THE EFFECT OF VARIETY AND INSECTICIDE AGAINST BEAN POD BORER (*MARUCA VITRATA*) ONSUMMER COUNTRY BEAN

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THE EFFECT OF VARIETY AND INSECTICIDE AGAINST BEAN POD BORER (*MARUCA VITRATA*) ON SUMMER COUNTRY BEAN

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CERTIFICATE

This is to certify that the thesis entitled **“THE EFFECT OF VARIETY AND INSECTICIDE AGAINST BEAN POD BORER (*MARUCA VITRATA*) ON SUMMER COUNTRY BEAN”** submitted to the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **ENTOMOLOGY**, embodies the result of a piece of *bona fide* research work carried out by **MEHEDI HASAN**, Registration No. **07-02434** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

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Dedicated To

My Beloved Parents

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THE EFFECT OF VARIETY AND INSECTICIDE AGAINST BEAN POD BORER (*MARUCA VITRATA*) ON SUMMER COUNTRY BEAN

ABSTRACT

The experiment was conducted to evaluate the performance of different varieties and management practices in controlling bean pod borerof country bean during the period from April to October, 2014. The experiment consists of the bean varieties as the IPSA Seem-1, IPSA Seem-2, BARI Seem 7, and insecticides Voliam Flexi 300 SC, Sumi Alfa 5 EC,Neem seed karnel as the treatments. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The minimum infestation percentage (11.71 %) and maximum yield (17.61 t/ha) was obtained from BARI Seem 7 while variety and the maximum infestation (14.86 %) and minimum yield (12.90 t/ha) was obtained from IPSA Seem-1 variety. The minimum infestation (12.24 %) and maximum yield (15.77 t/ha) was obtained while sprayed Voliam Flexi 300 SC treatment and the maximum infestation (14.56 %) and minimum yield (14.42 t/ha) was obtained from the control treatment. In case of combined effect the minimum infestation (9.52 %) and maximum yield (19.20 t/ha) was obtained from combination of BARI Seem 7 and Voliam Flexi 300 SCand the maximum infestation (22.02 %) and minimum yield (10.70 t/ha) was obtained from IPSA Seem-1 and control treatment combination. The relationship between percent pod infestation by number and yield (t/ha) is negatively co-related. From the study it may be concluded that BARI Seem 7 treated with Voliam Flexi 300 SC performed the best results.

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LIST OF ACRONYMS

ABBREVIATIONS		ELABORATIONS
%	:	Percent
et all	:	And others
J.	:	Journal
No.	:	Number
Cm	:	Centimeter
Agric.	:	Agriculture
ºC	:	Degree centigrade
Etc.	:	Etcetera
TSP	:	Triple Super Phosphate
MP	:	Murate of Potash
BARI	:	Bangladesh Agricultural Research Institute
LSD	:	Least Significant Difference
RCBD	:	Randomized Completely Block Design
Res.	:	Research
SAU	:	Sher-e-Bangla Agricultural University
Viz.	:	Namely
@	:	At the rate of
BRRI	:	Bangladesh Rice Research Institute
i.e.	:	That is
BBS	:	Bangladesh Bureau of Statistics
CV%	:	Percentage of Co-efficient of Varience
g	:	Gram
kg	:	Kilogram
mg	:	Miligram
t	:	Ton
Agril.	:	Agricultural
BARC	:	Bangladesh Agricultural Research Council
UNDP	:	United Nations Development Programme
AEZ	:	Agro-ecological Zones

CHAPTER I

INTRODUCTION

The country bean(*Lablab purpureus*Lin.) is an important vegetable-cum-pulse crop under the Leguminosae(Papilionaceae) family grown everywhere in Bangladesh. This bean frequently known as Seem, Hyacinth bean, Indian bean, Egyptian kidney bean and Bovanist bean (Rashid, 1999). The crop is very popular for its tender pods, which are consumed mostly as vegetables, sometimes as pickles. Its tender seeds are also used as vegetables; however, the matured and dried seeds are used as pulses.The foliage of the crop provides hay, silage and green manure. It is rich in nutritive value, the protein content of country bean is quite high varying from 20 to 28 per cent (Schaaffhausen, 1963). It also contains 110 mg calcium, 4.7 mg iron, 2.4 mg vitamin A and 35 mg vitamin C in 100 g edible parts.

In Bangladesh, the crop is usually grown in winter. But recently, a number of photo-insensitive and summer varieties are developed, which helped to promote the cultivation of country beans year-round. Thus the importance of country bean from season at point of view is highly significant. Because more than 70% of the vegetables are produced in the Rabi season while less than 30% are grown in Kharif season. (Hossainand Awrangzeb, 1992). Thus the seasonal distribution of vegetable production is highly contagious and supply of fresh vegetables from local production is not available year round. In this context, the country bean having varieties suitable for production during off season can play a vital role to meet up the off season vegetable deficiency.

The crop is cultivated in dry tropical parts of Asia, Africa, East and West Indies, South Central America and China. In Bangladesh,its cultivation intensity is found in Dhaka, Jessore, Comilla, Noakhali and Chittagong, but for the last ten years it has been seen growing extensively in Khulna and Barisal region as well (Aditya, 1993). About 40,992 metric tons of country beans are produced from 88,581 hectares of land per year in Bangladesh (BBS 2015).

The crop cultivation faces various problems including the pest management (Rashid, 1999). These include the availability of quality seeds, irrigation water and technical information, supply of fertilizers, incidence of pest and diseases, transportation, storage and marketing.

Among these problems, occurrence of frequent insect pest attacks has been most important, requiring the pests to be managed twice or thrice in a season. Insect pests, which cause colossal losses to bean crops, are serious problems. Reports reveal that in Bangladesh, over 30 different species of arthropods have been reported in country bean crop, although only a few occur regularly and cause economic damage (Alam, 1969; Begum, 1993; Karim, 1993, 1995; Das, 1998; Islam**,** 1999).

At the early stage of plant growth, the bean pod borer, attack the crop making clusters of leaves, tendrils and young shoots of the plant and later at flowering and pod setting stages of plants, the insect bore into these reproductive organs, where the insect feeds internally (Karim, 1993).Bean pod borer population has been found to reduce up to 100 percent of crop yields in pigeon pea in Bangladesh (Rahman*et al.*, 1981).Inspite of being a prospective crop, high incidence of insect pests have resulted its low yield and poor quality. Yield loss in country bean due to insect pests is reported to be about 12-30 percent (Hossain, Q. T., 1990).Farmers in Bangladesh frequently require application of different control measures to suppress the population of the pest and thereby to protect their crops from insect pest infestation (Rahman and Rahman, 1988; Begum, 1993). There are several pest control methods for controlling bean pod borer, such as cultural, natural and applied biological (Karim, 1995) and chemical control measures (Rahman and Rahman, 1988).

As the insect is an internal feeder and in most cases cultural, mechanical and biological management are not economically effective. So, insecticide based management package may be an effective means for suppressing the pod borer. A survey on pesticide use in vegetables conducted in 1988 revealed that only about 15% and 16% of the farmers received information from the pesticide dealers and extension agents respectively (Islam, 1999).

In most of the cases, the farmers either forgot the instructions or did not care to follow those instructions and went on using insecticides at their own choice or experience. Some farmers believed that excess use of insecticide could solve the insect pests' problem. As a result, harmful impact of insecticides on man, animal, wild life, beneficial insectsand environment is imposing a serious threat. Indiscriminate uses of insecticides are reported to cause insecticide resistance in insect pests, resurgence and secondary pests outbreak. The accumulation of insecticide residues in food is increasing at an alarming rate. So there is every reason of human health hazards due to these detrimental toxicants. Under these circumstances, insecticide application should be done at appropriate time and dose considering the environment.

Keeping the above situation in mind, the present study was undertaken to fulfill the following objectives to determine the effectiveness of some chemical and botanical and their combination against pod borer and to develop a suitable management technique for controlling the pod borer.

Considering the above facts, the experiment has been undertaken with the following objectives:

- To study the performance of various varieties against the infestation of bean pod borer in country bean;
- To evaluate the combined effect of variety and treatment against the infestation of bean pod borer; and
- To identify the most effective control measures against the insect pests of country bean.

CHAPTER II
REVIEW OF LITERATURE

Country bean is one of the important vegetable cum pulse crop in Bangladesh as well as many countries of the world. Insect pests, which cause colossal losses to bean crops, are serious problems. Farmers mainly control insect pests through use of different chemicals. Information related to management of insect pests of country bean using botanicals and chemical pesticide agents is very limited. Nevertheless, some of the important and informative works and research findings related to the control of insect pest of different country bean varieties through botanicals and chemical agents so far been done at home and abroad have been reviewed in this chapter.

2.1 General review of bean pod borer

2.1.1 Nomenclature

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta

Order: Lepidoptera

Family: Pyralidae

Genus: *Maruca*

Species: *Marucavitrata* Fab.

2.1.2 Biology of pod borer

The pod borer is a holometabolous insect. So, it has four stages to complete its life cycle viz. egg, larva, pupa and adult.

Egg

Marucavitrata females normally lay eggs on floral buds and flowers, although oviposition on leaves, leaf axils, terminal shoots, and pods has also been recorded (Krishnamurthy, 1963; Taylor, 1963, 1967, 1978; Vishakantaiah and Babu, 1980; Rai, 1983). The eggs are normal1y deposited on the under surface of plant parts (Vishakantaiah and Babu, 1980; Rai, 1983). A female may lay up to 400 eggs in batches of 2-16 (Okeyo-Owuor and Ochieng, 1981; Jackai., 1990). The effect of temperature on oviposition and adult longevity of Marucavitrata was examined by. Female adult longevity and pre-ovipositional period were shortened with increasing temperature. The egg laying period lasts an average of 3 days at 24-27ºC (Ramasubramanian and SundaraBabu, 1989). Eggs are light yellow, translucent, and have faint reticulate sculpturing on the delicate chorion, and measure 0.65 x 0.45 mm (Taylor, 1967).

Larva

The mean incubation period is around 3 days under at around 25-28°C and over 80% relative humidity (vishakantaiah and Babu, 1980; okeyo-owuor and ochieng, 1981; Rai, 1983). Mature larvae are 17-20 mm long. The head capsule is light to dark brown, and the prothoracic plate is dark brown and divided dorsally. The body is whitish to pale green or pale brown, with irregular brownish black spots; the spots become indistinct immediately before pupation. There are five instars that a larva has to pass through before molting into a pupa (Odebiyi, 1981). The total length of the larval period on cowpea was about 11 days in lndia (Singh1983), which was 8-13 days in Southern Nigeria (Taylor, 1967), and10-14 days in Kenya (okeyo-owour and ochieng, 1981). Early instars are dull white, but the later instars are black-headed, with irregularly shaped brown or black spots on the dorsal, lateral and ventral surfaces of each body segment.

Pupa

Once matured and the food materials required to consume and preserve for supporting the pupal stage, the fifth instar larva stops feeding and the body shrunk before entering in to the pupal stage. To pupate, the larva spins silken threads around it in a net fashion and molt into a pupa within the silken cocoon covered under dried leaves on soil. The color of the pre-pupa is light green and measures 13 mm in length and 2.59 mm in width (Rai, 1983). The pre-pupal period lasts for 2 to 3 days (Rai, 1983) at around 25-28°C. A pupa measures 11.59 mm in length and 2.83 mm in width (Rai, 1983). The pupa is reddish brown in color. Being a tropical and subtropical insect, M. vitrata does not require entering into diapause (Taylor, 1967). The lower developmental threshold temperature for pupae is 15.6 - 17.8°C and the upper threshold is 28 -34°C (Sharma, 1998).

Adult

About 8 or 9 days after pupation, an adult emerges from the pupa, (Rai, 1983). The adult moths of bean pod borers usually emerge in the night, most of them emerge between 20:00 hr. and 23:00 hr., although some may emerge late in the night or early in the morning (Jackai, 1981). Generally, adults of the emerged insect population comprise the male: female ratio of 1:1 (Rai, 1983). The moths are small, dark gray in color with white brown patterns of the wings. The adult moth has light brown forewings with white patches, and white hind wings with an irregular brown border. It often rests with the wings outspread measuring up to 25 mm. They are inactive during the day and can be found at rest with outspread wings under the lower leaves of the host plants.

Adults live, on average, 6-10 days. The female moths have been found to live 11 or 12 days, whereas the males live 9 or 10 days at around 2BOC (Singh 1983). Djamin (1961) reported that the female moths lived up to 22 days and male moths up to 12 days elsewhere. Taylor (1978) found that in Nigeria female moths could live for 4 to 8 days.

Okeyo-Owour and Ochieng (1981) reported that adults lived for 12 to 26 days in Kenya. The variations of the duration in the adult longevity were presumably due to the variations in ambient temperature and humidity in different regions. The life cycle is completed in 18-35 days depending upon temperature.

2.1.3 Host range of pod borers

The legume pod borer (*Marucavitrata* F.) is a polyphagous insect, which has been reported to feed on various types of plants, both cultivated and wild. Akinfenwa (1975) and Atachi and Djihou (1994) reported that the insect has been observed to feed on 39 host plants; most of these plants were leguminous. Among the host plants, the most frequent ones are *Cajanuscajan*, *Vignaunguiculata*, *Phaseoluslunatus*, and*Puerariaphaseoloids*. The insect has been reported to consume and survive well on pigeonpea, cowpea and hyacinth beans (Ramasubramanian and Babu, 1988; Ramasubramanian and Babu, 1989a). On the basis of number of eggs laid, percentage of egg hatch, growth index, and adult emergence are considered, despite several species of host plants are available, hyacinth bean has been found to be the most suitable host for culturing *M. vitrata* (Sharma, 1998). In absenceof the preferred hosts, the insect would perpetuate on alternate and wild hosts such as *Vignatriloba*, *Crotularia sp.*, *Phaseolus sp. and pigeonpeas* (Taylor, 1967). Sharma (1998) reviewed the host plants of the pest and compiled a list of about 40 plant species used by legume pod borers as their hosts.

2.1.4 Seasonal distribution of pod borer

Pod borer population build-up is related to cumulative rainfall and the number of rainy days between crop emergences to flowering (Sharma, 1998). The insect is multivoltine; having at least two over lapping generations a year in most places of its distribution (Sharma, 1998). Being a multivoltine insect with polyphagous nature of feeding activities, and with preference for some particular parts of a particular host plant (Karel, 1985; Sharma 1998; Singh and Taylor, 1978). Legume pod borer is likely to differ in its seasonal distribution spatially even within a host plant and temporally within the growing season of a particular host plant. Again, the weather pattern varies across continents, and therefore, the seasonal distribution of the insect is likely to vary regionally as well.

In Nigeria, the insect reaches to its peak infestation levels during June and July (Tayior, 1967). The first generation adults developing from the initial stock-generation in cowpea fields appears in July and the second generation between July and September. When host plants become scarce, or the prevailing environment becomes less favorable, the insects possibly migrate from South to North guided by air-movements of the inter-tropical convergence zone, and again head toward South in November-December (Taylor, 1967). Within a 24-hour timeframe, adults of the insects are more active from dusk to midnight, with a peak occurrence between 20:00 and 21:00 h (Akinfenwa, 1975). In Kenya, pod borer populations are low during the short rainy season, although infestation continues unless flower and pod production ceases (Okeyo-Owuor*et al*., 1983). At ICRISAT Headquarters, moth catches were greatest between early November to mid December in the light traps (Srivastava*et al*., 1992) with peak catches occurring during November. In Sri Lanka, Saxena*et al*. (1992) observed a high larval density in host crops planted in mid-

October. In Bihar of India, Akhauri*et al*. (1994) observed that on early pigeon pea the larval density increased from mid-October to the end of November, with the occurrence of peak larval density in the last week of November. Sharma (1998) reported that the presence of significant relationships between the peak occurrence of pod borers and cumulative rainfall and number of rainy days between crop emergences to flowering.

