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Mini Review

SCENARIO OF ENTOMOLOGICAL RESEARCH IN LEGUME CROPS IN NEPAL

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Abstract

This review paper highlights scenario of entomological research in grain legumes in Nepal into headings of the monitoring, survey and surveillance, insect pest management, existing problem and future strategies. A survey study on yield loss assessment of chickpea due to *Helicoverpa* pod borer under field condition has been recorded up to 75% in the year 1996-1998 at Banke and Bardiya district. While monitored *Helicoverpa armigera* through pheromone trap, during the 2nd week of March, peak catches of 91 male moths were recorded at Rampur, while it was the maximum (42 male moths) during the 3rd week of March. Synthetic pyrethroids, deltamethrin, fenvalerate and cypermethrin used at 0.01% concentration (a.i.), were effective in controlling the chickpea pod borer, *Helicoverpa armigera* Hubner. Genotypes NCH-18, NCH -31, NCH-138 and ICC 3075 WR were found resistant. Ripcord 10%@0.05% was found to be superior and effective chemical insecticides to control stem fly and soybean hairy caterpillar. The late sowing date December, 10 showed significantly higher percentage of chickpea pod borer damage with lower grain yield. Inter crops combinations of Chickpea +wheat (2:1) ratio was found effective against *Helicoverpa armigera* damage (1.2%) followed by chickpea+barley (2.36%) and Chickpea+linseed (2:1) ratio (3.7%). Bakaino (*Melia azederach* L.) was identified as the best indigenous pesticides to check the normal growth of hairy caterpillar (*Spilarctia casigneta* kollar) under laboratory condition. *Metarhizium anisopliae* was found effective for the management of *Helicoverpa armigera* that caused maximum mortality (94.67%), infection (45.33%) within 7.49 days (LT50). Similarly, *Beauveria bassiana* caused maximum mortality (98.67%), infection (80.00%) with the least LT50 value (5 days). Crop sprayed with *Ha*NPV had the lowest pod damage (0.3%) and the highest in Racer (2.2%). This review work provided a lot of information to conduct entomological research activity conducted in grain legumes and opens the door for future research and strategy.

Keywords: Legumes; insect management; biological control

Introduction

National Grain Legumes Research Program (NGLRP) was established in 1985 with the national mandate to develop and recommend suitable technologies on different grain legumes and increase production and productivity at national level.

Grain legumes (Pulses) are an important component of cropping system of Nepal. In the hills and high hills, pulses do not usually compete with other crops as they are generally grown in areas where other food crops are not cultivated or often mixed with cereals. The Fig. 1 shows the current estimates for area, production and productivity of grain legumes in Nepal are 334323 ha, 319770 metric tons and 956 kg/ha, respectively (Gharti *et al.*, 2014). Trends in area, production and productivity of grain legumes in Nepal from1985-2012 is shown in Fig. 2. Pulses rank fourth in terms of acreage and fifth in production after rice, maize, wheat and millet. Basically, all farmers in Nepal grow one or more species of grain legumes. Per capita consumption of pulses is rather low; its availability is influenced not only by production but also by economic status. In the mountains and hills, grain legumes are primarily for home consumption, while in the terai and also in some warmer valleys, they are grown both for home consumption and market. The bulk of production in the terai and inner terai is from the winter grain legumes such as lentil, chickpea, field peas and grasspea and in the summer from pigeon pea. In hills, summer grain legumes such as soybean, blackgram, horse gram and rice bean dominate while in the higher mountainous regions, peas and phaseolus bean are the important grain legumes.

Limited research activities on grain legumes were initiated since 1972. Grain legume program was upgraded to National Grain Legume Improvement Program (NGLIP) during 1985, after supports from IDRC and USAID were obtained for the creation of basic infrastructural facilities at its head quarter at Rampur. Research activities during 1994/95 were planned and implemented as per broad guidelines set in the current eight plan period. Lentil, Chickpea, Soybean, blackgram, Cowpea, mungbean and grasspea have been categorized as priority crops for research. Likewise varietal improvement, plant protection, agronomical, nutritional investigation and post-harvest technologies are priority research in that order.

