7)	37.0(6.0)	35.9
Chickpea+Coriander(6:1)	14.3(3.8)	20.3(4.5)	57.3(7.5)	82.7(9.0)	26.3(5.1)	36.3(6.0)	39.5
Chickpea+Coriander(4:2)	13.0(3.6)	18.6(4.2)	42.0(6.5)	71.6(8.4)	31.7(5.6)	32.0(5.6)	34.8
Chickpea+Coriander(7:2)	11.3(3.2)	18.6(4.3)	45.6(6.7)	43.7(6.5)	37.6(5.9)	37.0(5.8)	32.4
Chickpea+Linseed(2:1)	9.6(3.1)	22.0(4.6)	64.6(8.0)	81.7(9.0)	27.3(5.2)	45.0(6.4)	41.7
Chickpea+Linseed(4:1)	14.0(3.6)	14.0(3.7)	68.6(8.3)	81.0(9.0)	34.6(5.9)	39.3(6.0)	41.9
Chickpea+Linseed(6:1)	5.6(2.4)	29.3(5.4)	63.3(7.9)	75.0(8.5)	34.0(5.7)	44.0(6.4)	41.9
Chickpea+Linseed(4:2)	8.0(2.9)	21.3(4.6)	64.3(8.0)	65.6(8.0)	28.3(5.3)	35.3(5.6)	37.2
Chickpea+Linseed(7:2)	10.3(3.2)	26.0(5.1)	69.0(8.3)	47.3(6.9)	40.0(6.3)	35.0(6.0)	37.9
Sole Chickpea	7.0(2.5)	25.3(5.0)	65.6(8.1)	88.6(9.4)	53.6(7.2)	66.3(7.7)	51.1
F value	-	-	Sig	Sig	-	-	
SEM±	-	-	0.30	0.51	-	-	
CD (5%)	-	-	0.87	1.50	-	-	
CV%	26.49	14.81	7.04	11.04	17.57	17.28	

*Figures given in parentheses are square root transformed value ($\sqrt{x+0.5}$)
DAG:Date After Germination

intercrop was significantly different from that of chickpea sole crop. Almost 50% reduction in larval count was observed when chickpea is intercropped with barley, coriander and linseed in 2:1,7:2, &7:2 ratio, respectively.

At 122DAG larval population ranged from minimum of 23.3/m^2 in chickpea +coriander (2:1) to maximum of 53.7/m^2 in chickpea sole crop.

At maturity (129 DAG), the larval count ranged from minimum of 27/m^2 in chickpea +coriander (2:1) to maximum of 66.3/m^2 in chickpea sole crop. Eggs and larvae were low in number during three initial observations and therefore the larval population did not vary significantly among the treatments at 94, 101, 108 DAG during 2004-05.

At 94 DAG larval count ranged from minimum of 0.33/m^2 in chickpea+coriander (2:1), chickpea+linseed (4:1), to the maximum of 4.3/m^2 in chickpea sole crop. In general less number of larvae were recorded as compared to previous year because there were rigorous attack of root rot disease that caused heavy mortality of plants.

Table 5. Effect of intercropping on mean number of larval count of *Helicoverpa armigera* on chickpea during Rabi 2004-05.

