SUMMARY & CONCLUSION
Pulse crops are inseparable to Indian agriculture, as they are the paramount source of protein to the predominately vegetarian Indian dietary. India is the largest producer of pulses in the world. But its productivity is ranked to 118th in the world. In India pulses occupied about 23 millions hectare area and production is around 16 million tonnes and about 650 Kg per hectare yield. Most of the pulse crops are cultivated as a mixed or intercropping in dry land area where there is perpetual problem of resource crunch. Chickpea known as gram is considered to be third most important pulse crop of the world. In India it is most important source of protein in human diet. Chickpea was cultivated on 6.10 million hect. with the production of 5.27 million tonnes and productivity 865 Kg per hect. in India. In Uttar Pradesh it is grown on 0.862 million hectares with the production of 0.828 million tonnes and 860 Kg per hectare productivity.

Several biotic and abiotic factors are responsible for reducing the productivity of chickpea. Gram-Pod-Borer, *Helicoverpa armigera* (Hubner) is the key pest of chickpea and is responsible for devastating crop losses across the location and years. The average damage caused by *Helicoverpa armigera* in chickpea is around 30 percent of the total production. Therefore, *H. armigera* has declared the national pest in terms of economic damage in India. It has been reported to attack on 181 plant species from 45 families: 40 dicots and 5 monocots. No doubt the application of insecticides in agro-technical practice has resulted in a great percent unexpected progress in the control of insect-pests all over the world, but their wide spread and indiscriminate use of pesticides has decidedly created
hazards in men and biosphere. Therefore, it is important to use a systematic approach by integration of potential methods viz. monitoring through pheromone trap, use of resistance tolerant cultivars, cultural practices, intercropping, limited use of synthetic insecticides, insect growth regulators, bio control agents and botanical in the form of IPM modules which may be ecofriendly and economical to manage the present level of chickpea production and productivity. The present study “Biology and Management of *Helicoverpa armigera* (Hubner) in chickpea” has been under taken during 2003-2004 and 2004-2005 with the objectives. i. to study the biology of *H. armigera*, ii. ecological aspects of *Helicoverpa* in chickpea, iii. to evaluate integration of varietal resistance and Ha NPV, iv. to study the effect of integration of intercropping and chemical control, v. to observe the impact of mixture of resistant and susceptible genotypes, vi. to study the efficacy of biopesticides, botanicals and safer chemical insecticides and vii. to observe the impact of integration of varietal biological, biorational and chemical methods in the control of *H. armigera* in chickpea.

The experiment was conducted in the research farm of B.N.V. Post Graduate College, RATH, District – Hamirpur U.P. India (an affiliated College of Bundelkhand University, Jhansi) and Lab. experiments were conducted at the Department of Zoology, D.V. College, Orai (Jalaun) U.P.

The sowing of crop was made in between 10 to 15 November. The intercropping experiment was conducted with mustard, linseed and barley seperately for both resistant and susceptible varieties of chickpea. In field experiment, the insecticides viz. Ha NPV, *Beauveria bassiana*, *Bacillus thuringensis*, Azadirachtin (0.03%) Nimbecidine, Azadirachtin (0.03%) Multineem, Azadirachtin (Rakshak) cypermethrin 40 + profenphos 400, profenphos, dimethoate and endosulfan have been taken as treatment.
Biopesticides and insecticides were sprayed 3 times at 15 days intervals after the appearance of larvae of *H. armigera* in evening hours @ 600 litres per hectare. Each treatment was replicated thrice in R.B.D. and observations on percent pod damage and yield were taken at the maturity of crop and percent increase in yield over control was calculated.

Randomized block design was used for various field experiments on management practices viz. Chickpea genotypes and Ha NPV, intercropping and chickpea genotypes, interactive effect of chickpea resistant and susceptible genotypes, biopesticides, botanical and chemical insecticides and chickpea genotypes with safer pesticides.