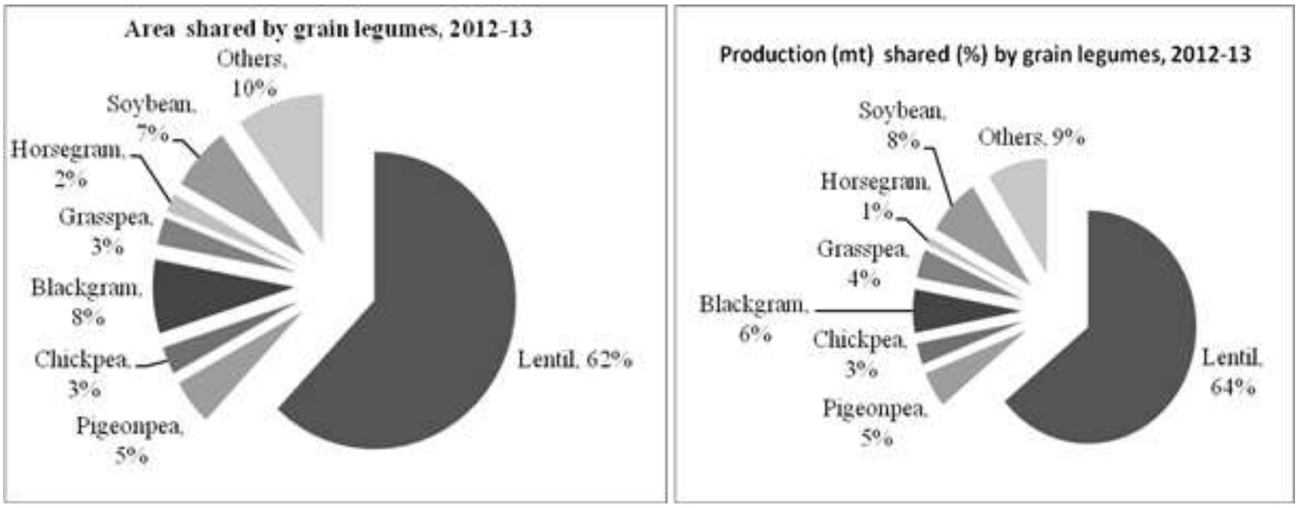

Fig. 1: Area and Production shared by grain legumes in Nepal in 2012/13 (Gharti *et al.*, 2014)

