International Journal of Agricultural Sciences ISSN: 2167-0447 Vol. 2 (4), pp.132-135, April, 2012. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Competency of Natural and Synthetic Chemicals in Controlling Gram Pod Borer, *Helicoverpa armigera* (Hubner) on Chickpea Crop

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Received January 6, 2012; Accepted April 17, 2012

As the chemical control methods are widely adopted tool for inhibiting insect pests populations in our agro ecosystem, therefore, it was contemplated to evaluate efficiency of botanical pesticide, Neemokill 60 EC (*Azadirachta indica*) and its comparison with synthetic chemicals, Endosulfan (Thiodan 35 EC), Cyhalothrin (Karate 2.5 EC) and Fenpropathrin (Sanitol 20 EC) against gram pod borer, *Helicoverpa armigera* (Hubner) on chickpea crop. Results from the present study revealed that after insecticidal applications all the treated plots gave significantly the best results for insect pest suppression than the untreated plots. Interestingly, the beneficial effects of all tested insecticides were noted on plant stand. Endosulfan gave the best results followed by Cyhalothrin, Fenpropathrin, Neemokill and the check plots in controlling larval population (0.33, 0.66, 0.83, 1.33 and 4.00 larvae/ 1 meter row), pods infestation (2.73, 3.58, 4.33, 13.15 and 39.26 %), and grain yield (1846.66, 1725.00, 1535.00, 1405.00 and 1211.66 gram/ 6 m^2), respectively. Results from the present investigations displayed that although both the botanical and synthetic insecticides contributed in reducing the pest population over the untreated plots, yet the synthetic chemicals are still the first line of defense against the ravages of insects and can be used freely when any insect outbreak occurs.

Key Words: Insecticides, Neem, Gram Pod Borer, *Helicoverpa,* Infestation, Chickpea.

INTRODUCTION

In the context of global agriculture, grain legumes occupy an important position by virtue of their high vegetable protein content. Increasing greatly the production of grain legumes can solve the problems of protein malnutrition in the developing countries, where, the food ration is especially vegetarian (Sarwar et al. 2005; 2010). Grain legumes contain, variously, approximately 18-32 % protein, which is nearly three times the quantity found in cereals. In addition, they are also rich source of energy, minerals and certain vitamins. Besides their nutritional value, grain legume crops are endowed with the unique property of maintaining and restoring soil fertility through biological nitrogen fixation (Kharkwal et al. 1988). Among the various grain legume crops, chickpea is the most important in Pakistan. Its production in Pakistan either fluctuated or suffered from severe stagnation during early or the late season. Many factors are responsible for its poor yield, but the most important limiting factor is the occurrence of different insect pest's populations upon this crop (Sarwar et al. 2011).

Among all the insect pests, gram pod borer, *Helicoverpa armigera* (Hubner) is one of the most destructive pests of chickpea (*Cicer arietinum* L.). This pest damages the chickpea plants from seedling stage to crop maturity stage and its larvae can thrive on leaves, tender twigs, flowers and pods. Before pod formation the larvae feed on the leaves and tender twigs of chickpea plants. After pod formation, the larvae bore into the pods and feed on the seed inside and cause considerable loss to seed yield. Its caterpillars feed on tender foliage and young pods by making holes in host and eat the developing seeds by inserting the half portion of their body inside the pod. About 20-30% of the chickpea yield can be reduced due to ravages of pod borer (Luckmann and Metcalf, 1975; Saleem and Younus, 1982; Hashmi, 1994). Shetgar and Puri (1979) mentioned it, a