In Bangladesh, Alam*et al.* (1969) studied the infestation levels of M. vitrata on different plant parts of country beans in Gazipur and Jessore. They found that the patterns of seasonal occurrence varied in flowers and pods in both localities. However, the authors did not provide any information regarding the seasonal distribution of the pest in either locality. But, they reported that pods experienced the more infestation than did flowers. Rahman and Rahman (1988) in a study found that the insect attacked the rabi-season pigeon peas from mid December until the crop was harvested in early February in Gazipur. The authors found in the same study that legume pod borer larvae occurred with their peaks during the second week of January to the beginning of February. However, according to them, the insect population may vary depending on the plant parts present; they found larval peak population in flowers around the middle of January, after which the population declined in flowers. On the other hand, the insect tended to occur increasingly in pigeon pea pods until the end of January. Such difference in the seasonal distribution of the pest infestation in different plant parts of the same host plant is presumably because of the preference of one part to the other, a phenomenon very common in insects. The suitability of a particular plant part as a feeding unit may also change over time. This may also be the case with pigeon peas causing a decline in frequency of infestation on flowers, while increasing the frequency of infestation on pods, as found in the study of Rahman and Rahman (1988).

2.1.5 Nature of damage of legume pod borers

Marucavitrata (Fabricius) is a tropical insect that attacks several species of plants, primarily the legume plants, although pod borers in the genus Maruca are polyphagous in nature (Taylor, 1978; Rahman, 1989; Babu, 1989). Babu (1989) reported that hyacinth bean, which is also known as the country bean, is the most favorable food plant for *M. vitrata* (testulalis). Generally the insect infestation begins at the terminal plant parts (Jackai, 1981). At the early stage of plant growth, the insect attacks plant leaves, fastens the leaves together to clusters and feed while living inside the tunnels of clusters (Singh, 1983; Das and Islam, 1985; Rahman, 1989; Karim, 1993). However, the insect prefers ovipositing at the flower bud stage, suggesting that at earlier stages of plant growth, infestations of legume pod borer may not be conspicuous. Pod borer infestation is more frequent from flowering stage of plants. As soon as buds and flowers appear on plants, many of the insect larvae can be present moving from buds/flowers to buds/flowers and bore into them. A single larva can consume 4-6 flowers before the larval development is completed (Sharma, 1998). The attacked buds and flowers subsequently wither and may fall down. Later the insects move into pods and bore into the pods; the insect would occasionally bore into peduncle and stems of host plants (Taylor, 1967). Generally, one larva bores into a single pod, although there have been instances where two or more larvae entered into a single pod (Das and Islam, 1985). In such a case, when more than one larvae enter into a single Pod, cannibalism might be occurring, a phenomenon very common in most leaf miners. However, there has been little research in this regard for legume pod borers.

The first and second instars larvae feed mostly on the inner walls of the young pods and scrap inside the bored pods/flowers. The larvae of later instars, in most cases, enter into the pods, bore into the seeds and feed these parts by making circular holes. The entry holes are often difficult to visualize, as the holes are often plugged with the faecal excretion of the pest. In instances where the extruded frass can be seen from the outside, it is rather an obvious indicator of pod borer infestation (van Emden, 1980). The infesting larva can consume the entire seeds within a pod. After entering into a pod, the larva usually does not leave it until the food is totally exhausted. The infested pod often becomes unfit for human consumption.

Although the insect has been found to feed on different plant parts as explained above, Karel (1985) in a study observed that more than 52% of the larval populations were feeding on flowers, and about 38% larvae were feeding on pods. In contrast, she found only about 10% of the larvae to be feeding on leaves. The result is consistent with Sharma (1998), who concluded that the order on preference of different plant parts is flowers > flower buds > terminal shoot > pods and seeds. As a result of the insect infestations, crop yields can often be severely affected (Singh and Taylor, 1978).

2.2 Yield loss caused by pod borer

M. vitrata (testulalis) is a very important pest causing profound damages to legume crops including the country beans in Bangladesh. Singh and Taylor (1978), Rahman (1987) and Rahman and Rahman (1988) reported that pod borer infestation may cause great reduction of yields of the infested crops. However, these authors did not provide any information with respect to the amount of percentage of yield reduction caused by the pest attack. Nevertheless, there have been several reports on quantified effects of the pest infestation on various crops. Singh and Allen (1980) reviewed the infestation of pod borers in field and horticultural corps across Africa, Asia, south Central America and Australia, and concluded that the insect can cause 20 – 60% damage to host crops. Karel (1985) in Tanzania found that the pod borer infestation could reduce seed yields of local French bean cultivars by 20%-50%. In Kenya, the insect was found to cause 80% reduction of cowpea production (Okeyo-Owuor and Ochieng, 1981). Rahman*et.al*., (1981) found the insect to cause as high as 100% infestation of black gram leaves, the effect of infestation at such high levels are likely to be profound on yield of the crop. Rahman*et al*. (1981) reported that bean pod borers could cause as high as 38% reduction of the yields of pigeon peas in Bangladesh. Ohno and Alam (1989) found that pod borer damage in cowpea was 54.4% at harvest, although the reduction of seed yield of cowpeas was estimated only 20 %. Sarder and Kundu (1987) studied pod borer infestation in four bean cultivars and reported that the borers caused up to 7% reduction of country bean yield in Bangladesh. *Kabir et al.* (1983) studied pod borer infestations on 32 different genotypes of country beans in Jamalpur, Bangladesh and found that the insect caused up to 17% damage to country bean pods. But for country beans the magnitude of infestation would be more severe, as infested pods are likely to be unfit and unacceptable for human consumption.

2.3 Pest complex of country bean

2.3.1 Effect of variety

Alam (2011)evaluated the performance of some country bean varieties against the attack of pod borer in summer. The study was comprised of five varieties; IPSA seam-1, IPSA seam-2, IPSA seam-3, BARI seem-3 and Goalgada. From the present study it was observed that the BARI seem-3 variety of country bean gave the highest result. The variety BARI seem-3 showed highest (14.67 ton ha^{-1}) total yield among the different varieties of country bean used in the present study. This variety (BARI seem-3) performed best results in increasing number of healthy flower for 5 inflorescences (11.00), lowest number of infested flower for 5 inflorescences (0.6667), lowest flower drops (4.333), highest total number of pods (127.3 pods $plot^{-1}$), increasing number of healthy pods (119.0 pods $plot^{-1}$), increased rate of length (14.83 cm) and girth (6.867 cm) of 5 healthy pods, highest total weight of healthy pods (758.3 g), lowest number of infested pods (8.333 pods $plot^{-1}$),increased rate of length (10.90 cm) and girth (6.033 cm) of 5 infested pods, highest total weight of infested pods (93.67 g) over the other varieties. The variety IPSA seam-1 showed the least performance regarding all the parameters. Whereas, IPSA seam-3 variety gave the second best performance regarding the above parameters including the second highest yield (10.67 ton ha^{-1}).

Hossain (2009)evaluated the effect of variety and planting dates, including their interaction on the incidence of pod borer in year round country bean. Five year round country bean varieties namely BARI Seem 3,IPSA Seem 1,IPSASeem 2,IPSA Seem 3 and CB 160 were planted on three different dates (15 April,30April and 15 May in summer and 15 September,30 September and 15 October in winter). Among the varieties, BARI Seem 3 manifested lowest pod borer infestation.15 May in summer and 15 September in winter planting had significantly lower pod borer infestation than other planting dates in both the seasons. Infestation increased with the progress of the season in winter but reverse in summer. In preventing pod borer attack, the best combination was BARI Seem 3 planted on 15 May in summer and 15 September in winter, while the IPSA Seem 2 planted on 15 April in summer and 15

October in winter showed highest susceptibility. The yield was the highest in variety BARI Seem 3 both in summer and winter while the lowest yield was observed in IPSA Seem 3. The year round country bean produced higher yield in winter season than in summer.

Ahmed *et al*. (2003) observed that IPSA seem 2 produce 4.33 ton/ha during winter under the treatment Carbofuran 5G@ 1.5 kg/ha + Cypermethrin 10 EC @ 1 ml/L water. It was reported that dolichos bean produced on an average, 5-8 ton per hectare.

Rouf and Sardar(2011)observed that Deltramethrin 2.5 EC @ 1ml/L water produced 5.0 ton/ha marketable pod as well as 32.7% yield increase over contron but curtap 50 WP @ 2g/L water produced 3.97 ton/ha marketable yield confirming 28.41 % marketable yield increase over control. It was found thatFenitrothion 50 EC @ 1.5 ml/L water IPSA seem-2 produced 7.42 ton/ha marketable yield during winter season.

2.3.2 Effects of treatments

Dandale*et al.* (1984) reported the superiority of cypermethrin, fenvalerate and endosalfan in reducing pod borer infestation in red gram. Four sprays of 0.08% cypermethrin (at flowering, at 50 and 100% flowering and at 100% pod setting) afforded complete protection against *Marucatestulalis*on pigeon pea in Bangladesh in winter season of 1987-88.

Rahman and Rahman (1988) reported that dimethoate was not as effective as cypermethrin. But no such trial 16 has so far been conducted on bean in Bangladesh. Several commonly used insecticides such as endosulfan, carbaryl, methomyl, monocrotophos have been found effective against *Marucatestulalis*G. on cowpea.

Mallikarjuna*et al.* (2012) revealed that sprays of GCK (0.5%), GE (1%) and Panchagavya (3%) gave per cent larval reduction to the tune of 57.80 per cent, 58.86 per cent, 55.94 per cent and 59.45 per cent, 56.91 per cent, 58.22 per cent after first and second spray, respectively. GCK (0.5 per cent), recorded per cent pod and seed damage of 19.56 per cent and 28.11 per cent, respectively and recorded yield of 8.30 q/ha. Among the new insecticide molecules, flubendiamide 24 per cent + thiacloprid 24-48 per cent SC recorded highest per cent larval reduction of 79.42 per cent and 79.09 per cent after first and second spray, respectively. It also recorded lowest per cent pod and seed damage of 13.33 per cent and 18.41 per cent, respectively and pod yield of 16.35 q/ha.

Atachi and Sourokou (1989) reported that a schedule of insecticide sprays using decis (Deltamethrin) and systoate (Dimethoate) on 35, 45, 55 and 65 days after planting was investigated in Benin to determine the most effective treatment against the pyralid*M. testulalis*on cowpea.

Rahman(1989) observed that application of deltamethrin, cypermethrin or fenvalerate @ 0.008% or dimethoate, fenitrothrin, malathion, quinalphos or monocrotophos @ 0.008% or endosulfan 0.10% one at flowering and then at pod setting stage would be highly effective. However, at lower infestation, insecticide application would not be economically advisable.

Karim(1995) observed that application of deltamethrin, cypermethrin or fenvalerate or cyfluthrin (Bethroid 0.50 EC) at the rate of 1.0 ml/1 of water may be helpful for the control of the pod borer.

Singh (1977) and Lalasangi(1988) reported that several commonly used insecticides such as endosulfan, carbaryl, methomyl, monocrotophos have been found effective against *Marucatestulalis*G. on cowpea

Kataria*et al.* (1994) also advocated that a sequential spray of dimethoate (0.03%) fenvalerate (0.02%) and monocrotophos (0.04%) was very effective.

Sreekanth and Seshamahalakshmi (2012) confirmed that only *B. bassiana*SC formulation at the highest dose (300 mg/l) slightly reduced pigeon pea pod damage by *M. vitrata*. In addition, neem is effective only at higher concentrations for most lepidopteran pests.

Ramasubramanian and Babu (1991) recorded significant reduction in flower damage due to spotted pod borer in lablab with foliar application of neem seed kernel extract.

Lakshmi *et al.* (2002) reported that two sprays of chlorpyriphos @ 0.05% at ten days interval was effective in reducing the larval population (48.86%) of *M. vitrata*on blackgram.

Ashok Kumar and Shivaraju (2009) reported that Thiodicarb 75 WP @ 562.5g a.i/ha and flubendiamide 480 SC @ 48g a.i/ha were highly effective followed by Indoxacarb 14.5 SC @ 75g a.i/ha in controlling the pod borers in blackgram.

In increasing yield, various insecticides such as Curtap, Deltramethrin, cypermethrin, Emamectin benzoate have been reported to be effective against *M. vitrata*on urdbeanChandrakar*et al.* 2001.

Barman (2011) also found the highest marketable yield by using 3 sprays of Ripcord 10 EC (Cypermethrin) @ 1.0ml/litre of water with mechanical control at 10 daysinterval applied in country bean.

Singh and Singh (2001) found that out of seven insecticides tested in reducing infestation of pods and seeds of pigeonpea by M. obtusa, fenvalerate (0.02%) was found most effective and also reported that fenvalerate gave the greatest profit per hectare, followed by fluvalinate (0.02%).

Hongo and Karel (1986) reported that neem seed powder and neem kernel extract were also effective against legume pod borer (Singh *et al.*, 1985; Hongo and Karel, 1986) but neem seed kernel extract (NSKE) was less effective than fenvalerate and monocrotophos. Aqueous extracts of neem seed kernels and chilli fruits exhibited high deterrent effects against the pests of common bean

Dandale*et al.* (1981) from Maharashtra compared the efficacy of synthetic pyrethroids with commonly used compounds and found that fenvalerate (0.01%) was the most effective followed by cypermethrin (0.01%), permethrin (0.01%), endosulfan (0.05%) and methamidophos (0.05%) in reducing pod infestation by borer complex of pigeonpea.

Patel and Patel (1989) evaluated that fenvalerate (0.01 and 0.02%), fenvalerate dust (0.4%) at 25 kg ha^{-1} were effective in reducing numbers of *H. armigera* in pods; fenvalerate at 0.02 per cent gave maximum protection of pods and grains against infestation by M. obtusa and the maximum grain yield was obtained from plots treated with 0.02 per cent fenvalerate in pigeonpea.

Patil*et al.* (1993) reported that fenvalerate (0.01%) treated plants showed the least damage and greatest grain yield than quinalphos (0.12%) and endosulfan (0.07%) in Maharashtra.

Baruah and Ramesh (1997) reported that on average, synthetic pyrethroids were more effective than endosulfan against H. armigera infesting pigeonpea. Pod damage was lowest following treatment with cypermethrin.

Yadav*et al.(*2000) reported that the synthetic pyrethroids were better than the other treatments in controlling yield loss due to insect pests but were at par with endosulfan and quinalphos in field pea.

Rao and Rao (2006) reported that thrice spraying of insecticide fenvalerate 20 EC (0.02%) on pigeonpea variety ICPL-85063 was found to be effective in reducing pod borer infestation, pod damage level and seed damage due to pod fly respectively and also contributed to yield enhancement.

Kumar and Nath (2003) evaluated the efficacy of some synthetic insecticides against pod bug and pod fly infesting pigeon pea cv. UPAS-120. The order of efficacy was cypermethrin (0.006%) >fenvalerate (0.02%) >deltamethrin (0.004%) > control.

Gopali*et al*. (2010) reported that neem Seed Kernel Extract (5%) + DDVP @ 0.5 ml/ liter of water were found next best treatment for the management of spotted pod borer.