Treatment	94DAG 28-2-05	101DAG 7-3-05	108DAG 14-3-05	115DAG 21-3-05	122DAG 28-3-05	129DAG 04-4-05	Overall Mean
Chickpea+Barley (2:1)	2.3(1.6)*	0.6(0.9)	5.6(2.4)	12.0(3.4)	20.6(4.5)	29.0(5.3)	11.7
Chickpea+Barley (4:1)	1.6(1.4)	0.6(1.0)	5.0(2.2)	11.6(3.3)	20.0(4.4)	38.3(6.2)	12.9
Chickpea+Barley (6:1)	1.6(1.3)	0.6(1.2)	7.0(2.7)	7.3(2.9)	26.6(5.1)	48.0(6.9)	15.2
chickpea+Barley (4:2)	1.0(1.1)	1.3(0.8)	4.0(2.1)	18.0(4.2)	30.3(5.4)	43.6(6.5)	16.4
Chickpea+Barley (7:2)	1.6(1.3)	0.3(0.8)	6.0(2.5)	13.6(3.6)	25.7(5.0)	70.0(8.2)	19.6
Chickpea+Coriander(2:1)	0.3(0.8)	0.0(0.7)	2.6 (1.7)	4.6 (2.2)	20.3(4.5)	27.0(5.1)	9.2
Chickpea+Coriander(4:1)	1.3(1.2)	0.3(1.4)	2.7(1.7)	11.6(3.4)	13.0(3.6)	29.3(5.4)	9.7
Chickpea+Coriander(6:1)	1.0(1.1)	2.0(1.3)	6.3(2.5)	7.3(2.7)	26.6(5.1)	43.0(6.5)	14.4
Chickpea+Coriander(4:2)	1.6(1.4)	1.3(0.8)	4.3(2.1)	8.0(2.9)	14.0(3.7)	31.6(5.5)	14.4
Chickpea+Coriander(7:2)	2.3(1.6)	0.3(0.8)	2.3(1.6)	8.3(2.9)	20.3(4.4)	36.6(6.0)	11.7
Chickpea+Linseed(2:1)	1.3(1.2)	0.3(1.4)	7.3(2.7)	12.3(3.5)	25.0(5.0)	48.3(6.8)	15.8
Chickpea+Linseed(4:1)	0.3(0.8)	1.7(1.1)	5.6(2.4)	12.0(3.3)	24.6(4.8)	54.6(7.4)	16.5
Chickpea+Linseed(6:1)	3.6(1.8)	1.3(1.3)	4.6(2.1)	11.0(3.2)	30.3(5.5)	50.3(7.0)	16.9
Chickpea+Linseed(4:2)	1.33(1.1)	1.3(1.4)	5.6 (2.3)	3.3(1.9)	35.0(5.8)	45.3(6.7)	15.3
Chickpea+Linseed(7:2)	2.6(1.7)	1.6(1.4)	9.0(3.0)	9.7(3.4)	41.3(6.3)	48.0(6.8)	21.2
Sole Chickpea	4.3(2.1)	2.6(1.7)	7.6(2.7)	24.3(4.9)	45.6(6.7)	94.6(9.6)	29.9
F value	-	-	-				
SEM±	-	-	-	0.46	0.53	0.59	
CD (5%)	-	-	-	1.32	1.53	1.70	
CV%	33.17	36.05	27.81	24.27	18.23	15.34	

* Figures given in parentheses are square root transformed value ($\sqrt{x+0.5}$)
DAG:Date After Germination

At 101 DAG larval count ranged from minimum of 0.0/m^2 in chickpea+coriander (2:1), to the maximum of 2.7/m^2 in chickpea sole crop.

At 108 DAG Minimum larval population of 2.3/m^2 was observed in chickpea +coriander (7:2) and maximum of 7.7/m^2 was observed in case of chickpea sole crop.

At 115 DAG, the larval count ranged significantly from minimum of 3.3/m^2 in chickpea+linseed (4:2) to maximum of 24.3/m^2 in chickpea sole crop. All the combinations of three intercrop viz. coriander, barley, linseed showed significantly low number of larvae when compared with chickpea sole crop. The intercropping with coriander was found to be more effective in reducing larval population.

At 122 DAG There were significant differences for larvae among the treatments. Minimum larval count 13.0/m^2 was observed in chickpea+coriander (4:1) and maximum 45.7/m^2 in case of chickpea sole crop.

At 129 DAG larval population varied significantly from minimum of 27/m^2 in chickpea+ coriander (2:1) to maximum of 94.7/m^2 in case

of chickpea sole crop. All the intercrop treatment showed significantly less number of larvae as compared to chickpea sole crop. Three treatments i.e. chickpea+coriander (2:1), chickpea+barley (2:1) and chickpea+coriander (4:1) received lowest number of larvae among the intercrops.

Table 6 revealed that larval population was observed from flowering, 94 DAG to the maturity, 129 DAG.Initially larval count was relatively low as compared to the pod formation stage (115, 122, 129 DAG). This corresponds to number of egg laid during these period. There were no significant difference in number of larvae at 94,101,115DAG .The number of larvae showed significant difference among the treatment at 108 , 122 and 129DAG. At 108 DAG larval count ranged significantly from minimum of 48.0/m^2 in chickpea+barley (2:1) and chickpea+coriander (7:2) and maximum of 78.7/m^2 in chickpea sole crop. All the treatments were significantly different from chickpea sole crop except chickpea+linseed(7:2). It was because of poor plant stand of Linseed plants.

122 DAG, larval count ranged significantly from minimum of 43.7/m^2 in chickpea+coriander (2:1) to the maximum of 99.3/m^2 in chickpea sole
crop. All the treatments are significantly different from chickpea sole crop.