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polyphagous pest, which feeds on flower buds, flowers and pods by boring, and bringing about considerable reduction in yield. Devastation by pod borer is considered to be the main impediment in stepping up the production of chickpea. Srivastava and Singh (1979) found that the infestation of pod borer was least in early sown and the highest in late sown chickpea crop, whereas, the yield was maximum in early sown, and least in the late sown crop. The delay in planting the crop caused gradual increase in population percentage of pod borer and reduction in yield. Dubey et al. (1981) reported gram borer as the primary pest of gram (chickpea), though it is known to feed on a variety of plants. The adult moths of this pest reared on chickpea laid significantly more eggs than those reared on other host plants species. Singh and Balan (1986) studied the population density of *H. armigera* on 123 plant species, of these species examined, 41 were found to be preferred hosts with its larval survival of 10-80 %, and 3 species including gram were the most preferred hosts with larval survival of greater than 80%. It was showed that when crop was not protected against *H. armigera*, yield losses could reach up to 80%. Singh and Singh (1987), studied the pattern of boring in pods, it was examined that most of the entry holes were recorded in the apical region followed by the basal region, and least on the dorsal sutures of the pods. These results were attributed to the hardness of pods; where the apical and dorsal regions were softer than the dorsal sutures. Sachan (1987) and Sehgal (1990) studied the pod damage due to *H. armigera* on chickpea crop, which could vary up to 100 percent, as a result, farmers are unable to harvest high yield. The pod borer, *H. armigera*, is the most serious pest in causing economic loss to the chickpea crop up to 40% in Pakistan (Sarwar et al. 2009). Hence, the occurrence and incidence of this insect is a serious threat faced by the growers, which existed in challenging form for the last several years. Having consideration of heavy loses occurring throughout this area where ever this crop is grown, in view, need was felt, that it is very essential to undertake research work on the management of this serious malady.

Application of insecticides against crop pests is still considered as the first line of defense in our region. Efforts were therefore, made to find out the effects of different insecticides on the chickpea crop against the population of gram pod borer and its relation to the incidence of pods infestation and grain yield. For the control of this pest, conventional insecticides are being used which are costly, produce the problems of residues, resistance, pollution, toxic to animals to a lesser or greater degree, due to which they posses the potential hazards to human health. In this connection, the entomologists diverted their attention towards plant products, which being the part of living organism are less hazardous. Further, increasing concern about pesticides accumulation in the environment has stimulated search for natural compounds that could replace synthetic insecticides in insect pests control. In this field, several attempts have been made by Ahmed et al. (1984), and Ascher (1993). Therefore, locally produced plant products are needed to test for insect pests management. Among several options, neem based formulations containing azadirachtin is known to have diverse biological activities. Extracts from seeds, leaves, bark and other part of neem tree (*Azadirachta indica* A. Juss) have been known to contain several insecticidal compounds (Naqvi, 1987). Fortunately, neem compounds have been proved safer, and no resistance in insects has been reported so far (Vollinger, 1987). In view of these considerations, before going for integrated approach for management of pod borer, it is desirable to identify the toxicants having effectiveness against majority of insect species and is relatively safer to ecosystem. Therefore, the present study was initiated to know comparative efficacy of 3 synthetic and one phyto product against the incidence of gram pod borer.

MATERIALS AND METHODS

During this course of study, a piece of land located at the experimental farm of Nuclear Institute of Agriculture (NIA), Tandojam, was selected for sowing chickpea crop variety “CM-1918” during 7 November, 2002-2003. The experiment was conducted in randomized complete block design with 5 treatments, and all the treatments and the control were replicated three times. Each seedbed under every replication measured an area of 6.0 m^2, consisting of 5 plant lines in each replicate. Seeds were planted in rows, 9 cm apart and 40 cm from row to row distance. All the recommended agro techniques were adopted for raising the chickpea crop and were uniform for all the plots, except for the insecticides applications, which were different for each set of plots. The endeavor was made to evaluate the performance of one plant origin product and 3 modern synthetic insecticides against gram pod borer in order to protect this delicate crop from the attack of this pest. The chemicals used for conducted trial were comprised, Endosulfan (Thiodan 35 EC) (2.5 l/ ha), Fenpropathrin (Sanitol 20 EC) (750 ml/ ha), Cyhalotrin (Karate 2.5 EC) (500 ml/ ha), Neemokill 60 EC (2.5 l/ ha), and the control treatment, with the view to assess their effect on the incidence of pods borer on the crop. Equal number of plots, were maintained without the application of insecticides, to serve as control. Insecticide solutions of the desired concentration were prepared and the crop was sprayed using knap sack hand sprayer. All the replicates were treated separately. Special care was taken as far as possible each time while spraying, by keeping same concentration of solution, which was sufficient to wet thoroughly the leaf surface of each plant.