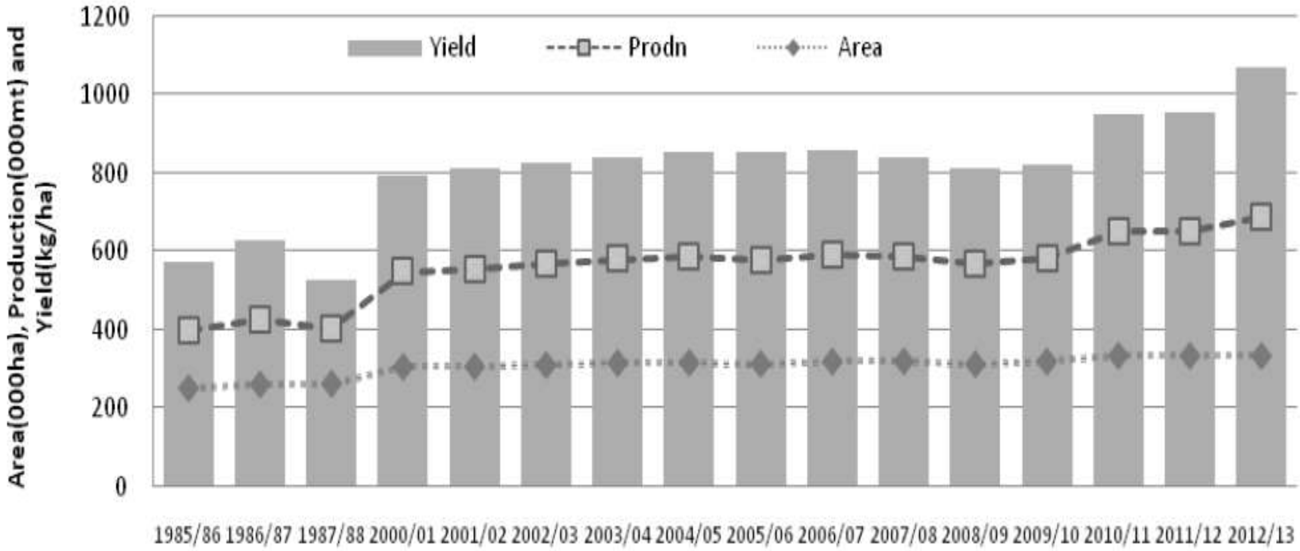

Fig. 2: Trends in area, production and productivity of grain legumes in Nepal from1985-2012 (Gharti *et al.*, 2014).

Review

Limited research works on some legume crops were carried out since 1972. However, after getting the status of national commodity program, it became operational only since 1985 in fulfilling its national mandate. Some of the reviewed of research work can be categorized into following headings:

Status of grain legume and its insects in Nepal

Important grain Legumes of Nepal cultivated and used as various sources of food is shown in Table 1. Problematic insects of these leguminous crops that cause various diseases are shown in Table 2.

Table 1: Important grain Legumes of Nepal:

SN	Crop	Region
1	Lentil (*Lens culinaris* subsp. Culinaris Medikus)	Terai/Midhill
2	Chickpea (*Cicer arietinum* L.)	Terai
3	Grasspea (*Lathyrus sativus* L.)	Midhill/terai
4	Fababean(*Vicia faba* L.)	Terai
5	Fieldpea (*Pisum sativum* L.)	Terai
6	Pigeonpea (*Cajanus cajan* L.)	Terai/High
7	Rajma/Simi (*Phaseolus vulgaris* L.)	hill
8	Soybean (*Glycine max* L.)	Mid hill
9	Blackgram (*Vigna mungo* L.)	Mid hill
10	Mungbean (*Vigna radiata* L.)	Terai
11	Cowpea (*Vigna unguiculata* L.)	Terai
12	Ricebean (*Vigna umbellate* L)	Mid hill
13	Horsegram (*Macrotyloma uniflorum* L.)	Mid hill

Table 2: Problematic insects of Leguminous Crops:

S.N.	Crops	Production Zone		
		Terai	Mid hills	High hills
1	Soybean	Hairy Caterpillar, podborer	Hairy Caterpillar	Hairy Caterpillar
2	Mungbean	Hairy caterpillar, Thrips, aphids, pod borer		
3	Blackgram	Hairy caterpillar, aphid, pod borer	Hairy caterpillar, Thrips, aphids, pod borer, beetle.	
4	Cowpea	Thrips, Aphid, podborer		
5	Pigeonpea	Podborer, pod fly		
6	Lentil	Cutworm, Aphid	Cutworm	
7	Lathyrus	Thrips		
8	Storage pest of pulses	*C. chinensis* L *C. maculates* F.		