Table 6: Pooled data of two years 2003-04 and 2004-05 showing effect of intercropping on mean number of larval count of Helicoverpa *armigera* in chickpea

Treatment	94 DAG	101 DAG	108DAG	115 DAG	122 DAG	129 DAG	Overall Mean
Chickpea+Barley (2:1)	10.0(3.2)*	17.0(4.1)	48.0(6.9)	53.3(7.5)	51.6(7.1)	68.0(8.2)	41.3
Chickpea+Barley (4:1)	9.0(3.0)	18.3(4.3)	55.0(7.4)	76.6(8.7)	53.0(7.2)	81.6(9.0)	48.9
Chickpea+Barley (6:1)	7.7(2.7)	25.7(5.1)	55.3(7.5)	70.0(8.3)	59.6(7.7)	81.0(8.9)	49.9
chickpea+Barley (4:2)	10.3(3.2)	16.0(4.0)	50.3(7.1)	80.6(9.0)	59.3(7.7)	80.6(8.9)	49.6
Chickpea+Barley (7:2)	13.0(3.5)	21.7(4.7)	59.0(7.7)	92.6(9.6)	65.0(7.9)	130.3(11.2)	63.6
Chickpea+Coriander(2:1)	12.7(3.6)	17.0(4.1)	53.3(7.3)	61.0(7.8)	43.6(6.6)	54.0(7.3)	40.3
Chickpea+Coriander(4:1)	9.3(3.1)	16.7(4.1)	57.3(7.5)	75.0(8.6)	46.0(6.7)	66.3(8.1)	45.1
Chickpea+Coriander(6:1)	15.3(3.9)	11.3(3.0)	63.6(8.0)	90.0(9.5)	53.0(7.2)	79.3(8.9)	52.1
Chickpea+Coriander(4:2)	14.7(3.9)	20.0(4.5)	49.0(7.0)	79.6(8.9)	45.6(6.7)	63.6(8.9)	42.5
Chickpea+Coriander(7:2)	13.7(3.5)	19.0(4.4)	48.0(6.9)	52.0(7.2)	58.0(7.5)	73.6(7.9)	44.0
Chickpea+Linseed(2:1)	11.0(3.3)	22.3(4.7)	72.0(8.4)	100.6(10.0)	52.3(7.2)	93.3(9.5)	58.6
Chickpea+Linseed(4:1)	14.3(3.8)	15.7(4.0)	74.0(8.6)	93.0(9.6)	59.3(7.6)	94.0(9.6)	58.4
Chickpea+Linseed(6:1)	9.3(3.0)	30.7(5.6)	68.0(8.2)	186.6(12.3)	64.3(7.9)	94.3(9.6)	75.6
Chickpea+Linseed(4:2)	9.3(3.1)	22.7(4.8)	70.0(8.3)	89.0(8.2)	63.0(7.9)	80.6(8.9)	55.8
Chickpea+Linseed(7:2)	13.0(3.7)	27.6(5.3)	78.3(8.8)	59.6(7.7)	81.3(9.01)	83.0(9.1)	57.2
Sole Chickpea	11.3(3.4)	28.0(5.3)	78.6(8.8)	113(10.6)	99.3(9.9)	161.0(12.6)	81.9
F value	-	-	Sig	-	Sig	Sig	
SEM±	-	-	0.3	-	0.5	0.5	
CD(5%)	-	-	0.9	-	1.6	1.6	
CV%	-	-	6.8	-	12.8	10.2	

*Figures given in parentheses are square root transformed value ($\sqrt{x+0.5}$)
DAG: Date After Germination

At 129 DAG, larval count ranged significantly from minimum of 54.0/m^2 in chickpea+coriander (2:1) to the maximum of 161.0/m^2 in chickpea sole crop. There were significantly more *H. armigera* larvae per plot in sole chickpea treatment than in intercropped treatments. However, maximum reduction in larval count was observed when chickpea intercropped with coriander, followed by barley and linseed.The results of present study are consistent with **Prasad *et al.*, 2002** who have reported that all intercrops like barley linseed ,coriander and mustard were found to be effective in suppressing the larval population ranging from 39.43 -58.62%, 26.0 -46.56%, 35.72 -60.25%, 32.86 - 32.72% respectively as compared to sole crop of chickpea. **Ghosh *el al.*, 1986** reported that lower incidence of *H. armigera* were recorded on chickpea intercropped with linseed, barley, wheat, mustard, safflower and sorghum as compared to sole crop. **Shekhar *et al.*, 1995** reported more *H. armigera* larvae per plot in chickpea sole treatment than in intercropped treatments with coriander or linseed.

In general, all the intercrops viz. barley, linseed, coriander gave suppressing effect on larval population of *H. armigera* on chickpea during successive growth stages of the crop. The sole crop of chickpea received higher larval population of *H. armigera* throughout the crop

period, which was significantly reduced, with the introduction of intercrops like coriander barley and linseed in various combinations.

4.3 Correlation of different Environmental factors with egg and larval population

There were no significant correlation coefficient between egg count and weather parameters during both the years 2003-04 and 2004-05.

There were no significant correlation coefficient between larval count and weather parameters during 2003-04. However in the year 2004-05 positive

correlation coefficient was observed between larval population and

Maximum temperature.