The criteria for measuring the efficacy of different treatments were larval population, percent of pods infestation and grains yield. The first insecticidal

Table 1. Effectiveness of different insecticides for the control of *Helicoverpa armigera.*

S. No.	Insecticides applied	Larval population/ m row	Pods infestation (%)	Yield/ plot (6 m^2) (gram)
1.	Endosulfan (Thiodan 35 EC)	0.33±0.1 c	2.73±0.4 d	1847.00±9 a
2.	Fenpropathrin (Sanitol 20 EC)	0.83±0.2 bc	4.33±0.7 c	1535.00±8 c
3.	Cyhalotrin (Karate 2.5 EC)	0.66±0.1 bc	3.58±0.8 cd	1725.00±7 b
4.	Neemokill 60 EC	1.33±0.2 b	13.15±0.6 b	1405.00±9 d
5.	Control	4.00±0.3 a	39.27±0.5 a	1212.00±7 e

Each value is a mean of three replicates and means sharing by the same letters in a column are not significantly different at P= 0.05.

application was started after 110 days of seed planting when crop was at pod developing stage. For the evaluation of population reduction of pod borers, post treatment counts were taken after 24 hours of spraying. Population and % pods infestations were counted by taking into account the extent of damage to the plants in the field, i.e., counting the number of larval population, damaged and undamaged number of pods, from 10 plants per replication selected randomly. The pest population and pods infestation was recorded simultaneously on each plant by observing it from different position. Second such foliar spray was given at the interval of 20 days after the first spraying with the same insecticides at the same dosage, and data was recorded by adopting the same procedure. The yield per treatment was calculated by recording the crop produce per plot of the respective treatments after harvesting and threshing the crop.

Data obtained after the final observation, was statistically analyzed and the results of mean values for different treatments based on fixed parameters were compared and their performance was worked out. Data were analyzed by DMR comparison test (Steel and Torrie) using SAS Version 6.1 software.

RESULTS AND DISCUSSION

A perusal of data presented in Table 1, based on the overall performance of the synthetic insecticides and plant product applied as foliar spray, indicated significant variations in bearing larval population, % pod infestation and grain yield after the post treatments. Synthetic insecticides significantly overcame the losses caused by gram pod borer, *Helicoverpa armigera* in chickpea than botanical insecticide. There were consistencies in superiority of all these insecticides over the control treatment. The results on the comparison investigation of natural and synthetic insecticides, viz., Endosulfan (Thiodan 35 EC), Fenpropathrin (Sanitol 20 EC), Cyhalotrin (Karate 2.5 EC) and Neemokill 60 EC, and check revealed that the plants after applying these treatments, supported 0.33, 0.83, 0.66, 1.33 and 4.00 larval population per meter row; and 2.73%, 4.33%, 3.58%, 13.15%, and 39.27% pods infestation of the crop plant, respectively.

The effective control of gram pod borer was manifested with marked effect of increasing the seed yield over the control. The yield and yield component were positively correlated with the effectiveness of insecticides. The insecticide treatments resulted in bringing about increased yield over the control trail, the highest being recorded in the plots treated with endosulfan giving 1847.0 gm grain per 6 m^2. Amongst the other compounds which were also resulted in increase of yield over the untreated control to a considerable level were cyhalothrin and fenpropathrin producing 1725.00 and 1535.0 gm seeds per plot, respectively, over the neemokill and control plots. The phyto product neemokill was not as effective as the synthetic insecticides; however, its effect on yield was the maximum over, the untreated control by generating 1405.00 and 1212.66 gm grain per plot, respectively. The comparison of 4 pesticides, revealed that endosulfan gave the lowest larval population and pods infestation, and the highest grain yield; while, the reasonably higher grain yield was obtained in neemokill treated plots than control plots.

Some studies pertaining to the chemical control of *H. armigera* have also been conducted by Singh *et al.,* (1976), Barum (1981), Yadav and Yadav (1983), Koul (1985), Naik et al. (1987) and Lohar and Junejo (1995), where the successful results for pest control were achieved. Similar to present study, superiority of endosulfan in controlling the gram pod borers on chickpea crop has been reported by several researchers in different parts of the world such as Sinha et al. (1977), Mishra and Saxena (1981), and Sachan and Lal (1993). Likewise, Srivastava and Sehgal (2002) found that endosulfan significantly provided protection against pod borer but plant product was not found so effective. Bhatt and Patel (2002) reported that endosulfan significantly proved superior in increasing grain yield over control. While, its superiority was negated by the observations of Rawat et al. (1979), Shetgar and Puri (1979), Sinha et al. (1983), Dhurve and Borle (1985), Gohokar et al. (1987), and Panchabhavi and Kadam (1990), where endosulfan was noted at medium level in controlling insect population. Cyhalothrin pesticide that remained second most efficient treatment during the present observations corroborates with the findings of Anwar and Shafique (1983), and Fang et al. (1990) where, it was also stood second in causing the greatest pest mortality. However, Lohar and Junejo (1995) reported endosulfan and cyhalothin to cause 80% overall reduction of larvae, but cyhalothin was more effective than endosulfan. Results of fenpropathrin (a pyrethroid), which stood third in its efficiency during the present research, is in contradictory to the findings of Bhalani and Kotadia (1986) where pyrethroids were reported superior in reducing the incidence of pest damage as compared with plots treated with endosulfan.