(Source: NGLRP, 2009)

There are many insect pests are associated with leguminous crops. However, economically important insect pests that have been significant economic losses as:

Monitoring, Survey and Surveillance

Different insects like *Aphis glycine, Chauliops falas, Diacrisia oblique, Diacrisia multigultata, Spilarctia casigneta, Ephilachna sparsa, Platypria sp, Phyllotrela sp., P. sinutata, Caxira verucosus, Microsiphum pist, Agromyza sp., Euproctis sp., Monolepta signata, Antigastra cataulanis, Achronti sp., Spodoptera sp,* pod borer, weevils and in store pulses *Callesobruchus chinensis, Callosobruchus pisorum, Bruchus sp* were recorded. Similarly, *Bruchus sp*, *Bruchus pisorum*, *Callesobruchus chinensis* were recorded from survey in store product (NARC, 1974). During 1987/88 cropping season at the National Grain Legume Research Program at Rampur, Chitwan, the male moth population of *Helicoverpa armigera* was monitored with a sex pheromone trap. Maximum moth activity occurred during the 3rd week of February and 1st week of March. Heavy infestation of *Helicoverpa armigera* larvae was found on chickpea and pigeonpea during the 2nd, 3rd and 4th week of March and the early part of April (Sah *et al.*, 1988). The incidence of gram pod borer (*Helicoverpa armigera*) was observed to be low in the tested locations (NGLIP, PAS and NAS). However, higher level of damage was observed at NGLIP as compared to PAS and NAS. The percentage of pod damage by *Helicoverpa armigera* ranged for 2-47% at Rampur, 3-22% at Parwanipur and no incidence at NAS (NGLRP, 1989). For monitoring the chickpea podborer, *Helicoverpa armigera,* the pheromone trap received from ICRISAT, India was installed in first week of January 1991 at Rampur, Chitwan. A synthetic pheromone, 97.3 mixture of (z)-11-Hexadecenal and (z)-9- Hexadecenal was observed on a rubber septum @ 1mg/septum. One rubber septum was changed after every 28 days interval. The first male moth trapped on 4th week of January and their highest number (156 and 115) was recorded on 1st and 2nd week of March, respectively. The maximum number of moth was trapped during March compared with February and April (NGLRP, 1991). Red gram insect pests were surveyed in Siraha, Janakpur and Nepalgunj and pests were documented (NARC, 1992). Monitoring of (*Helicoverpa armigera* Hubner.) during the spring seasons in the farm of Institute of Agriculture and Animal Science (IAAS) has indicated that March-April is the peak activity of this pest. The period coincides greatly with the flowering/fruiting season of tomato and receives a severe loss of the produce (GC and Thapa, 2000).

A survey study on yield loss assessment of chickpea due to *Helicoverpa* pod borer under field condition has been recorded up to 75% in the year 1996-1998 at Banke and Bardiya district. The damage was higher in closely planted and late sown crops attended without any plant protection measures. Pheromone trap study in the last few years has revealed that the pest attains the peak between March 15 and April 15 (NGLRP, 2000). Monitoring with pheromone trap was carried out at farmer's field in two locations (Rampur and Fulbari) of Mangalpur VDC, Chitwan to monitor the occurrence of *Helicoverpa armigera* Hubner during the winter season of 2004/05. During the 2nd week of March, Peak catches of 91 male moths were recorded at Rampur, while it was the maximum (42 male moths) during the 3rd week of March at Fulbari, Chitwan (Rijal *et al.*, 2007).

Insect Pest Management

Neupane and Sah (1988) reported that synthetic pyrethroids, deltamethrin, fenvalerate and cypermethrin used at 0.01% concentration (a.i.), were effective in controlling the chickpea pod borer, *Helicoverpa armigera* Hubner. Methyl parathion and endosulphan were found to have little effect on the mortality of the pod borer. Deltamethrin and fenvalerate were effective against *Helicoverpa armigera* up to 5 days after treatment. The initial effectiveness of cypermethrin was highest (90%) among all the insecticides. Ethyl parathion and endosulphan were least effective.