4.4 Mean percent pod damage due to *H.armigera* in different chickpea

and intercrop combinations

The data on Mean percent pod borer damage recorded in various treatments are given in Table 8. During 2003-04,mean percent pod borer damage ranged without significant differences among the treatments. Lowest of 54.8% and highest of 82.4% were recorded in chickpea +coriander (4:2) and chickpea sole crop respectively. All the three intercrop i.e.coriander, linseed and barley caused reduction in pod damage as compared to chickpea sole crop,though it was not

Table7:Correlation of different Environment Factors with egg and larval population during 2003-04 and 2004-05 in rabi season.

Factors (correlation)	Max. temperature(^{0}C)	Min. temperature (^{0}C)	RH (Max) (%)	RH (Min) (%)	Total Rainfall (mm.)	No. of rainy days	Wind speed
Egg Population (2003-04)	-0.34	-0.64	0.69	-0.14	0.0	0.0	-0.07
Larval population (2003-04)	0.73	0.53	-0.18	-0.59	0.0	0.0	0.09
Egg Population (2004-05)	-0.13	0.12	0.42	0.68	0.44	0.33	-0.39
Larval population (2004-05)	0.78 *	0.639	-0.51	-0.43	-0.002	-0.19	-0.64
Pooled Egg count for both the years	0.12	-0.06	0.27	-0.11	0.013	-0.08	-0.106
Pooled Egg count for both the years	0.82	0.65	-0.48	-0.65	-0.24	-0.37	-0.19

Table 8. Effect of intercropping on mean percent pod damage at maturity due to *H. armigera* (Hubner) in different chickpea and intercrop combinations.

Treatment	Mean pod damage% at harvest (2003-04)	Mean pod damage% at harvest (2004-05)	Pooled pod damage (%)
Chickpea+Barley (2:1)	75.31(60.24)*	98.43(85.82)	86.87(68.79)
Chickpea+Barley (4:1)	70.00(56.83)	98.89(86.49)	84.44(66.84)
Chickpea+Barley (6:1)	69.35(56.76)	100(90.00)	84.67(67.33)
chickpea+Barley (4:2)	68.12(56.20)	95.95(80.98)	82.13(65.55)
Chickpea+Barley (7:2)	72.72(58.52)	97.97(83.33)	85.34(67.51)
Chickpea+Coriander(2:1)	65.80(58.52)	80.89(64.76)	73.35(58.93)
Chickpea+Coriander(4:1)	57.45(54.25)	89.02(71.02)	74.39(59.63)
Chickpea+Coriander(6:1)	64.38(49.33)	87.97(70.19)	76.17(60.80)
Chickpea+Coriander(4:2)	54.82(53.52)	86.46(69.21)	70.64(57.23)
Chickpea+Coriander(7:2)	62.61(47.81)	86.26(68.93)	74.44(59.85)
Chickpea+Linseed(2:1)	70.11(52.45)	96.00(83.24)	83.05(65.71)
Chickpea+Linseed(4:1)	67.90(56.98)	95.98(78.48)	81.94(64.86)
Chickpea+Linseed(6:1)	66.74(55.25)	95.56(80.22)	81.14(64.87)
Chickpea+Linseed(4:2)	59.83(50.77)	98.98(86.65)	79.40(63.18)
Chickpea+Linseed(7:2)	63.71(53.24)	97.53(84.73)	80.70(64.10)
Sole Chickpea	82.36(65.16)	98.97(86.63)	90.67(72.22)
SEM±	-	3.93	2.11
CD (5%)	-	11.35	6.11
CV%	9.87	8.57	5.71

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*Figures given in parentheses are Angular transformed values.

significant.Maximum of 28% reduction in pod damage was obtained with chickpea + coriander(4:2) over chickpea crop.In subsequent year, mean percent pod borer damage varied significantly from minimum of 80.9% in chickpea + coriander(2:1) to maximum of 100% in Chickpea +Barley (6:1) as against 99% in Chickpea sole crop. All the combinations of Coriander with Chickpea significantly had reduced pod borer damage. In general heavy pod borer damage was recorded as compared to previous year. The crop was heavily attacked by root rot that caused heavy mortality of plants and the remaining plants succumb to pod borer attack.From the pooled pod borer damage data it was found that Mean percent pod damage ranged significantly from minimum of 70.6% in chickpea + coriander (4:2) to the maximum of 90.7% in chickpea sole crop. All the combinations of chickpea with coriander significantly reduced damage of pod borer. Maximum of 20% reduction in pod damage was obtained when chickpea intercropped with coriander in the ratio of 4:2 rows. The reducing effect of coriander was followed by linseed where maximum of 11.2% reduction in pod damage was observed. This indicated that by intercropping we can reduce at least 13-15% pod borer damage under severe attack of *H.armigera*.

4.5. Mean larval parasitization by *Campoletis chlorideae* in different intercrop combination

The data on Mean larval parasitization by *Campoletis chlorideae* recorded in various treatments are given in Table 9.