The biology of *H. armigera* was studied in the laboratory during January to February, 2005. The larval period was varied from 14-28 days with 5 larval instar. The developmental period of V\textsuperscript{th} larval instar was some what longer than the previous instar (3-6 days). The average larval period was 19.87 ± 1.82. The pre-pupal and pupal period ranged from 1-5 days and 12-23 days with an average of 2.56 ± 0.72 and 16.48 ± 1.44 days respectively. The longevity of male was ranged from 7-12 days whereas longevity of female was comparatively longer than the longevity of male, ranged from 10-14 days. The total development of *H. armigera* was completed within 36-73 days for male and 39-75 days for female. The average longevity of male & female came to 9.18 ± .91 days and 11.35 ± 0.90 days, respectively. The developmental period of the male insect was comparatively shorter than the female insect. The single female moth of *H. armigera* lays 695 to 1245 eggs in its total life period. The pre-oviposition oviposition and post-oviposition period was ranged from 1-4 days, 5-8 days and 0-3 days, respectively. The egg hatching was varied from 82.5 to 95.55 per cent. with an average of 89.75 ± 5.20.
The incidence of *H. armigera* (Hub.) was noticed in the first week of January during both years and remained in the field, up to the crop maturity (II\textsuperscript{nd} week of April during 2003-04 and III\textsuperscript{rd} week of April during 2004-05). The maximum larval population of *H. armigera* was noticed at the III\textsuperscript{rd} week of March with 22.8 larvae per 10 spots during 2003-04 and 30.8 larvae per 10 spots during 2004-2005, when temperature was ranging from 30.5\textdegree C to 32.3\textdegree C maximum and 13.4\textdegree C to 13.7\textdegree C minimum with relative humidity 57.4 to 36.5\%. The effect of atmospheric temperature play an important role in increasing the larval population of *H. armigera* having positive correlation between the population of larvae of *H. armigera* and maximum temperature as well as minimum temperature. The relative humidity showed non significant negative correlation with larval population during both the year.

The population dynamic of *H. armigera* moth in chickpea crop was observed by using pheromone trap. The data were correlated with temperature and relative humidity. The moth was started to trap in the pheromone trap since first week of January and was caught upto II\textsuperscript{nd} week of April during both the years. The maximum moth catches was noticed at IV\textsuperscript{th} week of February with 43.4 moth per trap during 2003-04 and I\textsuperscript{st} week of March with 10 moth per trap during 2004-05, when the temperature was ranging from 21.4\textdegree C to 27.7\textdegree C maximum and 9.4\textdegree C to 11.9\textdegree C minimum relative humidity 62.3 to 48.1 per cent. The significant correlation of moth catches with environmental factors, temperature and relative humidity could not be found. The impact of minimum and maximum temperature on moth population was insignificanct negative during 2003-04 but it was insignificanct positive during 2004-05, whereas relative humidity adversely effects the moth population during both years.
Among the natural enemies a larval parasitoid, *Compoletis chlorideae* was found associated with larvae of *H. armigera*. The larval parasitization was first recorded from end of February to 1st week of March. The maximum parasitization was observed in the last week of March with 24.0-26.9 per cent. The larval population of *H. armigera* was highly influenced by larval parasitoid, *C. chlorideae*. The larval parasitization was having highly significant positive correlation with larvae population being. correlation value (r) 0.879 during 2003-2004 and 0.954 during 2004-2005.

The intercropping of resistant as well as susceptible chickpea varieties with mustard, linseed and barley inter crop, significantly reduced the per cent pod damage. Intercropping of resistant chickpea with mustard suffered significantly low pod damage (6.3 to 8.3 per cent). Intercropping of susceptible chickpea with mustard was second most effective combination in term of per cent pod damage (8.1 to 10.7 per cent pod damage). The maximum percent increase in yield was obtained with resistant chickpea + mustard followed by resistant chickpea + barley during, 2003-04 being 33.76 percent and 31.59 percent respectively. During 2004-2005 again percentage in yield was obtained with resistance chickpea + mustard (35.85 %) followed by susceptible chickpea + mustard (28.64%).

Resistant chickpea variety intercropped with susceptible chickpea variety in the ratio of 1:3 suffer minimum pod damage (4.33 to 5.3%) followed by 1:2 and 3:1 having 5.0-9.2 and 7.3-7.6 per cent pod damage. Whereas in case of susceptible variety intercropped with resistant variety in the ratio of 1:3 suffer reduced pod damage 9.67 to 14.2 per cent during 2003-04 and 2004-05, respectively. The maximum grain yield of resistant variety was recorded in the ratio of 1:3 which was 2176.6-2376.6 kg/ha. The
grain yield of susceptible variety was maximum in the ratio 1:2 and 1:3 with 1917.5 and 2062.9 kg/ha during 2003-04 and 2004-2005 respectively.