Ivbijaro and Bolaji (1990) also observed that pod borer damage was reduced by four sprays of *Azadirachtaindica*or *Piper guinense*extracts. Different concentrations of neem oil emulsifiable concentrate (NOEC) (5, 10, and 20%) exhibited high degree of activity against *M.vitrata.*

Jackai and Oyediran(1991)Spraying two rounds of monocrotophos 0.5 kg a.i. /ha starting from pod formation stage and at 14 days later was very effective.

Bhalani and Parsana (1987) observed the highest larval mortality three days after spraying deltamethrin, cypermethrin and fluvalinate under laboratory conditions and monocrotophos was on par with pyrethroids. Triazophos, cypermethrin and endosulfan gave maximum benefit in controlling pod borers.

Ganapathy and Durairaj (1994) suggested sequential spraying of either monocrotophos (0.04%) - fenvalerate (0.02%) - dimethoate (0.03%) or monocrotophos (0.04%)-Cypermethrin (0.025%)-dimethoate (0.03%) starting from 50 per cent flowering time to pigeonpea.

The efficacy of dust formulations of methyl parathion, fenvalerate, quinalphos, hexachlorocyclohexane and endosulfan was well documented earlier (Patil*etal.*, 1990; Srivastava and Singh, 1994 and Yazdani*et al.*, 1994).

Rahman*et al*. (2011) evaluated the effectiveness of some IPM tools for the suppression of pod borer (*Euchrysopscnejus*) attacking yard long bean. Those were T1: Mechanical control (hand picking of larvae) at 7 days interval; T2: Neem oil @ 5ml/ L of water at 7 days interval; T3 : Neem oil @ 5 ml /L of water + Mechanical control at 7 days interval; T4 : Suntap 50 SP@ 3 g /L of water at7 days interval; T5 : suntap 50 SP @ 3 g /L of water +Mechanical control at 7days interval; T6 : Shobicron 425 EC @ 2 ml / L of water at 7 days inrterval ; T7: Shobicron 425 EC @ 2 ml /L of water +Mechanical control at 7 days interval; T8: Neem seed kernel @ 10 g /L of water + Mechanical control at 7 days interval & T9: Untreated control. Data recorded on infestation level, yield contributing characters & yield of yard long bean revealed that performance of treatment T3 (Neem oil @ 5 ml /L of water + Mechanical control at 7 days interval) was superior throughout the season as compared to others; the lowest performance in the control treatment (T9). The highest healthy pods by number (59.80) & by weight (993.87 g), similarly the lowest infestation per plant by number (7.06 %) & by weight (72.62 g) was recorded in T3 treatment. The highest healthy pod length (54.20 cm) the height length of edible portion (48.64 cm) of partially infested pod, the highest yield (22.15 ton /ha) was recorded in the T3 treatment; while the lowest healthy pod length (44.60 cm), lowest edible portion (30.11cm) of partially infested pod and the lowest yield (14.74 ton / ha) was recorded in the control treatment (T9). The highest benefit cost ratio (3.53) was recorded in the T3 treatment while the lowest benefit cost ratio (1.23) in T8 treatment.

Grainge and Ahmed, (1988) reported that neem*(Azadirachtaindica*) seed oil, a botanical pesticide have also been used to control different insect pests of important agricultural crops in different countries of the world. More than 2000 species of plants have been reported to posses' insecticidal properties.

Ketkar (1976) reviewed 95 and Jacobson (1985) reviewed 133 papers on neem and documented neem's potential in the management of arthropods pests.

Ahmed and Grainge (1985) and Saxena*et al*. (1992) summarized the effectiveness of neem oil against 87 arthropods and 5 nematodes, 100 insects and mites and 198 different species of insects, respectively.

The seed and leaves of the neem tree contain terpenoids with potent anti-insect activity. One of the most active terpenoids in neem seeds is “azadirachtain” which acts as an antifeedant and growth disrupter against a wide range of insect pest at microgram levels. The active terpenoids in neem leaves include nimbin, deactylnimbin and thionemone (Simmonds *et al.,* 1992).

Islam (1983) reported that extract of leaf, seed and oil of neem, showed potential as antifeedants or feeding and oviposition deterrents for the control of brown plant hopper, green leaf hopper, rice hispa and lesser rice weevil. He also conducted experiments to asscertain the optimal doses of the extract against rice hispa, and pulse beetle. Addition of sesame or linseed oil to extract of neem resulted in higher mortality of the grubs and in greater deterrence in feeding and oviposition compared to those obtained with extract alone.

Visalakshimi*et al*. (2005) reported that application of neem effectively reduced the oviposition of *H.armigera*througout the crop period. Among various IPM components (neem 0.06%, HaNPV 250 L/ha, bird perches one/plot, endosulfan 0.07%), neem and HaNPV found as effective as endosulfan in the terms of reduction larval population and pod damage

Stoll (1992) summarized the potential benefits of botanical pesticides which diminish the risk of resistance development, natural enemy elimination, secondary outbreak of pest and ensure overall safety to the environment.

Fagoonee (1986) used neem in vegetable crop protection in Mauritius and showed neem seed kernel extract was found to be effective as deltamethrin (Decis) against the *Plutellaxylostella*and *Crocidolomiabinotalis.* He also found neem extract alternate with insecticides gave best protection against *Helicovarpaarmigera.* Neem product have been used to control vegetable pests under field condition and good control of *Plutellaxylostella*and Pyralid, *Hellulaundalis*on cabbage was achieved with weekly application of 25 or 50 gmneem kernel powder/liter of water (Dreyer, 1987).

Ameh and Ogunwolu, (2000) the plant materials including *Azadirachtaindica*seeds reduced significantly the pod damage by *Marucavitrata*on cowpea as much as 75.3 - 81.5 %.

Mollah (2009)evaluated of 9 most commonly used insecticides were carried-out for their effectiveness in controlling aphid and pod borer infestation in IPSA seem 2 and their detrimental effect on biological control agents of aphid and pod borer. The insecticides were Ripcord 10EC, Sumithion 50EC, Fanfen 20 EC, Proclaim 5 SG, Decis 2.5EC, Sumialpha 5EC, Suntap 50SP, Neem oil (fresh) and Neem oil (stored). Among the insecticides, Decis 2.5EC @lml/L resulted in the highest (71.33%) reduction of inflorescence infestation by aphid over control. Proclaim 5 SG @ lg/L water and Sumithion50 EC @ 1.5ml/L water protected the crop against pod borer allowing the lowest infestation at only 2.98 % and 3.12% by number and weight, respectively. Among the insecticides, Neem oil (fresh) @ 2.5ml/L caused the lowest mortality of lady bird beetle (9.37%) and stink bug (16.09%) while Sumialpha 5EC@lml/L and Sumithion 50EC @ 1.5 ml/L water caused the highest mortality of the predator, lady bird beetle (33.78%) and Stink bug (50.59%) . Sumithion 50 EC@ 1.5 ml/L water and Furadan 5G @1.5kg/ha+ Ripcord 10 EC @ lml/L rendered the highest parasitization of pod borer larvae by braconids (70.96%) and tachinid (88.11%). Decis 2.5EC @ lml/L ensured the highest (46.70 %) yield increase over control.

Karel (1985) foundtheeffects of pod borers, *Marucatestulalis* (Geyer) and *Heliothisarmigera* (Hubner), infesting flowers, pods, and seeds, on dry-seed yield of common beans (*Phaseolus vulgaris* L.) under various insecticide treatments were studied. More larvae (52.3%) were found on flowersthan on pods (37.8%) and leaves

(9.9%). Up to 31% of flowers were damaged by feeding activity of the larvae of the two species. *M. testulalis* larvae were more abundant and damaged pods to a greater extent than did *H. armigera* (an average of 31 and 13%, respectively). Seed damage by larvae of both species averaged 16%. Insecticide applications were effective in controlling larvae of both species. Larva counts on flowers and pods were reduced in plots treated with insecticides resulting in increased dry-seed yields. Highest dryseed yield (an average of 1,442 kg/hal was recorded in lindane-treated plots. Seed-yield losses ranging from 33–53% resulted from *M. testulalis* and *H. armigera* damage. Insecticide applications provided a net monetary gain of Tanzania shillings ranging from 530.00 for dimethoate application to Sh 2,171.00 for lindane spraying.

Roufand Islam (2012) reported tahtthe IPM package – hand picking and destruction of infested flowers and pods with pod borer larvae, cutting of older leaves and twisted young twigs, integrated with spraying of Amamectin Benzoate (Proclaim) 5SG @ 1 g per litre of water at 7 days interval showed better performance in the reduction of 89.36 % flower and 80.53 %pod damage in country bean leading to 44.21 % yield increase. Another package -hand picking and cutting as in earlier package, integrating with spraying of Emamectin Benzoate (Proclaim) 5SG @ 1 g per litre and Neem seed extract @ 100g per litre of water separately at each alternate schedule date at 7 days interval might be considered as another strategy for management of legume pod borer.

Samolo and Patnaik (1986) reported that of the six insecticides tested, monocrotophos and endosulfan (0.5 kg a.i./ha) were most effective, and three applications of endosulfan starting at flower initiation (at 20 days interval) were most effective.

Srinivasan*et al.* (2012) studied on the effectiveness of biopesticides against legume pod borer (*Marucavitrata*) on yard-long bean in Lao PDR and Vietnam has limited their use in integrated pest management (IPM) strategies. An earlier study confirmed the susceptibility of *M. vitrata*to selected biopesticides under laboratory conditions in Vietnam. A series of field trials were carried out to confirm the potential of biopesticide application in combination with chemical pesticides against *M. vitrata*on yard-long bean in Lao PDR and Vietnam. The *Bacillus thuringiensis*-based treatments reduced pod damage by 50% in Vietnam, and yard-long bean yields were 17 to 50 times greater than the untreated check. Similarly, yard-long bean pod damage by *M. vitrata*in Lao PDR was reduced by 9-44%, with significant yield increases (63-68%) in *B.thuringiensis*-based treatments. Although the entomopathogenic fungi and neembased treatments included few *B. thuringiensis*and chemical pesticide sprayings, they slightly reduced marketable pod yield losses. Based on these results, *B. thuringiensis* in combination with chemical pesticides and/or neem is a promising component for IPM strategies against *M. vitrata*on yard-long bean in Lao PDR and Vietnam.

Rahman(1991) reported that foliar application of cypermethrin (0.008%) or dimethoate (0.07%) at flowering or when egg numbers reached 2 per meter row, and then repeated at 10-15 days interval provided effective protection against *M. vitrata.*

Dharmasena*et al*. (1992) reported that the number of flowers, pods, and seeds per plant was significantly greater in plots treated with insecticides based on the economic threshold level of 10 larvae per 100 flowers (3 insecticide applications) than in the untreated plots. The differences in the number of flowers, pods, and seeds per plant were not significant between plots sprayed 3 and 4 times. It has been concluded that 10 larvae per 100 flowers can be considered as a tentative threshold for *M. vitrata*on pigeonpea.

Venkaria and Vyas (1985) reported that the least number of pods were damaged in plots treated with fenvalerate (0.01%), endosulfan (0.07%) + miraculan (a plant growth stimulant), followed by those treated with fenvalerate (0.01%), endosulfan (0.07%) + miraculan, and monocrotophos (0.04%). Thiodicarb (613 ppm) andethofenprox (125 ppm) were as effective as methamidophos (200 ppm) for the control of legume pod borer on pigeonpea in Sri Lanka.

Sontakke and Mishra (1991) observed that Cypermethrin (75 g a.i.ha^{-1}) sprayed three times, has been found to be effective against pod borers, followed by decamethrin (12.5 g a.i. ha^{-1}), fenvalerate (150 g a.i. ha^{-1}), and endosulfan (400 g a.i. ha^{-1})

Alam (2013) evaluated several bio-rational management packages against pod borer complex attacking country bean. There were four treatment packages viz.,: Package 1= Sanitation (Hand picking and destruction of infested flowers, pods and larvae) + release of bio-control agents (*Trichogrammachilonis*and *Braconhebetor*) + spraying of Bt powder; Package 2= Sanitation + release of bio-control agents (*Trichogrammachilonis*and *Braconhebetor*) + spraying of Spinosad 45 SC; Package 3= Sanitation + release of bio-control agents (*Trichogrammachilonis* and *Braconhebetor*); Package 4 = Sanitation + spraying of Voliam flexi 300 SC (Chlorantraniliprole + Thiamethoxam) and an untreated control. Results indicated that, the management package P2 appeared as the best package which provided 75.93% and 90.17% reduction of flower and pod infestation, respectively over control by pod borers. The highest yield increase over control (84.46%) and benefit cost ratio (9.55) was also obtained from this management package.

Srinivasan*et al.* (2013) reported thatseed kernel extracts of China berry (*Meliaazedarach*) against oriental fruit fly (*Bactroceradorsalis*) and tomato fruit borer (*Helicoverpaarmigera*), and commercial neem formulations containing azadirachtin (Biofree–I® and Thai neem 111®) against the legume pod borer (*Marucavitrata*) were tested in Taiwan and Thailand to confirm their effects on oviposition, feeding, growth and development. Various extracts from *M.azedarach*seed kernels significantly reduced the oviposition of *B. dorsalis*and the efficacy was similar to Biofree–I®. The green drupe and dry seed kernel extracts of *M.azedarach*substantially increased larval mortality, and reduced successful pupation, pupal weight, adult emergence, fecundity and egg hatch of *H. armigera*larvae. Commercial neem formulations exhibited adverse morphogenic effects on various biological parameters of *M. vitrata*, but they did not reduce oviposition and egg hatch. *M.azedarach*extracts and commercial neem formulations

can be employed together for the sustainable management of *B. dorsalis*, *H. armigera*and *M. vitrata*.
Karim (1993) reported that spraying of synthetic pyrethroid insecticides at the rate of 1 ml per liter of water has been recommended for the control of the pest.

Suhas*et al.*(1999) reported that application of indoxacarb 14.5 SL @ 50 g a.i.ha" was very effective in bringing down the pod damage by H *armigcra*in pigeonpea to 23.1 per cent as against 47.5 per cent in untreated check.

Babu (2002) reported 44.07 per cent and 44.87 percent reduction of H. *armigera*and *M. rfirratq*larvae respectively when spinosad 48 SC @ 0.0144% was applied on iroundnut.

Balasubramanian*etal.*(1977)Conventional insecticides are found highly effective against pod borers.

Das and Srivastava (2002) reported that endosulfan @ 360g a.i/ ha was the best treatment in controlling pigeonpea pod borer, it recorded the least number of larvae of 0.9 when compared to 5.1 in untreated control.

Sahoo and Senapathi (2000) reported that NSKE 5% significantly reduced the pod borer larvae of pigeonpea per plant (1.95) at **3** days after treatment.

Girhepuje*et al.*(1997) reported that as compared to other treatments, neem seed kernel extract (5%) was fbund to be the least effective chemical against pod borer complex in pigeonpea and recorded minimum grain yield.

Sadwarte and Sarode (1997) reported that the applicnt~on of NSKE 5% + half recommended dose of insecticides resulted maximum larval reduction of H *armigera. Exelastisatomnsu*and minimum larval infestation of *M.ohtusa*on pigeonpea.whereas the application of NSKE alone was not ellective against pod borer complex of' pigeonpea. The lowest damage and the highest grain yicld was observed using NSKE at 5% + dimethoate 0.15%.

Schmutterer(1995).Azadirachtin is structurally similar to the insect moulting hormone ecdysone and interacts with the corpus cardiacum there by blocking the activity of moulting hormone. As such the compound acts as an insect growth regulator suppressing fecundity. moulting. pupation and adult formation.