During 2003-04 mean larval parasitization ranged from maximum of 30.2% in chickpea + coriander (4:1) to minimum of 15.7% in chickpea + barley (6:1) with 16.0% in chickpea sole crop. The results also suggest that all the combination of intercrop except chickpea+barley (6:1) caused increase in larval parasitization. It could be inferred that Coriander may have some nector/attractant for the *C. chloridae* adult.

In the subsequent year mean percent parasitization ranged from minimum of 19.27% in chickpea + barley (6:1) to the maximum of 50.5% in chickpea + coriander (2:1), in the last year also minimum parasitization was recorded in the same ratio of chickpea and barley it showed that this ratio had no significant importance in increasing percent parasitization.

The data on parasitization for all the treatments were combined date wise and are presented in Table 10.

During 2003-04 mean larval parasitization ranged from maximum of 33.1% at 116DAG (flowering) to minimum of 13.2% at 136 DAG.

Table 9:Mean percentage of *H.armigera* larvae parasitized by *C. chloridae* in field during 2003-04and 2004-05.

Treatment	Mean larval Parasitization (%) (2003-04)	Mean larval Parasitization (%) (2004-05)	Overall Mean
Chickpea+Barley (2:1)	26.49	26.16	26.32
Chickpea+Barley (4:1)	23.31	31.14	27.22
Chickpea+Barley (6:1)	15.73	19.27	17.5
chickpea+Barley (4:2)	25.31	23.58	24.45
Chickpea+Barley (7:2)	17.18	30.96	24.07
Chickpea+Coriander(2:1)	29.21	50.52	39.86
Chickpea+Coriander(4:1)	30.16	45.92	38.04
Chickpea+Coriander(6:1)	26.19	25.94	28.05
Chickpea+Coriander(4:2)	28.21	34.82	31.51
Chickpea+Coriander(7:2)	15.87	24.95	20.41
Chickpea+Linseed(2:1)	27.67	31.53	29.6
Chickpea+Linseed(4:1)	16.06	30.97	23.51
Chickpea+Linseed(6:1)	19.54	20.41	19.97
Chickpea+Linseed(4:2)	20.77	26.96	23.86
Chickpea+Linseed(7:2)	25.46	21.71	23.58
Sole Chickpea	15.98	23.13	19.55

Table 10. Percent parasitization of *H.armigera* larvae in different dates during 2003-04 and 2004-05

Date	% Parasitization	Date	% Parasitization
10-3-04 (109 DAG)	23.65	**1-3-05 (99 DAG)**	36.22
16-3-04 (116 DAG)	33.10	**8-3-05 (106 DAG)**	32.51
25-3-04 (125 DAG)	20.87	**15-3-05 (113 DAG)**	26.92
5-4-04 (136 DAG)	13.21	**22-3-05 (120 DAG)**	22.34
F value	4.63		13.44
Cd 1 2(5%)	8.034		6.33 Sig
Cd 1 3(5%)	8.03 Sig		6.33
Cd 1 4(5%)	8.03 Sig		6.33 Sig
Cd 2 3(5%)	8.03		6.33 Sig
Cd 2 4(5%)	8.03 Sig		6.33 Sig
Cd 3 4(5%)	8.03		6.33 Sig

Table 11:Correlation of different Environment Factors with % parasitization during 2003-04 and 2004-05 in rabi season.

Fators	Parasitization (2003-04)	Parasitization (2004-05)	Pooled parasitization for both the years
Max. temperature	-0.33	-0.89	-0.62
Min. temperature	-0.087	-0.90	-0.609
RH(Max)	0.956 Sig	0.68	0.89 Sig
RH(Min)	0.401	-0.86	0.43
Total Rainfall	0.00	-0.30	0.15
No. of rainy days	0.00	-0.39	0.11
Wind speed	0.313	0.57	0.39

In the subsequent year percent parasitization ranged from maximum of 36.2% at 99DAG (flowering) to minimum of 22.3% at 120 DAG .It indicated that at initial stage of crop growth, there was maximum parasitization and as the crop reached maturity parasitization reduced by *C. chlorideae* as the adults prefer to parasitize young larvae with low prevailing temperature which were more available at initial reproductive stage of crop growth as compared to advance stages. Increasing temperature may be one of the major factors for minimizing percent parasitization. The present investigations are supported by **Sachan and Bhaumik (1998)** who had reported that when the temperature is low and crop is in early stage, there is high level of parasitization.

4.6. Correlation of different Environmental factors with percent larval parasitization

Correlation of percent larval parasitization with different Environmental factors is summarized in Table 11 during 2003-04 lower percent larval parasitization was positively correlated with Relative humidity.

During the subsequent year no significant correlation was observed among the variables. Pooled data indicated that only Relative Humidity had significant correlation with percent parasitization of *H.armigera* larvae.