Eight genotypes for National Grain Legume Research Program, Rampur and 18 for Parwanipur Agricultural Station have been observed to resistant (less than 10% pod damage). However genotypes NCH-18, NCH -31, NCH-138 and ICC 3075 WR were rated as resistant in both the locations (NGLIP and PAS) (NGLRP, 1989). While screening the international chickpea Heliothis resistance Nursery (ICHRN) in early group mean grain yield ICCX790197-25PLB-12PLB-3 PLB-BPLB had produced highest grain yield (1670 kg/ha) with lowest pod percent damage at Parwanipur. Local check Kabuli produced highest grain yield 1864kg/ha with lowest borer damage (8%) followed by local check Dhanush (1850 kg/ha) with borer damaged (12%) and at Nepalgunj, in early group ICCX790197-23PLB-11PLB-2EB produced highest grain yield 215kg/ha with least pod damage (9.2%) by borer (NGLRP, 1992). A chickpea genotype Dhanush was evaluated during winter season at Rampur, Parwanipur and Nawalpur in split plot design with 4 replication and 4 sowing dates, D1= Oct. 25, D2= Nov 10, D3= Nov 25, and D4=Dec 10. Plots were also maintained spraying and non-spraying. The result indicated that spraying Thiodan, 4ml/lit water produced highest grain yield and was found highly significant at both Nawalpur and Parwanipur research stations. At Nawalpur Oct, 25 and Nov 10 produced higher yield 1969kg/ha and 1979kg/ha respectively, at lower pod borer damage percentage 2.7 and 2.9.At Parwanipur, Nov. 10 and Nov. 25 produced higher grain yield 1731kg/ha and 1532kg/ha with lower pod borer damage 6.4 and 6.05 percentage, respectively, (NGLRP, 1992). While evaluating the efficacy of different insecticides against chickpea pod borer (*Helicoverpa armigera*), thiodan (Endosulphan) 35% EC @ 2 litre/hac was found highly effective against pod borer management and produced highest grain yield (2010kg/ha) with lowest pod damage (6.9%) at Nawalpur, (NGLRP, 1993).

To find out the efficacy of insecticides against podfly and podborer in pigeonpea, host material genotypes Bageswori and ICPL 366 were evaluated at Nawalpur and Nepalgunj. Four insecticides were used and three spraying were maintained at 75% flowering, initiatial podding stage and 10-12 days after second spraying. The results indicated that efficacy of insecticides were non-significant at both Nawalpur and Nepalgunj respectively.However, Thiodan 35EC @4ml/lit produced noticeable higher yield (3612 kg/ha), decis gave measureable @1ml/lit (2999kg/ha) at Nawalpur. At Nepalgunj, Thiodan 35EC @4ml/lit produced noticeable higher yield (3566 kg/ha) (NGLRP, 1992). Ripcord 10%@0.05% was found to be superior and effective chemical insecticides to control stem fly and soybean hairy caterpillar produced highest soybean grain yield (1577 kg/ha) at difference was highly significant (NGLRP, 1992). While testing the efficacy of five insecticides Deltamethrin, Cypermethrin, Endosulphan, Methyl Parathion and Phosphamiden, endosulphan gave better result for the management of chickpea pod borer, *Helicoverpa armigera* (NGLRP, 1993). Among four sowing dates of chickpea (Oct. 25, Nov 10, Nov 25 and Dec. 10) and two level of insecticide application (Thiodan @ 2 lit/ha), the late sowing date showed significantly higher percentage of chickpea pod borer damage with lower grain yield (NGLRP, 1993).

Neem (*Azadirachta indica* A. Juss) has been widely reported for its repellent and insecticidal actions. Its leaves and kernels in crude form and its oil extracted from the kernels are used as insect repellents and insecticides on various crops and stored products (Neupane *et al.*, 1993 and Joshi *et al.*, 1991).