Reddy *et al.*(2001) reported that Ilipcl*(BI)*with deltarnethrin (0.004% (or) 0.002%) was most effective in reducing the damage due to pod borers in pigeonpea.

Pawar*et al.*(1999) reported that spraying with Halt **(**WockBiological-01) was on par with fenvalerate 100 ml ha.' when applied at50 per cent flowering stage,at fortnightly intervals in reducing the poddamage and increasing grain yield of chickpea.

Ramteke*et al.,* (2002) reported that the bioefficacy of various treatments showed that endosulfan 0.07% had the least larval population after three days of' spraying followed by NSKE 5% + endosulfan0.035%**.**

Ramasubramanian and Sundarabahu(1988) reported that among the insecticides tested on beans spraying ot'cndosulfan (0.518 kg ai. /h) and NSKE 5% were effective in reducing the larval population of *M.vitrata.*

Singh *et al.* (1985), Cobbinah and Osei (1988) reported that the neem seed extract applied @ 5%, neem emulsion, aqueous-methanol extract of defatted neem cake was most effective in reducing the incidence of *Marucavitrata*on cowpea, green gram, and pigeon pea.

Rahman (2013) advocated the conservation of predatory black ants + hand picking of infested flowers and pods at alternative days+ spraying of Neem oil @ 3ml/l of water or Cymbush 10 EC @ 1ml/l of water at seven days interval or application of

Sumialpha at a single flower infestation per inflorescence as an effective IPM package against pod borers of country bean.

Rekha (2005) reported 2 sprays of NSKE 5% were found efficient in controlling the pod borers of field bean. Similar findings are reported in mungbean (Shivaraju, 2009).

Dong and Zhao (1996) opined that azadirachtin has repellent, antifeedent, stomach and contact poison and growth inhibitor effects on many insects, whereas Kareem *et al.* (1988) noticed application of NSKE 5% against pest complex of mung bean, recorded superior to monocrotophos.

Choudhary and Sachan (1997) reported that,spraying endosulfan (0.07%) at flowering. pod formation and pod maturation stages of pigeonpea gave effective control of pod borer complex and resulted in higher yields. The highest cost benefit ratio was also obtained with one spray of quinolphos and two sprays of endosulfan (Singh, 1997).

Minja*et al.*(2000) reported that NSKE and *BI* were not as effective as the synthetic insecticides in reducing pest numbers and pigeonpea seed losses.
Reddy *et al.*(2001) reported that Ilipcl*(BI)*with deltarnethrin (0.004% (or) 0.002%) was most effective in reducing the damage due to pod borers in pigeonpea.

Sarode*et al.*,(1995) reported two applications of NSKE@ 5% concentration was the most effective treatment in minimizing pod damage and maximum larval reduction of *H, armigeru*in pigeonpea.

Prakash and Rao(1986, 1997) reported that botanical extracts induce insecticidal activity, repellence to pests, antifeedant effects and insect growth regulation, toxicity to nematodes, mites and other pests, as well as antifungal, antiviral and antibacterial properties against pathogens.

Kumar *et al*. (1989) reported that application of carbofuran 3G at 1 kg a.i./ha at the time of sowing did not give effective control at the later crop stages.

Durairaj and Venugopal (1995) reported that neem seed kernel extract (NSKE) 5% was effective against podfly and lepidopteran borers in pigeonpea.

Latif*et al.*(1996) observed that nimbicidine (0.3%) was next to monocrotophos 36 SL (0.04%) when sprayed thrice at 12 days interval in giving the highest protection and yielded maximum against major insect pests of pigeonpea.

Krishnaiah and Kalode (1991) observed Most of the cases, the user of neem oil use it at different doses ranged from 0.5-50% they use different emulsifier to mixeneem oil with the water. Neem oil normally stay separately on the upper surface of the water. In a field observation of neem oil Krishanaiah and Kalode (1991) used soap as emulsifier with water.

Hossain(2015) observed efficacy and profitability of insecticidal management practices using different insecticides were tested against insect pests of mungbean. Insect infestations were reduced significantly by the application of synthetic insecticides. Spraying of Imidachloprid (Imitaf 20 SL) @ 0.5 ml/l of water showed the best efficacy in reducing flower infestation and thrips population followed by Fipronil (Regent 50 SC). Spraying of Thiamethoxam + Chlorantraneliprol (Voliam flexi 300 SC) @ 0.5 ml/l of water showed the best efficacy in reducing pod borer and flea beetle infestations. Spraying of Fipronil (Regent 50 SC) performed highest efficacy against stemfly infestation. The yield and the highest net return were obtained from Voliam flexi 300 SC, the highest benefit was obtained from Regent 50 SC treated plots. This might be due to the higher cost of Voliam flexi that reduced the profit margin and showed the lower marginal benefit cost ratio (MBCR) compared to Regent. Therefore, considering the efficacy and benefit, spraying of Fipronil (Regent 50 SC) @ 0.5 ml/l is the most profitable insecticidal management approach against insect pests of mungbean followed by Imidachloprid (Imitaf 20 SL) at the same dose.

Prajapati*et al.* (2003) observed the neem seed extract @ 3-10 % to be effective against *Marucavitrata*on the yield of cowpea and green gram

Tanzubil (2000) who used neem seed extract, neem oil, neem cake and black pepper and garlic bulb extract with varied doses against the *Marucavitrata*attacking cowpea and pigeonpea

Meena*et al*. (2006) recorded higher grain yield in pigeonpea using emamectin benzoate 5 WSG @ 11 g a.i. /ha sprayed twice at 15 days interval.

Jacobson and Sheila (1994) reported that the leaf extract of neem tested against the leaf caterpillar of brinjal, Sele a docilisBult. at 5% concentration had a high anti-feedant activity with a feeding ratio of 28.29 followed by 3% having only medium antifeedant properties with 23.89.

Byrappa (2009) observed sequential spraying of carbarylendosulfan-malathion effectively reduced the pod damage, where he also observed 21.09, 29.33 and 20.64, 28.22 per cent pod and seed damage in NSKE 5% and panchagavya 3%, respectively. The present findings are in line with NSKE 5% on seed damage but latter treatment recorded higher pod damage.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted to study the performance of combined management practices in controlling bean pod borer country bean during the period from April to October, 2014. A brief description of the experimental site, climatic condition, soil characteristics, experimental design, treatments, cultural operations, data collection and analysis of different parameters were used for conducting this experiment are presented under the following headings:

3.1 Experimental site

The experiment was conducted at the central farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh, which is situated in $23^{0}74'$N latitude and $90^{0}35'$E longitude.

3.2 Weather condition

The climate of experimental site was subtropical, characterized by the winter season from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October. The details weather data of February to October, 2014 have been presented in Appendix I.

3.3 Soil characteristics

The soil of the experimental area belongs to the Modhupur Tract, corresponding AEZ No. 28. The soil of the experimental area is shallow red brown terrace soil.

3.4 Land preparation

The land was first opened with the tractor drawn disc plough. Then the soil was ploughed and cross ploughed. Ploughed soil was then brought into desirable fine tilth by the operations of ploughing, harrowing and laddering. The stubble and weeds were removed. Experimental land was divided into unit plots following the design of experiment. During final land preparation 10 t/ha decomposed cowdung were mixed with soil. In each plot measuring 3.0 m × 2.0 m, 2 pit were prepared for seedling transplantion.

3.5 Manures and fertilizers application

Recommended doses of fertilizer comprising Urea, TSP and MP at the rate of 30, 90 and 65 kg/ha respectively were applied. Entire dose of TSP and half amount of MP were applied to the soil of the pit 4-5 days before the seedling transplanting. The rest amount of Urea and MP were top dressed at 30 days and 45 days after transplanting.

3.6 Sowing of seeds in the field

For rapid germination the seeds of country bean varieties were soaked for 12 hours in water. Two seeds of variety were then sown per polyethylene bags (12 cm × 18 cm) containing a mixture of equal proportion of well-decomposed cowdung and loamy soil. Irrigation was given by watering cane as per requirement. After germination, the seedlings were placed to partly sunny place for hardening. Finally, 15 days old seedlings were transplanted to the experimental plots as three seedlings per pit on last week of April, 2014. At the time of transplanting the polybags were cut and removed carefully in order to keep the soil intact with the root of the seedlings. The seedlings were transplanted in the pits with the entire soil ball. The seedlings were watered until they got established. Out of six seedlings plot^{-1}, one was removed two weeks after transplanting.

3.7 Treatments of the experiment

The experiment consists of the following varieties and management practices:

Variety	Treatment
	T_0 : Untreated control
V_1 : IPSA seem-1	T_1 :Voliam Flexi 300 SC
V_2 : IPSA seem-2	T_2 : Sumi Alfa 5 EC
V_3 : BARI seem 7	T_3 : Neem Seed Kernel

Plate 1. IPSA Seem-1Plate 2. IPSA Seem-2

were collected from Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur; BARI seem 7 variety was collected from Bangladesh Agricultural Research Institute (BARI), Gazipur.

3.9 Pesticide collection

Voliam Flexi 300 SC, Sumi Alfa 5 EC andNeem Seed Kernelwere collected from the department of Entomology, Sher-e-Bangla Agricultural University,Dhaka-1207.

3.10 Experimental layout and design

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. A plot area was divided into three equal blocks. Each block was divided into 6 plots, where 6 treatments were allocated at random. There were 24 unit plots altogether in the experiment. The size of the each unit plot was 3.0 m × 2.0 m. The distance maintained between two blocks and two plots were 1.0 m and 1.0 m respectively (plate 4).

3.11Preparation for spraying experimental treatment

Voliam flexi 300 SC was applied to the field at the rate of 10ml/liter of water and Sumi Alfa 5 EC was applied to the field at the rate of 5ml/liter of water.For proper management of bean pod borer 4 ml Neem seed karnel in 1 Litre of water and then 1ml trix was mixed to obtain fine droplet to spray 3m x 2m area.

3.12 Intercultural operations

After transplanting the plants were initially irrigated by watering can and later on surface irrigation was given. After 7 days of transplanting, propping of each plant by bamboo sticks (1.75 m) was provided up to 1.5 m high from ground level for additional support to allow normal creeping. All the bamboo sticks in each row were fastened strongly by a galvanized wire to allow the vines to creep along. Weeding and mulching in the plots were done, whenever necessary.

3.13 Crop sampling and data collection

Single plant form single pit of a plot from each treatment were randomly marked with the help of sample card.

3.14 Monitoring and data collection

The country bean plants under different treatment were closely examined at regular intervals commencing from germination to harvest. The following data were collected during the course of the experiment-

- Incidence of insect
- Number of healthy pods
- Number of infested pods
- Pod infestation (%)in number
- Weight of healthy pods
- Weight of infested pods
- Pods infestation (%)in weight
- Number of inflorescence plant^{-1}
- Number of flower inflorescence^{-1}
- Number of pods inflorescence^{-1}
- Pod length (cm)
- Yield plot^{-1} (kg)

- Yield hectare^{-1} (ton)

3.15 Procedure of data collection

3.15.1 Incidence of insects

Among all of the plants 5 plants of each plot carefully observed for the identification of attacking insect pests. All the insects and larvars counted and recorded the data. The collected data were divided into early, mid and late pod development stage.

3.15.2 Counting of Aphid

The number of aphid on 5 selected plants from each plot was counted at an interval of 7 days at each harvest during early, mid and late fruiting stage of the plant. The top 10 cm apical twigs of 5 randomly selected inflorescence of selected plants were cut and brought to the laboratory in bags separately for counting the number of aphids plant-1 and also 5 randomly aphid infested pod of selected plants were collected by hand picking for counting of aphid plant^{-1}. The aphids were removed from the infested plant parts with the help of a soft camel hair brush and placed on a piece of white paper. Then the number of aphids was counted with the help of a magnifying glass and tally counter. The infested twigs and inflorescence were checked carefully. So that, single aphid could not escape at the time of counting.

3.15. 3 Counting of bean pod borer larvae

The flowers and pods infested by Bean pod borer at each harvest were counted and tagged. The number of infested flowers, pods removed instead of taggingwere also recorded. Then larvae were counted using hand magnifying glass and calculated as plant^{-1}. This operation was done at an interval of 7 days at each harvest during early, mid and late fruiting stage of the plant from 5 plants of each plot.

3.15.4 Number of healthy pods plant^{-1}

Number of healthy pods from each plot was counted and at early, mid and late pod development stages (plate 5).

3

Number of infested pods was counted at early, mid and late pod development stages (plate 6 and plate 7).

3.15.6 Estimation of % pod infestations

The numbers of healthy and infested pods were counted and the percent pod infestation was calculated using the following formula:

$$\% \text{ Pod infestation} = \frac{\text{Number of infested pods}}{\text{Total number of pods}} \times 100$$

3

Weight of healthy pods of selected plants from each plot was recorded at early, mid and late pod development stage.

3.15.8 Weight of infested pods plant

Weight (g) of infested pods of selected plants from each plot was recorded at early, mid and late pod development stages.

3.15.9 Estimation of % pod infestation

The weight of healthy and infested pods was measured and the percent pod infestation in weight basis was calculated using the following formula:

$$\% \text{ Pod infestation} = \frac{\text{Weight of infested pods}}{\text{Total weight of pods}} \times 100$$

3.15.10 Number of inflorescence plant^{-1}

Total number of inflorescence from each individual plantwas recorded in each treatment (plate 8 and 9).

3.15.11 Number of flower inflorescence^{-1}

Total number of flower inflorescence^{-1} were recorded in each treatment from 10 inflorescences for each treatment.

3.15.12 Number of pods inflorescence^{-1}

During the reproductive stage of the plant total numbers of pods from each individual inflorescence were recorded in each treatment.

3.15.13 Pod length (cm)

Pod length was taken of randomly selected twenty pods and the mean length was expressed on per pod basis.

3.15.14 Pod yield plot^{-1}(kg)

Total weight of collected pods of country bean from each plot was weighed and recorded and expressed in kilogram.

3.15.15 Pod yield hectare^{-1} (ton)

Pods yield of country bean per plot was converted into hectare.

3.16 Statistical analyses

The data on different parameters as well as yield of country bean were statistically analyzed to find out the significant differences among the effects of different treatments. The significance of the differences among the mean values of treatment in respect of different parameters was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV
RESULT AND DISCUSSION

The study was conducted to find out the effectiveness of different control options in controlling major insect pests of country bean. Data on the parameters of number of insect pest plant^{-1}, number and weight of healthy pods, infested pods and percentage of pod infestation in number and weight, yield contributing characters and yield of country bean were recorded. The results from different parameters have been presented and discussed, and possible interpretations have been given under the following headings:

4.1 Incidence of insect pest

Incidence of major insect pests of country bean was recorded for the entire cropping season. Remarkably bean pod borer and aphid were observed in the study. Insect pests from each plant during the reproductive stage which divided as at early, mid and late pod development stages depending on the duration of reproductive stage to investigate the performance of different treatments.

4.1.1 Early stage of pod development

The tested bean varieties showed the significant variations at early pod development stage while infested by pod borers and aphids (Appendix III). In case of single effect of variety, the lowest numberof bean pod borer per plant (13.00) was found from V_3(BARI Seem 7) variety and the highest number of bean pod borer (18.06) was found from V_1(IPSA-1) variety.In consideration of aphid, the lowest number plant^{-1}(7.18) was observed from V_3(BARI Seem 7) whereas the highest number (7.75) was observed from V_1(IPSA-1) variety (Table 1).Hossain (2009) observed the similar result with IPSA-1 and IPSA-2 varieties and found highest results in BARI Seem 3.