4.7. Mean Chickpea Equivalent Yield

Grain yield of chickpea recorded in different treatments were converted into equivalent yield of chickpea for comparison.

The data on mean Equivalent yield recorded in various treatments are given in Table 12.During 2003-04, the Equivalent yield ranged significantly from minimum of 366.6 kg/ha in chickpea sole crop to the maximum of 1052.1kg/ha in chickpea + barley (4:2). All the treatments received higher equivalent yield as compared to the yield obtained in chickpea sole crop.

In the subsequent year the Equivalent yield ranged significantly from minimum of 11.33 kg/ha in chickpea sole crop to the maximum of 1012.4 kg/ha in chickpea+coriander (4:2). Because of contribution of intercrop yield in the chickpea, more yield was obtained in intercrop combination as compared to chickpea sole crop.

When equivalent yield of both the year were considered together, minimum yield of 188.4 kg/ha in chickpea sole crop and maximum of 886.8 kg/ha was obtained in chickpea + coriander (4:2) ratio followed by

Table12: Mean Chickpea equivalent yield in Kg/ha during 2003-04 and 2004-05

Treatment	Mean equivalent yield .(2003-04)	Mean equivalent yield (2004-05)	Mean Yield
Chickpea+Barley (2:1)	775.0	816.3	674.6
Chickpea+Barley (4:1)	913.3	665.2	692.0
Chickpea+Barley (6:1)	630.4	521.3	500.2
chickpea+Barley (4:2)	1052.1	940.5	856.7
Chickpea+Barley (7:2)	910.0	739.7	711.3
Chickpea+Coriander(2:1)	780.7	756.3	693.6
Chickpea+Coriander(4:1)	585.9	822.3	622.9
Chickpea+Coriander(6:1)	570.9	374.5	436.3
Chickpea+Coriander(4:2)	962.5	1012.3	886.8
Chickpea+Coriander(7:2)	735.9	779.7	682.1
Chickpea+Linseed(2:1)	467.5	755.8	612.0
Chickpea+Linseed(4:1)	556.7	559.1	557.9
Chickpea+Linseed(6:1)	369.9	240.1	305.0
Chickpea+Linseed(4:2)	686.7	594.0	640.3
Chickpea+Linseed(7:2)	603.5	538.1	570.7
Sole Chickpea	366.5	11.3	188.9
SEM±	54.05	67.03	40.58
CD (5%)	156.13	193.61	117.22
CV (%)	13.66	18.34	11.67

856.8 kg/ha in chickpea + barley (4:2). The prices of coriander as well as yield of barley were higher which were responsible for more equivalent yield of chickpea. The present findings are supported by **Prasad and Chand, 1989** who obtained higher yield of Pea, Gram and Chickpea with intercrops.

SUMMARY AND CONCLUSION

The field experiments on effect of intercropping on *Helicoverpa armigera* (Hb.) and it's natural enemy *Campoletis chloridae* were carried out during winter season of 2003-04 and 2004-05.

1. A reduction in egg count of *Helicoverpa armigera* was observed when chickpea was intercropped with coriander, barley or linseed. During the year 2003-04, mean egg count ranged from minimum of 10.6/m^2 in chickpea + linseed (7:2) to a maximum of 26.8/m^2 in chickpea sole crop. In all the intercropping combinations the weekly mean number of egg count was lower than chickpea sole crop. In the subsequent year, the egg count ranged from minimum of 3.0/m^2 in chickpea + coriander (2:1) to the maximum of 13.6/m^2 in chickpea sole crop.
2. Overall, mean number of egg count varied from minimum of 17/m^2 in chickpea + coriander (2:1) and chickpea + barley (4:2) to the maximum of 37.7/m^2 in chickpea sole crop. The results obtained from pooled data of two years have indicated that the chickpea carried a significantly lower egg count in all the intercropping combinations as compared to chickpea sole crop. The reducing

effect of intercropping on egg count is more pronounced when coriander was put as intercrop with chickpea in 2:1 ratio.

3. During the year 2003-04, mean number of larvae/m^2 varied from minimum of 30.3 in chickpea+ barley (2:1) to maximum of 51.1 in chickpea sole crop. During the year 2004-05, mean number of larvae/m^2 ranged from 9.2 in chickpea + coriander (2:1) to 29.9 in chickpea sole crop.
4. Overall data on larval count of both the years indicated that minimum number of mean number of larval count was obtained in chickpea + coriander (2:1) to maximum of 81.9 in chickpea sole crop. This suggested that both egg and larval count of *H. armigera* can significantly be reduced if chickpea is intercropped with coriander in 2:1 rows.
5. Mean percent pod damage by *H. armigera* in different intercrop combinations ranged from 70.6 chickpea+ coriander (4:2) to the maximum of 90.7 in chickpea sole crop. The highest pod damage caused by *H. armigera* was recorded in chickpea sole crop, which was significantly suppressed with introduction of intercrops. The role of intercrops were pronounced in reducing the pod damage ranging from 20 to 25 %.