The effect of microbial, neem based and chemical insecticides against *H. armigera* on chickpea crop was evaluated. The use of profenophos, dimethioate, *B.t.* (Halt) and Polytrin were most effective, which reduced the per cent pod damage upto 1.84, 1.98, 2.95 and 3.26 per cent and 1.65, 1.89, 2.05 and 2.95 per cent during 2003-04 and 2004-05, respectively. Ha NPV (local), nimbicidine and multineem were also effective to reduced pod damage upto 3.65, 4.28 and 4.94 per cent and 2.55, 4.32 and 4.44 per cent during both the year, respectively. The application of profenphos, dimethioate and *B.t.* (Halt) were found more effective against the pest and increased the yield upto 33.4%, 31.26% and 27.43% during 2003-2004 and 27.65% and 25.57% and 23.00% during 2004-05, respectively. Ha NPV (local) increases the grain yield 25.32% and 22.01%, nimbicidine 19.30%, 16.59% and multineem 18.44% and 15.59% during 2003-04 and 2004-05, respectively.

The application of endosulfan on resistant as well as susceptible varieties was most effective to reduce pod damage by *H. armigera* on chickpea followed by R + *Bt.*, R + Ha NPV (350 LE) and R + Ha NPV (250 LE), which reduce the pod damage up to 2.08, 2.36, 2.96, 3.03 and 3.56 per cent and 1.96, 2.39, 2.69, 2.86 and 3.21 per cent during 2003-04 and 2004-05 respectively. Application of NSKE on resistant variety was less effective than application on susceptible variety when compared to there control. During both the years application of endosulfan an resistant variety was most effective to increase the yield over control (30.4 to 32.6%). Among the bio pesticide *Bt* applied on resistant variety was also better effective to increase the yield over control followed by R + Ha NPV (350 LE), R + Ha
Bt., S + Ha NPV (350 LE) and R + NSKE which increase the yield over control upto 21.2, 20.67, 18.05, 17.32, 16.46 an d15.16 per cent and 22.00, 21.73, 21.82, 19.23, 14.16 and 14.70 per cent during 2003-04 and 2004-05, respectively.

**Conclusion**-

In the present investigation efforts have been made to develop new technique of pest management of chickpea crop by using resistant variety intercropping microbial, neem based and chemical insecticides as an ideal IPM package. The following conclusions have been drawn from the above study:-

The development period of male insect was comparatively shorter than the female insect. The larval population was found maximum at budding stage with peak on IIIrd and IVth week of March, when temperature was ranging from 30.5°C to 32.2°C maximum and 13.4°C to 13.7°C minimum with relative humidity 36.5 to 47.4 per cent. The incidence of *H. armigera* larvae showed positive correlation with temperature and negative correlation with relative humidity. The moth catches in pheromone trap was maximum in the IVth week of February and Ith week of March, when the temperature was ranging for 21.4°C to 27.7°C maximum and 9.4°C-11.9°C minimum relative humidity 5.23 to 48.1 per cent. Impact of temperature on moth population could not be established where as relative humidity adversely affect the moth population. The maximum larval parasitization by C.
chlorideae was observed in the last week of March whereas larval parasitization significantly reduce the larval population.

Intercropping of mustard with resistant variety of chickpea was affected to reduce the pod damage and to increase the grain yield. Mixture of resistant and susceptible chickpea variety in the ratio of 1:3 suffer minimum pod damage with maximum increase in yield over control.

Profenophos, dimethoate, Bt (Halt) was most effective to reduce the per cent pod damage and to increase grain yield Ha NPV (local strain). nimbicidine and multineem were also significantly effective. Among the interaction of resistant/susceptible variety of chickpea with insecticides, endosulfan was most effective followed by Bt., Ha NPV (350 LE) and Ha NPV (250 LE) with resistant variety. Application of N.S.K.E. on resistant variety was also significantly effective.