At early pod development stage, statistically significant variation was recorded for bean pod borer and aphid due to different management practices (Appendix III). In case of single effect of treatment, the lowest number of bean pod borer per plant (12.83) was found from T_1 (Voliam Flexi 300 SC) treatment and the highest number of bean pod borer (16.92) was found from T_0 (control) treatment. In consideration of aphid, the lowest number plant^{-1} (4.52) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the highest number (10.17) was observed from T_0 (control) treatment (Table 1).Dandale*et al.* (1984) reported the superiority of fenvalerate in reducing pod borer infestation in red gram.

Table 1. Effect of different management practices against the major insect pests plant^{-1} of different country bean varieties at early stage of pod development

Treatments	At early pod development stage	
	Larva of bean pod borer (No./plant)	Aphid (No./plant)
V_1	18.06 a	7.750 a
V_2	15.19 b	7.438 ab
V_3	13.00 c	7.188 b
LSD (0.05)	**2.032**	**0.4165**
T_0	16.92 a	10.17 a
T_1	12.83 b	4.528 d
T_2	15.92 a	9.083 b
T_3	16.00 a	6.056 c
LSD (0.05)	**2.347**	**0.4809**
CV(%)	**15.57**	**6.60**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

At early pod development stage statistically significant variation was recorded for bean pod borer and aphid due to interaction effect of different variety and management practices (Appendix III). In case of combined effect of variety and treatment, the lowest number of bean pod borer per plant (5.00) was found

Table 2.Combinedeffect of different varieties and management practices on number of major insect pests plant^{-1} of country bean at early stage of pod development

Treatments	Number of insect pests plant^{-1} at early pod development stage	
	Larva of bean pod borer	Aphid
V_1T_0	27.50 a	15.25 a
V_1T_1	19.00 cd	8.250 c
V_1T_2	14.00 ef	8.750 c
V_1T_3	14.75 ef	4.000 f
V_2T_0	9.250 gh	5.000 e
V_2T_1	14.50 ef	2.000 g
V_2T_2	24.50 ab	12.00 b
V_2T_3	22.00 bc	5.917 d
V_3T_0	17.00 de	12.00 b
V_3T_1	5.000 i	3.250 f
V_3T_2	6.250 hi	6.500 d
V_3T_3	11.25 fg	6.583 d
LSD (0.05)	**4.064**	**0.8330**
CV(%)	**15.57**	**6.60**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment and the highest number of bean pod borer (27.50) was found from T_0 (control) treatment. In consideration of aphid, the lowest number plant^{-1} (4.52) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the highest number (15.25) was observed from V_1T_0 (IPSA-1 + no pesticide) treatment (Table 2).

Table 3. Effect of individual management practices on number of major insect pests plant^{-1} of different country bean varieties at mid stage of pod development

Treatments	Number of insect pests plant^{-1} atmid pod development stage	
	Larva of bean pod borer	Aphid
V_1	22.56 a	8.395 a
V_2	18.25 b	7.875 ab
V_3	14.19 c	7.520 b
LSD (0.05)	**2.397**	**0.5212**
T_0	19.92 a	9.777 a
T_1	15.47 b	5.806 d
T_2	19.08 a	7.194 c
T_3	18.86 a	8.943 b
LSD (0.05)	**2.768**	**0.6019**
CV(%)	**15.44**	**7.74**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

4.1.2 Midstage of pod development

At mid pod development stage statistically significant variation was recorded for bean pod borer and aphid due to different variety (Appendix IV). In case of single effect of variety, the lowest number of bean pod borer per plant (14.19) was found from V_3 (BARI Seem 7) variety and the highest number of bean pod borer (22.56) was found from V_1 (IPSA-1) variety. In consideration of aphid, the lowest number plant^{-1} (7.52) was observed from V_3 (BARI Seem 7) whereas the highest number (8.39) was observed from V_1 (IPSA-1) variety (Table 3).

Table 4.Combinedeffect of different varieties and management practices on number of major insect pests plant^{-1} of country bean at mid stage of pod development

Treatments	Number of insect pests plant^{-1} at mid stage of pod development	
	Larva of bean pod borer	Aphid
V_1T_0	34.00 a	14.33 a
V_1T_1	24.25 cd	6.750 de
V_1T_2	17.00 ef	9.250 c
V_1T_3	17.50 e	5.750 e
V_2T_0	12.33 fg	6.583 de
V_2T_1	31.50 ab	7.417 d
V_2T_2	16.17 ef	11.83 b
V_2T_3	26.75 bc	9.250 c
V_3T_0	19.50 de	11.75 b
V_3T_1	6.000 h	3.250 f
V_3T_2	6.250 h	5.290 e
V_3T_3	8.750 gh	5.750 e
LSD (0.05)	**4.794**	**1.042**
CV(%)	**15.44**	**7.74**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

At mid pod development stage statistically significant variation was recorded for bean pod borer and aphid due to different management practices (Appendix IV). In case of single effect of treatment, the lowest number of bean pod borer per plant (15.47) was found from T_1 (Voliam Flexi 300 SC) treatment and the highest number of bean pod borer (19.92) was found from T_0 (control) treatment. In consideration of aphid, the lowest number plant^{-1} (5.80) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the highest number (9.77) was observed from T_0 (control) treatment (Table 3). Rao and Rao (2006) reported that thrice spraying of insecticide fenvalerate 20 EC (0.02%) on pigeonpea variety ICPL-85063 was found to be effective in reducing pod borer infestation.

At mid pod development stage statistically significant variation was recorded for bean pod borer and aphid due to interaction effect of different variety and management practices (Appendix IV). In case of combined effect of variety and treatment, the lowest number of bean pod borer per plant (6.00) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment and the highest number of bean pod borer (34.00) was found from T_0 (control) treatment. In consideration of aphid, the lowest number plant^{-1} (3.25) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the highest number (14.33) was observed from V_1T_0 (IPSA-1 + no pesticide) treatment (Table 4).

4.1.3 Late stage of pod development

At late pod development stage statistically significant variation was recorded for bean pod borer and aphid due to different variety (Appendix V). In case of single effect of variety, the lowest number of bean pod borer per plant (15.56) was found from V_3 (BARI Seem 7) variety and the highest number of bean pod borer (27.38) was found from V_1 (IPSA-1) variety. In consideration of aphid, the lowest number plant^{-1} (8.75) was observed from V_3 (BARI Seem 7) whereas the highest number (10.19) was observed from V_1 (IPSA-1) variety (Table 5).

At late pod development stage statistically significant variation was recorded for bean pod borer and aphid due to different management practices (Appendix V). In case of single effect of treatment, the lowest number of bean pod borer per plant (19.81) was found from T_1 (Voliam Flexi 300 SC) treatment and the highest number of bean pod borer (23.86) was found from T_0 (control) treatment. Mollah (2009)evaluated of 9 most commonly used insecticides were carried-out for their effectiveness in controlling aphid and pod borer infestation in IPSA seem 2 and their detrimental effect on biological control agents of aphid and pod borer.

Table 5. Effect of individual management practices on number of major insect pests plant^{-1} of different country bean varieties at late stage of pod development

Treatments	Number of insect pests plant^{-1} at late pod development stage	
	Larva of bean pod borer	Aphid
V_1	27.38 a	10.19 a
V_2	22.56 b	9.063 ab
V_3	15.56 c	8.750 b
LSD (0.05)	**2.397**	**1.199**
T_0	23.86 a	12.08 a
T_1	19.81 b	7.222 b
T_2	22.08 ab	7.250 b
T_3	21.58 ab	10.78 a
LSD (0.05)	**2.768**	**1.384**
CV(%)	**12.97**	**15.17**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

In consideration of aphid, the lowest number plant^{-1} (7.22) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the highest number (12.08) was observed from T_0 (control) treatment (Table 5).

Table 6.Combinedeffect of different varieties and management practices on number of major insect pests plant^{-1} of country bean at late stage of pod development

Treatments	Number of insect pests plant^{-1} at late pod development stage	
	Larva of bean pod borer	Aphid
V_1T_0	38.50 a	17.25 a

V_1T_1	33.25 b	7.750 cd
V_1T_2	19.00 c	11.75 b
V_1T_3	20.25 c	7.250 de
V_2T_0	9.750 ef	9.917 bc
V_2T_1	14.08 de	15.25 a
V_2T_2	37.00 ab	6.120 def
V_2T_3	34.75 ab	9.750 bc
V_3T_0	20.50 c	11.83 b
V_3T_1	8.250 f	4.000 f
V_3T_2	8.750 f	5.250 ef
V_3T_3	17.92 cd	6.000 def
LSD (0.05)	**4.794**	**2.397**
CV(%)	**12.97**	**15.17**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

At late pod development stage statistically significant variation was recorded for bean pod borer and aphid due to interaction effect of different variety and management practices (Appendix V). In case of combined effect of variety and treatment, the lowest number of bean pod borer per plant (8.25) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the highest number of bean pod borer (38.50) was found from V_1T_0 (IPSA-1 + no pesticide) treatment combination. In consideration of aphid, the lowest

number plant^{-1} (4.00) was observed from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination whereas the highest number (17.25) was observed from V_1T_0 (IPSA-1 + no pesticide) treatment combination (Table 6).It was also observed the trend of pest’s infestations was at increasing fashion from early to late pod development stages in this study which is supported by the others researchers finding. The pod borer infestation increases on the late sown crop (Alghali, 1993) and Pod borer population tends to build up over the season (Ekesi*et al.*, 1996)

4.2 Pod bearing status

4.2.1 Pod bearing status at early stage of pod development in number

Significant variation were observed in number of healthy, infested pods and percent infestation at early pod development stage for different varieties, management practices in controlling insect pests and their interaction effect on country bean (Appendix VI). In case of single effect of variety, the highest number of healthy pod per plant (91.24) was found from V_3 (BARI Seem 7) variety and the lowest number of healthy pod per plant (76.00) was found from V_1 (IPSA-1) variety. In consideration of infested pod, the lowest number of infested pod plant^{-1} (9.36) was observed from V_3 (BARI Seem 7) whereas the highest number of infested pod plant^{-1} (11.63) was observed from V_1 (IPSA-1) variety. The lowest infestation percentage (9.31 %) was obtained from V_3 (BARI Seem 7) variety and the highest infestation percentage (13.27 %) was obtained from V_1 (IPSA-1) variety (Table 7).

Table 7. Effect of individualmanagement practices in controlling major insect pests of different country bean varieties at early stage of pod development in terms of pods plant^{-1} by number

Treatments	Bean pods by number plant^{-1}		
	Healthy	Infested	% Infestation
V_1	76.00 c	11.63 a	13.27
V_2	81.09 b	11.34 a	12.27
V_3	91.24 a	9.363 b	9.31
LSD (0.05)	**2.08**	**0.67**	**0.83**
T_0	79.43 c	11.98 a	13.11
T_1	85.12 a	9.572 c	10.11
T_2	82.46 b	10.85 b	11.49
T_3	81.09 b	10.70 b	11.80
LSD (0.05)	**2.40**	**0.78**	**0.96**
CV(%)	**2.97**	**7.43**	**8.27**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

In case of single effect of treatment, the highest number of healthy pod per plant (85.12) was found from T_1 (Voliam Flexi 300 SC) treatment and the lowest number of healthy pod per plant (79.43) was found from T_0 (control) treatment. In consideration of infested pod, the lowest number of infested pod plant^{-1} (9.57) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the highest number of infested pod plant^{-1} (11.98) was observed from T_0 (control) treatment. The lowest infestation percentage (10.11 %) was obtained from T_1 (Voliam Flexi 300 SC) treatment and the highest infestation percentage (13.11 %) was obtained from T_0 (control) treatment (Table 7).Pedigo (1999) reported that at early pod development stage pod borer and aphid infestation reduced the number of healthy pods in country bean field and similar trend of results found in this study. Patil*et al.* (1993) reported that fenvalerate (0.01%) treated plants showed the performed best in reducing the infestation of pods of country bean by bean pod borer than quinalphos (0.12%) and endosulfan (0.07%).

Table 8.Combinedeffect of different varieties and management practices in controlling major insect pests of country bean at early stage of pod development in terms of pods plant^{-1} by number

Treatments	Bean pods by number plant^{-1}		
	Healthy	Infested	% Infestation
V_1T_0	62.00 g	18.80 a	23.27
V_1T_1	72.00 f	13.00 c	15.29
V_1T_2	89.00 cd	8.000 e	8.25
V_1T_3	81.00 e	9.000 de	10.00
V_2T_0	74.30 f	9.133 de	10.95
V_2T_1	94.75 ab	10.22 d	9.74
V_2T_2	64.30 g	16.50 b	20.42

V_2T_3	91.00 bc	15.30 b	14.39
V_3T_0	91.30 bc	10.30 d	10.14
V_3T_1	97.05 a	5.500 f	5.36
V_3T_2	89.97 cd	5.750 f	6.01
V_3T_3	86.63 d	7.800 e	8.26
LSD (0.05)	**4.16**	**1.35**	**1.67**
CV(%)	**2.97**	**7.43**	**8.27**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

In case of combined effect of variety and treatment, the highest number of healthy pod per plant (97.05) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the lowest number of healthy pod per plant (62.00) was found from V_1T_0 (IPSA-1 + no pesticede) treatment combination. In consideration of infested pod, the lowest number of infested pod plant^{-1} (5.50) was observed from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination whereas the highest number of infested pod plant^{-1} (18.80) was observed from V_1T_0 (IPSA-1 + no pesticede) treatment combination. The lowest infestation percentage (5.36 %) was obtained from V_3T_1 (BARI Seem-7 + Voliam Flexi 300 SC) treatment combination and the highest infestation percentage (23.27 %) was obtained from V_1T_0 (IPSA-1 + no pesticede) treatment combination (Table 8).

4.2.2 Pod bearing status at early stage of pod development in weight

Significant variation were observed in weight of healthy, infested pods and percent infestation at early pod development stage in weight for different varieties, management practices in controlling insect pests and their interaction effectson country bean (Appendix VII). In case of single effect of variety, the maximum weight of healthy pod per plant (755.7 g) was found from V_3 (BARI Seem 7) variety and the minimum weight of healthy pod per plant (631.9 g) was found from V_1

(IPSA-1) variety. In consideration of infested pod, the minimum weight of infested pod plant^{-1} (59.27 g) was observed from V_3 (BARI Seem 7) whereas the maximum weight of infested pod plant^{-1} (90.17 g) was observed from V_1 (IPSA-1) variety. The minimum infestation percentage (7.27 %) was obtained from V_3 (BARI Seem 7) variety and the maximum infestation percentage (12.49 %) was obtained from V_1 (IPSA-1) variety (Table 9).

In case of single effect of treatment, the maximum weight of healthy pod per plant (694.3 g) was found from T_1 (Voliam Flexi 300 SC) treatment and the minimum weight of healthy pod per plant (676.3 g) was found from T_0 (control) treatment. In consideration of infested pod, the minimum weight of infested pod plant^{-1} (74.05 g) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the maximum weight of infested pod plant^{-1} (79.78 g) was observed from T_0 (control) treatment. The minimum infestation percentage (9.64 %) was obtained from T_1 (Voliam Flexi 300 SC) treatment and the maximum infestation percentage (10.55 %) was obtained from T_0 (control) treatment (Table 9).Hongo and Karel (1986) reported that neem seed powder and neem kernel extract were also effective against legume pod borer (Singh *et al*., 1985; Hongo and Karel, 1986) but neem seed kernel extract (NSKE) was less effective than fenvalerate and monocrotophos.