6. Parasitization of *H. armigera* larvae by *C. chloridae* in chickpea with intercrops was studied at Pantnagar during rabi in 2003-04 and 2004-05. Maximum larval parasitization of 39.9 % was obtained with chickpea+ coriander (2:1) and minimum of 17.5% in chickpea + barley (6:1) and chickpea sole crop (19.6).
7. Mean equivalent grain yield in intercropping combinations ranged from maximum of 886.8 Kg/ha in chickpea+ coriander (4:2) to the minimum of 188.9 Kg/ha in chickpea sole crop. This has indicated that intercropping can be recommended to farmers as a suitable strategy to get extra returns from intercrops even if the main chickpea crop is failed due to heavy infestation of *H. armigera*. Intercropping will also reduce the number of sprays by conserving parasitoids. The results also suggest that *C. chloridae* is quite active in different cropping systems ,the only safe insecticide to be used in emergency.

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Appendix

Table: Standard weekly meteorological parameters during experimental period (2002-03 & 2003-04) at Pantnagar

Month & year	Week no	Temperature		Relative humidity (%)		Rainfall (mm)	Wind speed (Km/hr)
		Max. (°C)	Min. (°C)	Max.	Min.		
Aug. 2003	32	33.1	25.9	88	65	69.2	2.5
	33	30.9	24.9	93	79	351.8	4.3
	34	32.0	24.9	89	71	48.2	4.7
	35	31.2	25.3	91	74	103.8	3.3
Sep., 2003	36	30.8	24.2	94	79	143.4	2.7
	37	30.4	24.5	94	78	67.4	2.4
	38	30.3	22.9	94	76	156.4	3.2
	39	30.0	21.5	90	76	108.6	3.4
Oct., 2003	40	32.1	19.4	84	53	0.00	2.0
	41	31.4	16.3	86	45	0.0	2.7
	42	31.3	15.4	82	37	0.0	1.7
	43	00.0	15.3	85	41	0.0	1.9
	44	29.0	14.4	87	40	0.0	1.5
Nov., 2003	45	29.0	11.6	87	38	0.0	2.5
	46	27.0	12.8	89	45	0.2	1.8
	47	26.1	7.8	81	37	0.0	2.6
	48	24.5	6.8	93	40	0.0	1.1
Dec., 2003	49	23.4	8.1	93	49	0.0	1.5
	50	24.8	11.0	87	50	14.4	3.7
	51	19.0	9.2	93	66	0.0	3.1
	52	15.2	7.5	9.3	72	4.2	3.0
Jan., 2004	1	12.9	7.5	94	75	0.0	2.6
	2	18.3	5.8	97	61	0.0	2.1
	3	18.7	8.9	93	66	Trace	3.3
	4	17.9	7.7	96	68	2.3	4.0
	5	17.3	7.7	95	67	1.9	3.7
Feb., 2004	6	20.8	6.9	94	64	0.0	2.6
	7	25.0	9.2	88	48	0.0	2.0
	8	25.3	9.2	93	48	0.0	3.1
	9	22.3	11.0	88	46	0.0	5.0

Month	Week No.	Temp.		Relative humidity (%)		Total rain fall (mm)	Wind speed (Km/hr)
		Max. (^{0}C)	Min. (^{0}C)	Max.	Min.		
March; 2004	10	28.3	9.9	85	34	0.0	5.2
	11	30.3	149.	83	46	0.0	2.4
	12	34.4	16.5	86	34	0.0	5.0
	13	35.0	14.0	79	19	0.0	4.0
April; 2004	14	35.9	17.0	70	26	0.0	4.0
	15	38.0	19.0	62	22	Trace	6.1
	16	38.2	20.6	60	20	0.0	6.8
	17	32.9	19.2	66	39	0.9	4.7
	18	32.6	17.8	76	37	4.0	4.5
May; 2004	19	39.0	20.3	63	26	0.0	6.2
	20	41.1	24.6	62	29	0.0	9.5
	21	35.3	24.2	75	47	3.7	9.9
	22	34.2	26.1	71	49	4.1	7.2
June 2004	23	34.5	24.7	72	51	50.4	8.2
	24	37.3	26.8	67	43	13.6	7.5
	25	32.3	25.4	82	64	115.4	6.0
	26	33.1	24.5	89	61	133.6	4.3
July 2004	27	33.5	26.3	85	67	5.2	6.7
	28	29.3	23.9	92	81	351.2	16.6
	29	37.5	26.0	85	68	94.4	6.2
	30	34.0	26.3	85	65	28.6	5.0
	31	31.0	25.0	90	75	59.0	6.6
Aug., 2004	32	31.6	25.6	93	80	292.6	3.3
	33	31.4	25.2	91	68	22.0	4.3
	34	31.3	25.0	88	69	17.2	5.3
	35	33.0	21.3	85	64	0.0	3.5
	32	31.6	25.6	93	80	292.6	3.3
Sep., 2004	36	27.8	23.0	93	86	205.0	5.8
	37	28.8	22.5	92	80	53.2	5.0
	38	31.7	21.8	89	63	0.8	2.3
	39	31.3	21.5	90	59	0.0	2.5
Oct., 2004	40	32.4	19.1	89	57	0.0	1.5
	41	31.4	19.2	86	52	0.0	2.7
	42	30.4	18.0	87	52	0.0	2.0
	43	29.9	14.5	88	43	0.0	1.7
	44	29.4	13.3	84	54	0.0	1.4