To find out the efficacy of some local plant materials against the pulse beetle (*Callosobruchus chinensis* L) of chickpea in storage, eight kinds of plant materials viz. Shed dried leaf powders of neem(*Adadirachta indica*), Titepati (*Artimisia vulgaris*), Chinaberry (*Melia azadirachta*) and Malbarnut (*Adhatoda vasica*), berry dust of hot pepper (*Capsicum annum*),Oil of mustard (*Brassica compestris*) and ash of cow dung were tested taking a standard check of malathion (10% dust) in 1994-1995 at Agriculture Research Station, Surkhet. Among these plant materials, mustard oil @10ml/kg of seed proved quite effective against the beetle whereas the treatments of other plant materials including control were completely damaged. No damage was observed in the seed lots treated with malathion (Sharma *et al.*, 1995). Pathogenic nuclear polyhedrosis virus (NPV) and an antifeedant to the insect larvae (bioneem) were applied @1ml/litre, and 5ml/litre of water at weekly intervals respectively. The NPV, though reported to be useful against *Helicoverpa armigera* elsewhere was not very promising in our condition while the bioneem was found to be effective than the contact pesticides Thiodane (GC and Thapa, 2000).

The experiment with botanical showed that mustard (*Brassica compestris* L. var toria Duth) oil, neem (*Azadirachta indica* A. Juss) oil and bojho (*Acorus calamus* L.) rhizome powder are very effective to cause the mortality of adult weevils while thoroughly mixing with the grains at 0.5, 1 and 2% concentration level, 100% mortality occurred within 5 days in the treated grains. (NARC, 1999). A field experiment was conducted at RARS, Nepalgunj with seven of inter crops combinations to identify suitable inter crops for Helicoverpa armigera management in chickpea. Among them, Chickpea +wheat (2:1) ratio combination was found effective against Helicoverpa armigera damage (1.2%)

followed by chickpea+barley (2.36%) and Chickpea+linseed (2:1) ratio (3.7%). Grain yield was also obtained highest in the chickpea+wheat combination (1612) followed by chickpea+coriander (147kg) and chickpea+linseed (139kg), respectively (Yadav and Thakur, 2001).

With an objective to test the efficacy of plant materials to soybean hairy caterpillar (*Spilactia cassigneta*, Kollar), an experiment was conducted at Entomology Laboratory of IAAS, Rampur in the spring of 2001. A total of seven different types of plants such as titepati (*Artimisia vulgaris* L), asuro *(Justicia adhatoda* L.), garlic (*Allium sativum* L.), bakaino (*Melia azederach*. L.) and Khirro (*Holarrhena pubescens* Buch. Ham) leaves were used in all the cases as a suitable plant parts for the extraction of the active ingredients. The result indicated that all the plant materials possess some sorts of antifeedant effects to the larval development, however; the bakaino (*Melia azederach* L.) was identified as the best indigenous pesticides to check the normal growth of hairy caterpillar (*Spilarctia casigneta* kollar) under laboratory condition (GC and Ranabhat, 2001). Test of botanicals for their pesticidal properties against bruchid, *Callosobruchus maculates* F. (Coleoptera: Bruchidae) in lentil grains. *Achorus calamus*, Rice husk ash and Mustard were found effective against bruchid when treated with lentil (NARC, 2001). For the management of insect-pest of beans, a trail on integrated pest management was conducted at ARS, Jumla during summer, 2001-02. The treatments consisted of application of Carbofuran, Chloropyriphos, Monocrotophos, Multineem and Cypermethrin at 35 days after seedling emergence followed by 2 sprays at 15 days intervals. Due to the lower pressure of insect pest during both growing seasons, treatment difference could not be detected. However, application of Cypermethrin and carbofuran resulted in higher grain yield than other treatments. It appears that insect populations are kept at low level, due to the natural prevailing conditions and there is no need of any insecticide spray under normal growing season (NGLRP, 2003).

Baral *et al.* (2007) conducted an experiment on the management of cowpea beetle, *Callosobruchus maculates* (F.) with selected botanical materials in Entomology Laboratory of IAAS, Rampur from August 2001 to May 2002 (175 days). The treatments were neem leaf dust (Azadirchta indica), Timur fruit dust (*Xanthoxylum armatum*), Bhojo rhizome dust *(Acorus calamus* L), Neem kernel dust (*Azadirchta indica*), acetallic and untreated control. Ten adults, of *Callosobruchus maculates* F. were inoculated in each replication as test insects. Of the four different botanical dusts, bhojho rhizome and neem kernel were found as effective as acetalic (organophosphate) with minimum losses (0% and 0.17%) respectively. While the neem leaf dust was non-effective with respect to pest build up during the experimental period (1179.5 days) and grain loss (21.7%).