Table 9. Effect of individual management practices in controlling major insect pests of different country bean varietiesat early stage of pod development in terms of pods plant^{-1} by weight

Treatments	Weight of pods (g/plant)		
	Healthy	Infested	% Infestation
V_1	631.9 c	90.17 a	12.49
V_2	669.6 b	82.47 b	10.97
V_3	755.7 a	59.27 c	7.27
LSD (0.05)	**7.549**	**1.803**	**0.2540**
T_0	676.3 b	79.78 a	10.55
T_1	694.3 a	74.05 b	9.64
T_2	681.1 b	79.60 a	10.46

T_3	691.1 a	75.78 b	9.88
LSD (0.05)	**8.717**	**2.082**	**0.2933**
CV(%)	**1.30**	**2.75**	**2.81**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

In case of combined effect of variety and treatment, the maximum weight of healthy pod per plant (808.0 g) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the minimum weight of healthy pod per plant (498.9 g) was found from V_1T_0 (IPSA-1 + no pesticede) treatment combination. In consideration of infested pod, the minimum weight of infested

Table 10.Combinedeffect of different varieties and management practices in controlling major insect pests of country bean at earlystage of pod development in terms of pods plant^{-1} by weight

Treatments	Weight of pods (g/plant)		
	Healthy	Infested	% Infestation
V_1T_0	498.9 h	123.3 a	19.82
V_1T_1	595.0 g	105.8 b	15.10
V_1T_2	756.0 e	61.31 d	7.50
V_1T_3	677.7 f	70.30 c	9.40
V_2T_0	771.8 cd	52.40 e	6.36
V_2T_1	680.0 f	63.64 d	8.56
V_2T_2	501.3 h	125.6 a	19.04
V_2T_3	597.3 g	108.1 b	15.32
V_3T_0	758.3 de	72.63 c	8.74
V_3T_1	808.0 a	43.75 f	5.14
V_3T_2	786.2 bc	51.85 e	6.19
V_3T_3	798.2 ab	48.96 e	5.78
LSD (0.05)	**15.10**	**3.60**	**0.50**

CV(%)	1.30	2.75	2.81

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

pod plant^{-1} (43.75 g) was observed from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination whereas the maximum weight of infested podplant^{-1} (123.3 g) was observed from V_1T_0 (IPSA-1 + no pesticede) treatment combination. The minimum infestation percentage (5.14 %) was obtained from V_3T_1 (BARI Seem-7 + Voliam Flexi 300 SC) treatment combination and themaximum infestation percentage (19.82 %) was obtained from V_1T_0 (IPSA-1 + control) treatment combination (Table 10).

4.2.3 Pod bearing status at mid pod stage ofdevelopment in number

Significant variation were observed in number of healthy, infested pods and percent infestation at mid pod development stage in number for different varieties, management practices in controlling insect pests and their interaction effects on country bean (Appendix VIII). In case of single effect of variety, the highest number of healthy pod per plant (139.7) was found from V_3 (BARI Seem 7) variety and the lowest number of healthy pod per plant (114.3) was found from V_1 (IPSA-1) variety. In consideration of infested pod, the lowest number of infested pod plant^{-1} (18.67) was observed from V_3 (BARI Seem 7) whereas the highest number of infested pod plant^{-1} (19.50) was observed from V_1 (IPSA-1) variety. The lowest infestation percentage (11.79 %) was obtained from V_3 (BARI Seem 7) variety and the highest infestation percentage (17.36 %) was obtained from V_1 (IPSA-1) variety (Table 11).

In case of single effect of treatment, the highest number of healthy pod per plant (127.20) was found from T_1 (Voliam Flexi 300 SC) treatment and the lowest number of healthy pod per plant (121.60) was found from T_0 (control) treatment. In consideration of infested pod, the lowest number of infested pod plant^{-1} (18.82) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the highest number of infested pod plant^{-1} (20.33) was observed from T_0 (control) treatment. The lowest infestation percentage (14.79 %) was obtained from T_1 (Voliam Flexi 300 SC) treatment and the highest infestation percentage (16.71 %) was obtained from T_0 (control) treatment (Table 11).Pawar*et al*. (1999) reported that fenvalerate 100 ml/ha when applied at 50 percent flowering stage, at fortnightly intervals in reducing the pod damage and increasing grain yield of chickpea.

In case of combined effect of variety and treatment, the highest number of healthy pod per plant (144.90) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the lowest number of healthy pod per plant (92.20) was found from V_1T_0 (IPSA-1 + no pesticede) treatment combination. In consideration of infested pod, the lowest number of infested pod plant^{-1} (18.20) was observed from

Table 11.Effect ofindividual management practices in controlling major insect pests of different country bean varietiesat mid stage ofpod development in terms of pods plant^{-1} by number

Treatments	Bean pods by number plant^{-1}		
	Healthy	Infested	% Infestation
V_1	114.3 c	19.85 a	17.36
V_2	119.8 b	19.50 ab	16.27
V_3	139.7 a	18.67 b	11.79
LSD (0.05)	**2.216**	**0.9702**	**0.4782**
T_0	121.6 b	20.33 a	16.71
T_1	127.2 a	18.82 b	14.79
T_2	126.7 a	19.07 b	15.05
T_3	121.9 b	19.13 b	15.69
LSD (0.05)	**2.558**	**1.120**	**0.5522**
CV(%)	**2.10**	**5.92**	**4.05**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

Table 12.Combinedeffect of different varieties and management practices in controlling major insect pests of country bean at mid stage ofpod development in terms of pods plant^{-1} by number

Treatments	Bean pods by number plant^{-1}		
	Healthy	Infested	% Infestation
V_1T_0	89.00 f	27.20 a	30.56
V_1T_1	103.0 e	22.00 d	17.60
V_1T_2	136.0 c	15.00 g	9.93
V_1T_3	129.0 d	17.00 ef	11.64
V_2T_0	137.0 c	15.00 g	9.87
V_2T_1	136.25 c	17.20 e	12.62
V_2T_2	92.20 f	24.00 bc	26.03
V_2T_3	106.2 e	25.20 b	19.18
V_3T_0	141.9 ab	22.47 cd	13.67
V_3T_1	144.9 a	12.00 h	8.28
V_3T_2	137.5 bc	18.80 e	12.03
V_3T_3	134.5 c	15.20 fg	10.15
LSD (0.05)	**4.43**	**1.94**	**0.95**
CV(%)	**2.10**	**5.92**	**4.05**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination whereas the highest number of infested pod plant^{-1} (27.20) was observed from V_1T_0 (IPSA-1 + no pesticede) treatment combination. The lowest infestation percentage (8.28 %) was obtained from V_3T_1 (BARI Seem-7 + Voliam Flexi 300 SC) treatment combination and the highest infestation percentage (30.56 %) was obtained from V_1T_0 (IPSA-1 + no pesticede) treatment combination (Table 12).

4.2.4 Pod bearing status at mid stage ofpod development in weight

Significant variation were observed in weight of healthy, infested pods and percent infestation at mid pod development stage in weight for different varieties, management practices in controlling insect pests and their interaction effects on country bean (Appendix IX). In case of single effect of variety, the maximum weight of healthy pod per plant (1170.12 g) was found from V_3 (BARI Seem 7) variety and the minimum weight of healthy pod per plant (970.46 g) was found from V_1 (IPSA-1) variety. In consideration of infested pod, the minimum weight of infested pod plant^{-1} (131.6 g) was observed from

Table 13. Effect of individual management practices in controlling major insect pests of different country bean varietiesat mid stage ofpod development in terms of pods plant^{-1} by weight

Treatments	Weight of pods (g/plant)		
	Healthy	Infested	% Infestation
V_1	970.46 c	167.6 a	14.73
V_2	1004.05 b	156.8 b	13.51
V_3	1170.12 a	131.6 c	10.11
LSD (0.05)	**24.84**	**9.32**	**0.83**
T_0	1027. 12 c	155.3 a	13.13
T_1	1081. 02 a	142.3 b	11.63
T_2	1028. 13 bc	156.7 a	13.03
T_3	1056.32 ab	153.7 a	12.70
LSD (0.05)	**28.68**	**10.77**	**0.96**
CV(%)	**2.80**	**7.24**	**7.80**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

V_3 (BARI Seem 7) whereas the maximum weight of infested pod plant^{-1} (167.6 g) was observed from V_1 (IPSA-1) variety. The minimum infestation percentage (10.11

%) was obtained from V_3 (BARI Seem 7) variety and the maximum infestation percentage (14.73 %) was obtained from V_1 (IPSA-1) variety (Table 13).

In case of single effect of treatment, the maximum weight of healthy pod per plant (1081.02 g) was found from T_1 (Voliam Flexi 300 SC) treatment and the minimum weight of healthy pod per plant (1027.12 g) was found from T_0 (control) treatment. In consideration of infested pod, the minimum weight of infested pod plant^{-1} (142.3 g) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the maximum weight of infested pod plant^{-1} (155.3 g) was observed from T_0 (control) treatment. The minimum infestation percentage (11.63 %) was obtained from T_1 (Voliam Flexi 300 SC) treatment and the maximum infestation percentage (13.13 %) was obtained from T_0 (control) treatment (Table 13).Singh and Singh (2001) reported that lowest pod damage caused by the pod borer (2.40%) was obtained upon treatments with fenvalerate (0.02%) and the highest (22.80%) was recorded from the untreated plot.

In case of combined effect of variety and treatment, the maximum weight of healthy pod per plant (1225.0 g) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the minimum weight of healthy pod per plant (746.2 g) was found from V_1T_0 (IPSA-1 + no pesticede) treatment combination. In consideration of infested pod, the minimum weight of infested pod plant^{-1} (207.40 g) was observed from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination whereas the maximum weight of infested pod plant^{-1} (102.9 g) was observed from V_1T_0 (IPSA-1 + no pesticede) treatment combination. The minimum infestation percentage (9.60 %) was obtained from V_2T_1 (IPSA-2 + Voliam Flexi 300 SC) treatment combination and the maximum infestation percentage (15.44 %) was obtained from V_2T_0 (IPSA-2 + no pesticede) treatment combination (Table 14).

4.2.5 Pod bearing status at late stage of pod development in number

Significant variation were observed in number of healthy, infested pods and percent infestation at late pod development stage for different varieties, management practices in controlling insect pests and their interaction effects on country bean

(Appendix X). In case of single effect of variety, the highestnumber of healthy pod per plant (75.20) was found from V_3 (BARI Seem 7)

Table 14.Combinedeffect of different varieties and management practices in controlling major insect pests of country bean at mid stage of pod development in terms of pods plant^{-1} by weight

Treatments	Weight of pods (g/plant)		
	Healthy	Infested	% Infestation
V_1T_0	746.2 e	102.9 e	12.12
V_1T_1	867.4 d	187.0 b	17.74
V_1T_2	1162.0 b	132.7 cd	10.25
V_1T_3	1106.0 c	147.6 c	11.77
V_2T_0	1168.0 b	125.9 d	15.44
V_2T_1	1150. 0 bc	122.1 d	9.60
V_2T_2	750.5 e	137.0 cd	9.73
V_2T_3	871.7 d	191.3 ab	18.00
V_3T_0	1167.0 b	137.0 cd	10.51
V_3T_1	1225.0 a	207.4 a	14.48
V_3T_2	1172. 0 b	130.2 cd	10.00
V_3T_3	1190. 0 ab	203.1 ab	14.58
LSD (0.05)	**49.68**	**18.65**	**1.67**
CV(%)	**2.80**	**7.24**	**7.80**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

variety and the lowest number of healthy pod per plant (62.75) was found from V_1 (IPSA-1) variety. In consideration of infested pod, the lowest number of infested pod plant^{-1} (12.00) was observed from V_3 (BARI Seem 7) whereas the highest number of infested pod plant^{-1} (12.98) was observed from V_1 (IPSA-1) variety. The lowest infestation percentage (13.76 %) was obtained from V_3 (BARI Seem 7) variety and the highest infestation percentage (17.14 %) was obtained from V_1 (IPSA-1) variety (Table 15).

In case of single effect of treatment, the highest number of healthy pod per plant (70.51) was found from T_1 (Voliam Flexi 300 SC) treatment and the lowest number of healthy pod per plant (66.07) was found from T_0 (control) treatment. In consideration of infested pod, the lowest number of infested pod plant^{-1} (10.96) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the highest number of infested pod plant^{-1} (13.72) was observed from T_0 (control) treatment. The lowest infestation percentage (13.45 %) was obtained from T_1 (Voliam Flexi 300 SC) treatment and the highest infestation percentage (17.20 %) was obtained from T_0 (control) treatment (Table 15).Sharma (1998) observed the similar result where at late pod development stage plants are highly likely to experience elevated levels of pod borer attacks compared with the early and mid pod development stage as found in the present study.

In case of combined effect of variety and treatment, the highest number of healthy pod per plant (77.87) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the lowest number of healthy pod per plant (54.00) was found from V_1T_0 (IPSA-1 + no pesticede) treatment combination. In consideration of infested pod, the lowest number of infested pod plant^{-1} (6.75) was observed from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination whereas the highest number of infested pod plant^{-1} (17.20) was observed from V_1T_0 (IPSA-1 + no pesticede) treatment combination. The lowest infestation percentage (7.97 %) was obtained from V_3T_1 (BARI Seem-7 + Voliam Flexi 300 SC) treatment combination and the highest infestation percentage (24.15 %) was obtained from V_1T_0 (IPSA-1 + no pesticede) treatment combination (Table 16).

Table 15. Effect of individual managementpractices in controlling major insect pests of different country bean varietiesat late stage of pod development in terms of pods plant^{-1} by number

	Bean pods by number plant^{-1}

Treatments	Healthy	Infested	% Infestation
V_1	62.75 c	12.98 a	17.14
V_2	67.35 b	12.57 ab	15.73
V_3	75.20 a	12.00 b	13.76
LSD (0.05)	**2.08**	**0.67**	**0.98**
T_0	66.07 c	13.72 a	17.20
T_1	70.51 a	10.96 c	13.45
T_2	67.47 bc	12.32 b	15.44
T_3	69.69 ab	13.08 ab	15.80
LSD (0.05)	**2.40**	**0.78**	**1.14**
CV(%)	**3.60**	**6.39**	**7.49**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

4.2.6 Pod bearing status at late stage of pod development in weight

Significant variation were observed in weight of healthy, infested pods and percent infestation at late pod development stage in weight for different varieties, management practices in controlling insect pests and their interaction effects on country bean (Appendix XI). In case of single effect of variety, the maximum weight of healthy pod per plant (529.0 g) was found from V_3 (BARI Seem 7) variety and the minimum weight of healthy pod per plant (458.1 g) was found from V_1 (IPSA-1) variety.

Table 16.Combinedeffect of different varieties and management practices in controlling major insect pests of country bean at late stage of pod development in terms of pods plant^{-1} by number

Treatments	Bean pods by number plant^{-1}		
	Healthy	Infested	% Infestation
V_1T_0	54.00 e	17.20 a	24.15

V_1T_1	74.20 a	13.00 c	14.91
V_1T_2	70.00 b	9.000 d	11.39
V_1T_3	67.00 bc	10.00 d	12.99
V_2T_0	70.00 b	12.750 c	9.97
V_2T_1	77.00 a	10.95 d	13.43
V_2T_2	58.20 d	14.20 c	23.39
V_2T_3	64.20 c	16.00 a	21.56
V_3T_0	60.00 d	13.20 c	18.03
V_3T_1	77.87 a	6.750 e	7.97
V_3T_2	74.20 a	13.12 c	15.03
V_3T_3	74.53 a	12.03 c	13.90
LSD (0.05)	**4.16**	**1.35**	**1.98**
CV(%)	**3.60**	**6.39**	**7.49**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

In consideration of infested pod, the minimum weight of infested pod plant^{-1} (69.97 g) was observed from V_3 (BARI Seem 7) whereas the maximum weight of infested pod plant^{-1} (88.27 g) was observed from V_1 (IPSA-1) variety. The minimum infestation percentage (11.68 %) was obtained from V_3 (BARI Seem 7) variety and the maximum infestation percentage (16.16 %) was obtained from V_1 (IPSA-1) variety (Table 17).