Month	Week No.	Temp.		Relative humidity (%)		Total rain fall (mm)	Wind speed (Km/hr)
		Max. (^{0}C)	Min. (^{0}C)	Max.	Min.		
Nov., 2004	45	28.5	11.7	86	47	0.0	1.4
	46	27.0	11.7	90	43	0.0	3.0
	47	27.0	10.4	90	35	0.0	1.3
	48	26.8	8.2	93	36	0.0	1.0
Dec., 2004.	49	25.0	7.5	92	41	0.0	1.4
	50	23.9	7.7	93	43	0.0	1.5
	51	23.5	7.7	93	51	0.0	2.7
	52	18.8	7.6	95	67	6.4	4.0
Jan., 2005	1	20.5	7.6	95	61	4.6	2.4
	2	18.9	3.9	96	61	0.0	1.7
	3	18.3	6.8	93	62	17.8	2.7
	4	17.6	8.7	94	61	18.0	3.0
	5	18.9	7.9	94	64	7.2	2.3
Feb., 2005	6	22.4	10.8	90	61	27	2.8
	7	22.2	11.4	89	54	12	6.0
	8	23.5	8.3	89	49	3.4	4.8
	9	26.2	11.1	88	46	0.0	6.6
March 2005	10	27.5	12.9	92	43	16.6	3.5
	11	29.1	14.8	88	50	0.0	1.9
	12	28.7	14.4	84	53	13.8	4.1
	13	31.9	13.2	82	34	0.0	2.9
April 2005	14	34.4	16.9	66	27	0.0	3.8
	15	34.8	13.9	74	23	0.0	4.1
	16	37.0	15.7	62	20	0.0	3.3
	17	37.1	20.4	63	18	0.0	5.8

VITA

The authoress was born on 17.01.1982 at Pantnagar. She passed her Highschool and Intermediate examinations from G.G.I.C. Pantanagar in 1997 and 1999 respectively. She graduated in Agriculture from G.B.Pant University of Ag. & Tech. Pantnagar in 2003. She joined the Department of Entomology of the same university in 2003 for the degree of Masters in Science in Agriculture with major in Entomology ..During his MSc., she was recipient of graduate research assistantship.

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ABSTRACT

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Thesis title: "**Effect of intercropping on, *Helicoverpa armigera* (Hubner)and its larval parasitoid in chickpea.**"

The field experiments were carried out at Crop Research Centre of G.B. Pant University of Agriculture and Technology Pantnagar, Distt. U.S.Nagar, Uttranchal, India, during rabi season of 2003-04 and 2004-05 to find out the effect of intercropping on the incidence of *Helicoverpa armigera* (Hubner) infesting chickpea and its natural enemy *Campoletis chloridae*. In general, all the intercrops viz. barley,linseed and coriander were found to be effective in reducing the egg count and larval population. Overall, mean number of egg count varied from minimum of 17/m^2 in chickpea + coriander (2:1) and chickpea + barley (4:2) to the maximum of 37.7/m^2 in chickpea sole crop.

The reducing effect of intercropping on egg count is more pronounced when coriander was put as intercrop with chickpea in 2:1 ratio. Minimum number of mean number of larval count was obtained in chickpea + coriander (2:1) to maximum of 81.9 in chickpea sole crop. This has suggested that both egg and larval count of *H. armigera* can significantly be reduced if chickpea is intercropped with coriander in 2:1 rows. The highest pod damage caused by *H. armigera* was recorded in chickpea sole crop, which was significantly suppressed with introduction of intercrops. Maximum larval parasitization of 39.9 % was obtained with chickpea+ coriander (2:1) and minimum of 17.5% in chickpea + barley (6:1) and chickpea sole crop (19.6). Mean equivalent grain yield in intercropping combinations ranged from maximum of 886.8 Kg/ha in chickpea+ coriander (4:2) to the minimum of 188.9 Kg/ha in chickpea sole crop.

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