Furthermore, effectiveness of phyto product neemokill, as revealed from the present study, although, was inferior to synthetic insecticides, but, was fairly effective than control plots which is in agreement with the findings from those of Sinha and Mehrotra (1988) who reported that neem oil did not have a significant effect on pest than synthetic insecticides. Similarlt, Rajput et al. (2003)

evidenced that synthetic insecticide gave the best results than all sets of natural products. On the other hand, it is not in conformity with the findings of Gohokar et al. (1987) where neem extract gave better control than insecticide. Sachan and Lal (1993) reported that neem seed kernel extract and neem leaf extract were more effective for controlling the pest on chickpea, but endosulfan was not most effective. Naqvi (1987), Butani and Mittal (1993), and Talpur et al. (1997) concluded that neem seed solution was equally effective in reducing pest population, as compared with conventional insecticides, but grain yield was the least. Gilani (2001) reported that neem extract have anti-feeding, repellent and insecticidal influences.

Hence, the superiority of endosulfan as an insecticide especially for the control of pod borer is a well-established fact. The performance of other insecticides like cyhalothin against the pod borer was also satisfactory which is evidenced from the present study and the findings of the several earlier workers. Results showed that 2 spray applications of endosulfan at pods formation initiation and before pod maturation could result in the highest cost benefit ratio. Saxena et al. (1971) also recommended foliar sprays to protect the crop against this pest. From viewpoint of safety of consumers, when Handa et al. (1982) evaluated the residues of endosulfan used as foliar spray on chickpea crop, its residues in plants and pods were well below the tolerance limit after 15 days of treatment. However, no detectable residues of endosulfan or its metabolites could be found in seeds at harvest.

The interesting results of the present findings were that, all the tested insecticides have beneficial effects on the plant population. Ten days post treatments to onward observations revealed that all the treated plants showed maximum and earlier response of blooming in comparison to the control plots, which showed poor and late blooming response. Further, the treated plants were taller having dense canopy than untreated plants. Moreover, different pollinators were seen in abundance number visiting the flowers of treated and untreated plants. The residual toxic deposits of insecticides perhaps did not affect these pollinators.

CONCLUSIONS

Although natural and synthetic insecticides contributed in reducing the pest population over the untreated plots, yet the synthetic chemicals are still better solution against the ravages of insects, but, these should be used only as a last resort. Further, need based use of safer pest control chemicals is advocated as an effective and dependable component of integrated pest management strategy. It is suggested that neemokill could be used as anti-feedant in an integrated pest management programme because it is harmless to beneficial arthropods and cheaper than commercial insecticides. Besides being an organic insecticide, using this product would allow to hit target pest only and if it is properly applied, can kill pest only when it ingests the sprayed foliage.

REFERENCES

Ahmed S, Garinge M, Hylin JW, Mitchel WC, Singer JAL (1984). Some promising plant species for use as pest control agents under traditional farming system. Proc. 2nd. Intl. Neem Conf. (Rauischholzausen, 1983), pp. 565-580. Anwar M, Shafique M (1983). Integrated control of gram pod borer *Heliothis armigera* (Hubner) in Sindh. . Proc. Pakistan Conger. Zool., 3: 215-222.

Ascher, KRS (1993). Non-conventional insecticidal effects of pesticides available from neem tree *azadirachta indica*. Arch. Insect. Biochem. Physiol., 22: 433-449.

Barum LO (1981). Tests with nine insecticides intended to protect tomato crops in New Caledonia. Rep. Appl. Entomol., 70: 28-57.

Bhalani PA, Kotadia VS (1986). Field evaluation of certain synthetic pyrethroid against *Heliothis armigera* Hubner of gram crop. Pesticides, 20: 24-26.