Table 17. Effect of individual management practices in controlling major insect pests of different country bean varietiesat late stage of pod development in terms of pods plant^{-1}by weight

Treatments	Weight of pods (g/plant)		
	Healthy	Infested	% Infestation
V_1	458.1 c	88.27 a	16.16
V_2	481.9 b	85.18 a	15.02

V_3	529.0 a	69.97 b	11.68
LSD (0.05)	**16.16**	**4.10**	**1.00**
T_0	474.9 c	86.42 a	15.39
T_1	510.6 a	73.21 c	12.54
T_2	477.3 bc	84.89 a	15.09
T_3	495.8 ab	80.05 b	13.90
LSD (0.05)	**18.66**	**4.73**	**1.16**
CV(%)	**3.90**	**5.97**	**7.37**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

In case of single effect of treatment, the maximum weight of healthy pod per plant (510.6 g) was found from T_1 (Voliam Flexi 300 SC) treatment and the minimum weight of healthy pod per plant (474.9 g) was found from T_0 (control) treatment. In consideration of infested pod, the minimum weight of infested pod plant^{-1} (73.21 g) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the maximum weight of infested pod plant^{-1} (86.42 g) was observed from T_0 (control) treatment. The minimum infestation percentage (12.54 %) was obtained from T_1 (Voliam Flexi 300 SC) treatment and the maximum infestation percentage (15.39 %) was obtained from T_0 (control) treatment (Table 17).It was found that using fenvalerate (0.01%) was the most effective in reducing the infestation of country bean pest and increasing the pod yield Dandale et al. (1981)

Table 18.Combinedeffect of different varieties and management practices in controlling major insect pests of country bean at late stage of pod development in terms of pods plant^{-1} by weight

Treatments	Weight of pods (g/plant)		
	Healthy	Infested	% Infestation
V_1T_0	389.9 f	118.8 a	23.35
V_1T_1	439.2 e	95.56 b	17.87

V_1T_2	512.1 cd	67.28 cde	11.61
V_1T_3	491.0 d	71.45 cd	12.70
V_2T_0	515.5 cd	59.79 ef	10.39
V_2T_1	524.1 bc	72.29 cd	12.12
V_2T_2	397.0 f	126.2 a	24.12
V_2T_3	446.4 e	103.0 b	18.75
V_3T_0	519.3 bcd	74.68 c	12.57
V_3T_1	568.5 a	51.77 f	8.35
V_3T_2	522.8 bcd	67.19 cde	11.39
V_3T_3	549.9 ab	65.73 de	10.68
LSD (0.05)	**32.32**	**8.204**	**2.018**
CV(%)			

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

In case of combined effect of variety and treatment, the maximum weight of healthy pod per plant (568.5 g) was found from V_3T_1 (BARI Seem 7 + VoliamFlexi 300 SC) treatment combination and the minimum weight of healthy pod per plant (397.0 g) was found from V_2T_2 (IPSA-2 + Sumi Alfa 5 EC) treatment combination. In consideration of infested pod, the minimum weight of infested pod plant^{-1} (51.77 g) was observed from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination whereas the maximum weight of infested pod plant^{-1} (126.20 g) was observed from V_1T_0 (IPSA-1 + no pesticede) treatment combination. The minimum infestation percentage (8.35 %) was obtained from V_3T_1 (IPSA-2 + Voliam Flexi 300 SC) treatment combination and the maximum infestation percentage (24.12 %) was obtained from V_2T_2 (IPSA-2 + Sumi Alfa 5 EC) treatment combination (Table 18).

4.2.7 Pod bearing status at total growing stage in number

Significant variation were observed in total number of healthy, total infested pods and percent infestation at total growing stage for different varieties, management practices in controlling insect pests and their interaction effects on country bean (Appendix XII). In case of single effect of variety, the highest total number of healthy pod per plant (306.1) was found from V_3 (BARI Seem 7) variety and the lowest total number of healthy pod per plant (253.0) was found from V_1 (IPSA-1) variety. In consideration of infested pod, the lowest total number of infested pod plant^{-1} (40.60) was observed from V_3 (BARI Seem 7) whereas the highest total number of infested pod plant^{-1} (44.16) was observed from V_1 (IPSA-1) variety. The lowest infestation percentage (11.71 %) was obtained from V_3 (BARI Seem 7) variety and the highest infestation percentage (14.86 %) was obtained from V_1 (IPSA-1) variety (Table 19).

In case of single effect of treatment, the highest total number of healthy pod per plant (282.1) was found from T_1 (Voliam Flexi 300 SC) treatment and the lowest total number of healthy pod per plant (270.1) was found from T_0 (control) treatment. In consideration of infested pod, the lowest total number of infested pod plant^{-1} (39.35) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the highest total number of infested pod plant^{-1} (46.03) was observed from T_0 (control) treatment. The lowest infestation percentage (12.24 %) was obtained from T_1 (Voliam Flexi 300 SC) treatment and the highest infestation percentage (14.56 %) was obtained from T_0 (control) treatment (Table 19).Rouf and Islam (2012) and Hossain (2014) who reported that the best efficacy of Voliam flexi in controlling pod borers of mungbean.

Table 19. Effect of individual management practices in controlling major insect pests of different country bean varietiesat total pod growing period in terms of pods plant^{-1} by number

Treatments	Bean pods by number plant^{-1}		
	Healthy	Infested	% Infestation
V_1	253.01 c	44.11 a	14.86
V_2	268.24 b	43.76 b	13.85

V_3	306.14 a	40.03 c	11.71
LSD (0.05)	**5.526**	**0.8072**	**1.402**
T_0	268.10 b	46.03 a	14.56
T_1	280.17 a	40.73 c	12.24
T_2	275.26 a	41.99 b	13.50
T_3	276.71 a	41.78 b	13.27
LSD (0.05)	**6.381**	**0.9321**	**1.619**
CV(%)	**2.37**	**2.24**	**3.99**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

In case of combined effect of variety and treatment, the highest total number of healthy pod per plant (319.82) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the lowest total number of healthy pod per plant (208.82) was found from V_1T_0 (IPSA-1 + no pesticede) treatment combination. In consideration of infested pod, the lowest total number of infested pod plant^{-1} (33.65) was observed from V_3T_1 (BARI Seem 7 + VoliamFlexi 300 SC) treatment combination whereas the highest total number of infested pod plant^{-1} (58.80) was observed from V_1T_0 (IPSA-1 + no pesticede) treatment combination. The lowest infestation percentage (9.52 %) was obtained from V_3T_1 (BARI Seem-7 + Voliam Flexi 300 SC) treatment combination and the highest infestation percentage (22.02 %) was obtained from V_1T_0 (IPSA-1 + no pesticede) treatment combination (Table 20).

Table 20.Combinedeffect of different varieties and management practices in controlling major insect pests of country bean at total pod growing period in terms of pods plant^{-1} by number

Treatments	Bean pods by number plant^{-1}		
	Healthy	Infested	% Infestation
V_1T_0	208.20 g	58.80 a	22.02

V_1T_1	249.20 f	48.00 c	16.15
V_1T_2	295.00 d	32.00 d	9.79
V_1T_3	277.00 e	36.00 g	11.50
V_2T_0	281.30 cd	36.88 g	11.59
V_2T_1	308.00 ab	28.97 h	9.60
V_2T_2	211.50 g	57.90 b	21.49
V_2T_3	261.40 f	57.70 b	18.08
V_3T_0	293.20 bc	45.97 e	13.55
V_3T_1	319.82 a	33.65 i	9.52
V_3T_2	301.67 cd	37.67 f	11.10
V_3T_3	295.66 d	35.03 g	10.59
LSD (0.05)	**11.05**	**1.614**	**2.805**
CV(%)	**2.37**	**2.24**	**3.99**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

4.2.8 Pod bearing status at total growing stage in weight

Significant variation were observed in total weight of healthy, infested pods and percent infestation at late pod development stage in weight for different varieties, management practices in controlling insect pests and their interaction effects on country bean (Appendix XIII). In case of single effect of variety, the maximum total weight of healthy pod per plant (2454.43 g) was found from V_3 (BARI Seem 7) variety and the minimum total weight of healthy pod per plant (2060.01 g) was found from V_1 (IPSA-1) variety. In consideration of infested pod, the minimum total weight of infested pod plant^{-1} (260.8 g) was observed from V_3 (BARI Seem 7) whereas the maximum total weight of infested pod plant^{-1} (346.0 g) was observed from V_1 (IPSA-1) variety. The minimum infestation percentage (9.61 %) was obtained from V_3 (BARI Seem 7) variety and the maximum infestation percentage (14.38 %) was obtained from V_1 (IPSA-1) variety (Table 21).

In case of single effect of treatment, the maximum total weight of healthy pod per plant (2286.03 g) was found from T_1 (Voliam Flexi 300 SC) treatment and the minimum total weight of healthy pod per plant (2178.02 g) was found from T_0 (control) treatment. In consideration of infested pod, the minimum total weight of infested pod plant^{-1} (289.5 g) was observed from T_1 (Voliam Flexi 300 SC) treatment whereas the maximum total weight of infested pod plant^{-1} (319 g) was observed from T_0 (control) treatment. The minimum infestation percentage (11.24 %) was obtained from T_1 (Voliam Flexi 300 SC) treatment and the maximum infestation percentage (12.79 %) was obtained from T_0 (control) treatment (Table 21).Venkaria and Vyas (1985) reported that the least number of pods were damaged in plots treated with fenvalerate (0.01%), endosulfan (0.07%) + miraculan) were as effective for the control of legume pod borer on pigeonpea.

Table 21. Effect of different single management practices in controlling major insect pests of different country bean varietiesat total pod growing period in terms of pods plant^{-1} by weight

Treatments	Weight of pods (g/plant)		
	Healthy	Infested	% Infestation
V_1	2060.46 c	346.04 a	14.38
V_2	2155.55 b	324.45 b	13.08
V_3	2454.82 a	260.84 c	9.61
LSD (0.05)	**45.25**	**14.41**	**1.883**
T_0	2178. 32 b	319.50 a	12.79
T_1	2285. 92 a	289.56 b	11.24
T_2	2186.53 b	323.19 a	12.68
T_3	2243.22 a	309.53 a	12.13
LSD (0.05)	**52.25**	**16.64**	**2.174**

CV(%)	2.40	5.48	5.79

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

In case of combined effect of variety and treatment, the maximum total weight of healthy pod per plant (2602.21 g) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the minimum total weight of healthy pod per plant (1635.01 g) was found from V_2T_2 (IPSA-2 + Sumi Alfa 5 EC) treatment combination. In consideration of infested pod, the minimum total weight of infested pod plant^{-1} (198.4 g) was observed from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination whereas the maximum total weight of infested pod plant^{-1} (445.2 g) was observed from V_1T_0 (IPSA-1 + no pesticede) treatment combination. The minimum infestation percentage (10.42 %) was obtained from V_3T_1 (IPSA-2 + Voliam Flexi 300 SC) treatment combination and the maximum infestation percentage (19.75 %) was obtained from V_2T_2 (IPSA-2 + Sumi Alfa 5 EC) treatment combination (Table 22).

Table 22.Combinedeffect of different varieties and management practices in controlling major insect pests of country bean at total pod growing period in terms of pods plant^{-1} by weight

Treatments	Weight of pods (g/plant)		
	Healthy	Infested	% Infestation
V_1T_0	1635. 00 g	402.40 a	19.75
V_1T_1	1901.60 f	388.36 a	16.96
V_1T_2	2430.10 cd	261.29 cd	11.71
V_1T_3	2274.15 e	289.35 c	11.28
V_2T_0	2455.30 bc	238.09 e	10.84
V_2T_1	2354.10 de	258.03 cd	10.88
V_2T_2	1648.80 g	388.80 a	19.08
V_2T_3	1915.40 f	345.00 b	15.26

V_3T_0	2444.60 cd	284.31 c	10.59
V_3T_1	2602.50 a	302.92 c	10.42
V_3T_2	2481.00 bc	249.24 cd	12.13
V_3T_3	2538.10 ab	317.79 b	11.13
LSD (0.05)	**90.49**	**28.82**	**3.765**
CV(%)	**2.40**	**5.48**	**5.79**

V_1 : IPSA-1 | T_0 : Control
V_2 : IPSA-2 | T_1 :Voliam Flexi 300 SC
V_3 : BARI Seem 7 | T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

4.3 Yield contributing characters and yield of country bean

4.3.1 Number of inflorescence plant^{-1}

Number of inflorescence plant^{-1}of country bean showed statistically significant variation for different varieties in controlling insect pest of country bean (Appendix XIV). In case of single effect of variety, the maximum number of inflorescence per plant (38.44) was found from V_3 (BARI Seem 7) variety and the minimum number of inflorescence per plant (34.06) was found from V_1 (IPSA-1) variety (Table 23).

Number of inflorescence plant^{-1}of country bean did not show statistically significant variation for different management practices in controlling insect pest of country bean (Appendix XIV). In case of single effect of treatment, the maximum number of inflorescence per plant (36.42) was found from T_1 (Voliam Flexi 300 SC) treatment and the minimum number of inflorescence per plant (35.74) was found from T_0 (control) treatment (Table 23).

Number of inflorescence plant^{-1}of country bean showed statistically significant variation for different combined management practices in controlling insect pest of country bean (Appendix XIV). In case of combined effect of variety and treatment, the maximum number of inflorescence per plant (38.97) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the minimum number of inflorescence per plant (31.50) was found from V_1T_0 (IPSA-1 + Voliam Flexi 300 SC) treatment combination. (Table 24).

4.3.2 Number of flower inflorescence^{-1}

Number of flower inflorescence^{-1} of country bean showed statistically significant variation for different varieties in controlling insect pest of country bean (Appendix XIV). In case of single effect of variety, the maximum number of flower per inflorescence (15.59) was found from V_3 (BARI Seem 7) variety and the minimum number of flower per inflorescence (12.76) was found from V_1 (IPSA-1) variety (Table 23).

Number of flower inflorescence^{-1} of country bean did not show statistically significant variation for different management practices in controlling insect pest of country bean (Appendix XIV).Pedigo (1999) reported that larger inflorescence and more flower buds increase appetency and food security, meaning more attraction of insects with increased inflorescence length and flower bud numbers.

Number of flower inflorescence^{-1} of country bean showed statistically significant variation for different combined management practices in controlling insect pest of country bean (Appendix XIV). In case of combined effect of variety and treatment, the maximum number of flower per inflorescence (16.02) was found from V_3T_3 (BARI Seem 7 + Neem seed karnel) treatment combination and the minimum number of flower per inflorescence (11.75) was found from V_1T_0 (IPSA-1 + Voliam Flexi 300 SC) treatment combination. (Table 24).