An experiment was conducted at Insect Pathology Unit, Department of Entomology, Institute of Agriculture and Animal Science, Rampur during 2005 to test the comparative efficacies of native isolates of two entomogenous fungi, *Metarhizium anisopliae* (Metsch.) Sorokin and *Beauveria bassiana* (Bals.) Vuill against the third instar larvae of *Helicoverpa armigera*. Each experimental unit included 25 larvae, which were observed for 21 days for mortality assessment. Out of four isolates (M1, M48, M65 and M70) of *Metarhizium anisopliae*, M1 caused maximum mortality (94.67%), infection (45.33%) within 7.49 days (LT50). Similarly, maximum mortality (98.67%), infection (80.00%) with the least LT50 value (5 days) was resulted by B3 isolate (between B1 and B3) of *Beauveria bassiana*. Mycosis was observed at 7.22 days after the death of larvae in B3 followed by B1 (7.36 days) and M70 (7.39 days), respectively. (Rijal *et al.*, 2007). Crop sprayed with HaNPV had the lowest pod damage (0.3%) and the highest in Racer (2.2%). Bio-pesticides, however, the comparative performance of the treatment under study need to be compared with the control plots (NGLRP, 2008).

Existing Problems and Future Strategy

A large number of insect pests that infest the legumes in Nepal but only some of them are major threat to them. For example, the pod borer (*H. armigera*) is a very serious pest that can cause more than 60% yield damage in chickpea on farmers' fields of Banke and Bardia districts located in the western part of the country (Thakur, 1997). It is also a serious pest of pigeonpea. Similarly, *Spilosoma* (*Diacrisia*) *obliqua* Walker (hairy catterpillar) is a major pest of soybean, black gram, mung bean, and groundnut. Aphids are commonly found on khesari (lathyrus), mung bean, black gram, cowpea, and lentil, particularly during dry spells. Insect pests are also major problems in storage where they can damage the seed and cause loss of seed viability. Seeds of pulses are severely damaged by the bruchids, *Callasubruchus chinensis* (L.) and *C. maculatus* Fab. There is lack of alternative technology to chemical pesticides to manage major insect pests. The laboratory facility is inadequate. There is lack of resistant variety against major insect pests. The trained man powers are lacking. The functional linkage among stakeholders is not sufficient. The farmer oriented publications are lacking. There is lack of monitoring and evaluation of recommended plant protection technology

As pod borer (*H. armigera*) causes serious damage to pulse crops, onfarm implementation of integrated pest management strategies is required. This would involve greater use of cultivars showing some resistance to insect attack or ability to escape from it, combined with need-based use of pesticides, both chemical and biological [*nucleopolyhedro virus* (NPV)]. The focus of research will be on biological control-especially in the production and use of NPV/Bt/Predators/Parasitoids. The priotization of grain legume insect pests in national, regional and location basis should be done. The present status of pest of grain legumes in regional and national basis should be identified.

Conclusion

Although, numerous insect-pests are associated in pulse crops, research on few insects has conducted and this need to be broadens. The focus of research should be on biological control-especially in the production and use of NPV/Bt/Predators/Parasitoids. Present status of pest of grain legumes in regional and national basis should be updated and should priotize the insect pests in national, regional and location basis. There are different problems associated to with research like lack of proper governmental policy, alternatives of chemical pesticides, skill man power and poor coordination among different stakeholders. Anyway, this review work gave a lot of information to conduct entomological research activity conducted in grain legumes and opens the door for future research and strategy.

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