Bhatt NJ, Patel RK (2002). Bio-efficacy of various insecticides against *Helicoverpa armigera* on chickpea. I. J. Entomol., 64 (1): 27-34.

Butani PG, Mittal VP (1993). Comparative efficacy of botanical insecticide (neem seed kernel suspension) and other insecticides against *Heliothis armigera* (Hubner). I. Soci. Tobacco Sci., 276-281.

Chari MS, Patel AR, Bharpoda TM (1985). Bioefficacy of some new insecticides in the control of *Heliothis armigera* Hb. on chickpea. Pesticides, 19 (11): 51-52.

Dhurve SB Borle MN (1985). Chemical control of gram pod borer (*Heliothis armigera*) (Hubner). PKV Res. J., 9 (2): 83-85.

Dubey AK, Mishra US, Dixit SA (1981). Effect of host plants on the developmental stages of gram pod borer *Heliothis armigera* (Hubner). I. J. Entomol., 43 (2): 178-182.

Fang HS, Nee MM, Chu C, Hwang SH (1990). Occurrence and chemical control of tomato fruitworm, *Helicoverpa armigera* (Lepidoptera: Noctuidae) of flue-cured tobacco. Bull. Taiwan Tobacco Res: Insti., No.33: 57-64.

Gilani G 2001). Neem the wonder tree. In farming, Oct- Nov. Ed: M.T. Saleem, SAFE Foundation, pp. 27-30.

Gohokar RT, Thakre SM, Borle MM (1987). Chemical control of gram pod borer (*Heliothis armigera* Hubner) by different synthetic pyrethroid and insecticides. Pesticides, 21 (11): 55-56.

Handa SK, Awasthi MD, Dikshit AK, Verma S (1982). Dissipation of carbaryl and endosulfan residues in/ on chickpea crop. I. J. Entomol., 44 (2):158-161.

Hashmi AA (1994). Insect Pest Management, Taxonomy and Identification. PARC Islamabad pp. 1034.

Kharkwal MC, Jain HK, Sharma B (1988). Induced mutations for improvement of chickpea, lentil, pea and cowpea. In: Improvement of grain legume production using induced mutation for improvement of grain legume production using induced mutations, IAEA, Vienna, pp. 89-109.

Koul O (1985). Azadirachtin interaction with development of *spodoptera litura*. I. J. Exp. Bio., 23: 160-163.

Lohar MK, Junejo GM (1995). Susceptibility of last instar larvae of *Spodoptera litura* F. against different insecticides. Proc. Pakistan Conger. Zool., 15: 183-187.

Luckmann WH, Metcalf L (1975). The pest management Concept. In: Introduction to Insect Pest Management. Johan Wiley and Sons, N.Y., pp. 3-35.

Mishra PN, Saxena HP (1981). Search for safer insecticides while controlling pod borer in chickpea, *Cicer arietinum* L. Int. Chickpea Newlet. No.5: 12-13.

Naik RL, Pokharakar DS, Ambekar JS, Pohkarakar RN (1987). A study on control of chickpea pod borer by some insecticides. J. Maharashtra Agric. Univ., 12: 176-177.

Naqvi SNH (1987). Biological evaluation of fresh neem extracts and their components with reference to abnormalities and esterase activity in insects. Proc. Pakistan Conger. Zool., 17: 315-330.

Panchabhavi KS, Kadam ML (1990). A note on the control of *Heliothis armgiera* Hubn. in bengal gram. Karnataka J. Agric. Sci., 3 (3-4): 271-272.

Rajput AA, Sarwar M, Bux M, Toufiq M (2003). Evaluation of synthetic and some plant origin insecticides against *Helicoverpa armigera* (Hubner) on chickpea. Pak. J. Biol. Sci., 6 (5): 496-499.

Rawat RR, Patel RK, Veda OP, Patitunda A (1979). Control of gram pod borer, *Heliothis armigera* (Hub.). I. J. Entomol., 41(1): 33-35.

Sachan JN (1987). Status of gram pod borer, *H. armigera* Hub. in

India and its management. In: (Y.K.Mathur, A.K.Bhattacharya; A.K.Pandey; N.D.Pandey; K.D.Srivastava and J.P.Srivastava eds). Recent advances in Entomol., 91-100.

Sachan JN, Lal SS (1993). Role of botanical insecticides in *Helicoverpa armigera* management in pulses. In botanical pesticides in integrated pest management. I. Soci. Tobacco Sci., 261-269

Saleem M, Younus M (1982). Host plants and extent of damage of *Heliothis armigera* (Hub.). Pakistan J. Agric. Res., 3: 54-58.

Sarwar M, Ahmad N, Sattar M, Tofique M (2005). Evaluating the Seed's Reaction of Certain Chickpea Genotypes against the Action of Pulse Beetle, *Callosobruchus analis* L. (Bruchidae: Coleoptera). Pakistan J. Seed Technol., 1 (6): 14-21.

Sarwar M, Ahmad N, Tofique M (2009). Host plant resistance relationships in chickpea (*Cicer arietinum* L.) against gram pod borer (*Helicoverpa armigera*) (Hubner). Pakistan J. Bot., 41 (6): 3047-3052.

Sarwar M, Ahmad N, Tofique M (2011). Identification of susceptible and tolerant gram (*Cicer arietinum* L.) genotypes against gram pod borer (*Helicoverpa armigera*) (Hubner). Pakistan J. Bot., 43 (2): 1265-1270.

Sarwar M, Xuenong Xu, Kongming W (2010). Effects of different flours on the biology of the pry *Tyrophagus putrescentiae* (Schrank) (Acarina: Acaridae) and the predator *Neoseiulus pseudolongispinosus* (Xin, Liang and Ke) (Acari: Phytoseiidae). Intl J. Acarol., 36 (5): 363-369.

Saxena HP, Phokhela A, Singh Y (1971). Effectiveness of insecticides against gram pod borer. Entomologist's News, 2: 17-18.

Sehgal VK (1990). Damage yield relationship due to *H. armigera* (Hubner) larvae in chickpea in India. Proc 2nd. Int. Work. On chickpea improvement. Chickpea in Nineties. ICARDA/ICRISTI, 4-8 Dec., 1989.

Shetgar SS, Puri SN (1979). Efficacy of Quinalphos and other insecticides against pod borer, *Heliothis armigera* Hubner infesting chickpea. Ind. J. Enotomol., 41 (4) : 403-405.

Singh G, Balan JS (1986). Host plant and natural enemies of *Heliothis armigera* (Hubner) in Haryana. I. J. Ecol., 13 (1): 175-178.

Singh RN, Singh J (1987). Pattern of boring of chickpea pods by *Heliothis armigera* Hubn. I. J. Agric. Sci., 57 (5): 376-377.

Singh D, Ramzan M, Bindra OS (1976). Field evaluation of some new insecticides against the tomato fruit borer, *Heliothis armigera* Hub, I. J. Plant Prot., 4: 112-113.

Sinha MM, Yazdani SS, Kumar A, Lal K 1983. Relative efficacy of different spray formulations against gram pod borer. Pesticides, 17 (12): 33-44.

Sinha NM, Yadav RP, Kumar A (1977). Evaluation of some insecticides for the control of plume moth (*Exelastis atomosa* Walsche) and pod fly (*Melanagromyza obtuse* M.) on red gram (*Cajanus cajan* L.). Pesticides, 11: 29-30.

Sinha SN, Mehrotra KN (1988). Diflubenzuron and neem (*Azadirachta indica*) oil in control of *Heliothis armigera* infesting chickpea (*Cicer arietimum*). I. J. Agric. Sci., 58 (3): 238-239.

Srivastava RM, Sehgal VK (2002). Bioefficacy of various insecticides against *Helicoverpa armigera* in chickpea. I. J. Entomol., 64 (1): 17-20.

Srivastava KM, Singh RP (1979). Forecasting of yield losses and infestation level of pod borer, *Heliothis armigera* Hubner in chickpea. I. J. Entomol., 41 (4): 375-378.

Talpur MA, Rustamani MA, Khan MM, Baloch HB, Hussain T, Shar MU (1997). Plants extracts and insecticidal value of conventional pesticide (Thiodan) against *Helicoverpa armigera* Hbn. on chickpea. Proc. Pakistan Conger. Zool., 17: 179-185.

Vollinger M (1987). The possible development of resistance against neem seed kernel extract and deltamethrin in *Plutella xylostella.* Proc. 3rd. Intl. Neem Conf. (Nairobi, 1986), pp. 543-554.

Yadav LS, Yadav PR (1983). Insecticidal control of pod bore, *Heliothis armigera* Hbn. on Kabuli gram. Pesticides, 17: 25-26.