Table 23. Effect of individual management practices in controlling major insect pests of different country bean varietiesfor yield contributing characters and yield during April to October, 2014

Treatments	Number of inflorescence plant^{-1}	Number of flower inflorescence^{-1}	Number of pod inflorescence^{-1}	Pod Length
V_1	34.06 c	12.76 c	8.292 c	10.12 c
V_2	35.78 b	14.32 b	9.573 b	10.96 b
V_3	38.44 a	15.59 a	10.39 a	11.59 a
LSD (0.05)	**0.6564**	**0.6302**	**0.6453**	**0.026**
T_0	35.74	13.87	9.177	10.62 d

T_1	36.42	14.48	9.740	11.16 a
T_2	36.04	14.08	9.599	10.95 b
T_3	36.16	14.45	9.162	10.83 c
LSD (0.05)	**0.7579**	**0.7277**	**0.7452**	**0.030**
CV(%)	**2.15**	**5.23**	**8.09**	**4.56**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

Table 24.Combinedeffect of different varieties and management practices in controlling major insect pests of country bean for yield contributing characters and yield during April to October, 2014

Treatments	Number of inflorescence plant^{-1}	Number of flower inflorescence^{-1}	Number of pod inflorescence^{-1}	Pod Length
V_1T_0	31.50 h	11.75 f	7.450 f	9.850 k
V_1T_1	33.25 g	12.68 ef	8.070 ef	10.13 j
V_1T_2	36.50 cd	13.52 de	8.880 cde	10.20 i
V_1T_3	35.00 ef	13.08 de	8.770 de	10.30 h
V_2T_0	36.75 bcd	13.85 cde	9.200 bcde	10.80 g
V_2T_1	37.00 bc	13.98 bcd	9.570 bcd	11.05 f
V_2T_2	33.80 fg	14.25 bcd	9.450 bcd	10.85 g
V_2T_3	35.55 de	15.18 ab	10.07 abc	11.13 e
V_3T_0	37.88 ab	15.09 abc	9.847 abcd	11.20 d
V_3T_1	38.97 a	16.02 a	10.88 a	12.05 a
V_3T_2	38.52 a	15.68 a	10.47 ab	11.80 b
V_3T_3	37.93 ab	15.58 a	10.38 ab	11.30 c
LSD (0.05)	**1.313**	**1.260**	**1.291**	**0.053**
CV(%)	**2.15**	**5.23**	**8.09**	**4.56**

V_1 : IPSA-1	T_0 : Control
V_2 : IPSA-2	T_1 :Voliam Flexi 300 SC
V_3 : BARI Seem 7	T_2 : Sumi Alfa 5 EC
	T_3 : Neem Seed Kernel

4.3.3 Number of pod inflorescence^{-1}

Number of pod inflorescence^{-1} of country bean showed statistically significant variation for different varieties in controlling insect pest of country bean (Appendix XIV). In case of single effect of variety, the maximum number of pod per inflorescence (10.39) was found from V_3 (BARI Seem 7) variety and the minimum number of pod per inflorescence (8.292) was found from V_1 (IPSA-1) variety (Table 23).

Number of pod inflorescence^{-1} of country bean did not show statistically significant variation for different management practices in controlling insect pest of country bean (Appendix XIV). In case of single effect of treatment, the maximum number of pod per inflorescence (9.74) was found from T_1 (Voliam Flexi 300 SC) treatment and the minimum number of pod per inflorescence (9.17) was found from T_0 (control) treatment (Table 23).

Number of pod inflorescence^{-1} of country bean showed statistically significant variation for different combined management practices in controlling insect pest of country bean (Appendix XIV). In case of combined effect of variety and treatment, the maximum number of pod per inflorescence (10.88) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the minimum number of pod per inflorescence (7.45) was found from V_1T_0 (IPSA-1 + Voliam Flexi 300 SC) treatment combination (Table 24).

4.3.4 Pod length

Pod length of country bean showed statistically significant variation for different varieties in controlling insect pest of country bean (Appendix XIV). In case of single effect of variety, the maximum Pod length (11.59 cm) was found from V_3 (BARI Seem 7) variety and the minimum Pod length (10.12 cm) was found from V_1 (IPSA-1) variety (Table 23).

Pod length of country bean showed statistically significant variation for different management practices in controlling insect pest of country bean (Appendix XIV). In case of single effect of treatment, the maximum Pod length (11.16 cm) was found from T_1 (Voliam Flexi 300 SC) treatment and the minimum Pod length (10.62 cm) was found from T_0 (control) treatment (Table 23).Usa and Singh (1977) reported that different physical and biochemical factors influence the level of pod borer infestation. They did not provide any information regarding the length and girth bean pods.

Pod length of country bean showed statistically significant variation for different combined management practices in controlling insect pest of country bean (Appendix XIV). In case of combined effect of variety and treatment, the maximum Pod length (12.05 cm) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the minimum Pod length (9.85 cm) was found from V_1T_0 (IPSA-1 + Voliam Flexi 300 SC) treatment combination (Table 24).

4.3.5 Number of pod plant^{-1}

Number of pod per plant of country bean showed statistically significant variation for different varieties in controlling insect pest of country bean (Appendix XV). In case of single effect of variety, the maximum number of pod per plant (399.39) was found from V_3 (BARI Seem 7) variety and the minimum number of pod per plant (282.43) was found from V_1 (IPSA-1) variety (Table 25).

Number of pod per plant of country bean did not show statistically significant variation for different management practices in controlling insect pest of country bean (Appendix XV). In case of single effect of treatment, the maximum number of pod per plant (354.73) was found from T_1 (Voliam Flexi 300 SC) treatment and the minimum number of pod per plant (327.99) was found from T_0 (control) treatment (Table 25).

Number of pod per plant of country bean showed statistically significant variation for different combined management practices in controlling insect pest of country bean (Appendix XV). In case of combined effect of variety and treatment, the maximum number of pod per plant (423.99) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the minimum number of pod per plant (234.68) was found from V_1T_0 (IPSA-1 + Voliam Flexi 300 SC) treatment combination (Table 26).

Table 25. Effect of different single management practices in controlling major insect pests of different country bean varietiesfor yield contributing characters and yield during April to October, 2014

Treatments	Number of pod plant^{-1}	Yield plot^{-1} (kg)	Yield hectare^{-1} (ton)
V_1	282.43 c	7.738 c	12.90 c
V_2	342.52 b	8.792 b	14.65 b
V_3	399.39 a	10.57 a	17.61 a
LSD (0.05)	**27.89**	**0.3501**	**0.5841**
T_0	327.99	8.650 c	14.42 c
T_1	354.73	9.463 a	15.77 a
T_2	345.95	9.198 ab	15.33 ab
T_3	331.30	8.817 bc	14.70 bc
LSD (0.05)	**32.21**	**0.4043**	**0.6745**
CV(%)	**9.63**	**4.58**	**4.58**

V_1 : IPSA-1
V_2 : IPSA-2
V_3 : BARI Seem 7

T_0 : Control
T_1 :Voliam Flexi 300 SC
T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

4.3.6 Yield per plot (kg)

Yield per plot of country bean showed statistically significant variation for different varieties in controlling insect pest of country bean (Appendix XV). In case of single effect of variety, the maximum yield per plot (10.57 kg) was found from V_3 (BARI Seem 7) variety and the minimum yield per plot (7.73 kg) was found from V_1 (IPSA-1) variety (Table 25).

Yield per plot of country bean showed statistically significant variation for different management practices in controlling insect pest of country bean (Appendix XV). In case of single effect of treatment, the maximum yield per plot (9.46 kg) was found from T_1 (Voliam Flexi 300 SC) treatment and the minimum yield per plot (8.65 kg) was found from T_0 (control) treatment (Table 25).Patel and Patel (1989) evaluated that fenvalerate (0.01 and 0.02%), fenvalerate dust (0.4%) at 25 kg ha^{-1} were effective in reducing numbers of *H. armigera* in pods; fenvalerate at 0.02 percent gave maximum production of pods and grains against infestation by M. obtusa and the maximum grain yield was obtained from plots treated with 0.02 percent fenvalerate in pigeonpea.

Table 26.Combinedeffect of different varieties and management practices in controlling major insect pests of country bean for yield and yield contributing characters and yield during April to October, 2014

Treatments	Number of pod $plant^{-1}$	Yield $plot^{-1}$ (kg)	Yield $hectare^{-1}$ (ton)
V_1T_0	234.68 f	6.420 f	10.70 f
V_1T_1	268.33 ef	7.300 e	12.17 e
V_1T_2	324.12 cd	8.860 cd	14.77 cd
V_1T_3	306.95 cd	8.370 d	13.95 d
V_2T_0	338.10 bcd	9.470 bc	15.78 bc
V_2T_1	354.09 cde	9.580 b	15.97 b
V_2T_2	319.41 bcd	7.620 e	12.70 e
V_2T_3	357.99 abc	8.500 d	14.17 d
V_3T_0	373.00 cd	10.06 b	16.77 b
V_3T_1	423.99 a	11.52 a	19.20 a
V_3T_2	403.30 ab	10.46 a	17.43 b
V_3T_3	393.71 ab	9.570 b	15.95 b
LSD (0.05)	**55.79**	**0.7002**	**1.168**
CV(%)	**9.63**	**4.58**	**4.58**

V_1 : IPSA-1 T_0 : Control

V_2 : IPSA-2 T_1 :Voliam Flexi 300 SC
V_3 : BARI Seem 7 T_2 : Sumi Alfa 5 EC
T_3 : Neem Seed Kernel

Yield per plot of country bean showed statistically significant variation for different combined management practices in controlling insect pest of country bean (Appendix XV). In case of combined effect of variety and treatment, the maximum yield per plot (11.52 kg) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the minimum yield per plot (6.42) was found from V_1T_0 (IPSA-1 + Voliam Flexi 300 SC) treatment combination (Table 26).Rahman (1987) and Rahman and Rahman (1988) reported that pod borer infestation may cause great reduction of yields of the infested crops.

4.3.7 Yield per hectare (ton)

Yield per hectare of country bean showed statistically significant variation for different varieties in controlling insect pest of country bean (Appendix XV). In case of single effect of variety, the maximum yield per hectare (17.61 t/ha) was found from V_3 (BARI Seem 7) variety and the minimum yield per hectare (12.90 t/ha) was found from V_1 (IPSA-1) variety (Table 25). Alam (2011)evaluated the performance of some country bean varieties against the attack of pod borer in summer. From the present study it was observed that the IPSA Seem-1 and IPSA Seem-2 gave the lowest yield result.

Yield per hectare of country bean showed statistically significant variation for different management practices in controlling insect pest of country bean (Appendix XV). In case of single effect of treatment, the maximum yield per hectare (15.77 t/ha) was found from T_1 (Voliam Flexi 300 SC) treatment and the minimum yield per hectare (14.42 t/ha) was found from T_0 (control) treatment (Table 25).Alam (2011) showed Varietal performance of country bean on total yield the BARI seem-3 variety of country bean gave the highest result among the different varieties of country bean used in the present study. Singh and Singh (2001) found that out of seven insecticides tested in reducing infestation of pods and seeds of pigeonpea by M. obtusa, fenvalerate (0.02%) was found most effective and also reported that fenvalerate gave the greatest profit per hectare, followed by fluvalinate (0.02%). Hossain (2015) The yield and the highest net return were obtained from Voliam flexi 300 SC.

Yield per hectare of country bean showed statistically significant variation for different combined management practices in controlling insect pest of country bean (Appendix XV). In case of combined effect of variety and treatment, the maximum yield per hectare (19.20 t/ha) was found from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination and the minimum yield per hectare (10.70 t/ha) was found from V_1T_0 (IPSA-1 + Voliam Flexi 300 SC) treatment combination (Table 26).Hongo and Karel (1986) reported that neem seed powder and neem kernel extract were also effective against legume pod borer (Singh *et al*., 1985; Hongo and Karel, 1986) but neem seed kernel extract (NSKE) was less effective than fenvalerate and monocrotophos. Singh and Singh (2001) found that out of seven insecticides tested in reducing infestation of pods and seeds of pigeonpea by M. obtusa, fenvalerate (0.02%) was found most effective and also reported that fenvalerate gave the greatest profit per hectare, followed by fluvalinate (0.02%).

4.4 Relationship between %pod infestation of country bean by number at total growing period and yield (t/ha)

Correlation study was done to establish the relationship between % pod infestation of country bean in number at total growing period and yield (t/ha) among different management practices. From the figure 1 it was observed that negative correlation was observed between the parameters. The regression equation y = - 0.4069x + 20.558 gave a good fit to the data and the co-efficient of determination (R^2 = 0.608) had a significant regression co-efficient. From this figure it was observed that 22.02 % pod infestation in number gives the yield 10.70 (t/ha) and 9.52 % pod infestation in number gives the yield 19.20 (t/ha). So, the reduction of 12.50 % pod infestation in number increased the yield 8.50 (t/ha) which was produced by using the variety BARI Seem 7 and voliam flexi 300 SC treatment.

From the figure, it may be concluded that % pod infestation of country bean in number negatively correlated with pod yield (t/ha).

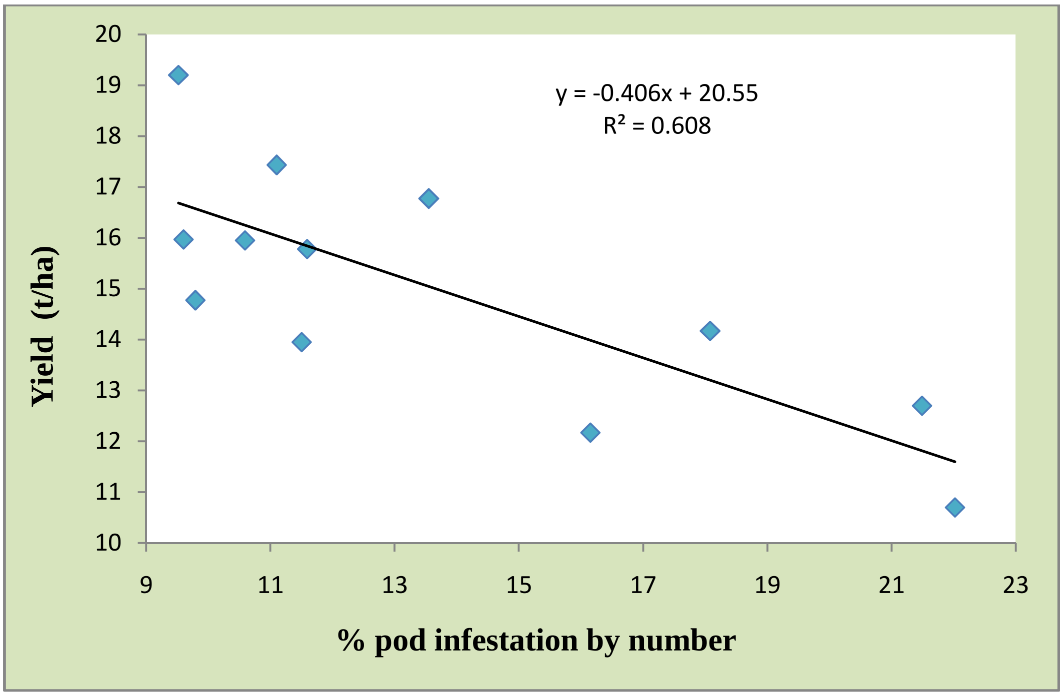

Figure 1. Relationship between % pod infestation of country bean by number at total growing period and yield (t/ha)

CHAPTER V
SUMMARY AND CONCLUSION

The experiment consists of the following varieties and treatments: V_1: IPSA Seem-1, V_2: IPSA Seem-2, V_3: BARI Seem 7, T_0: Untreated control; T_1: Voliam Flexi 300 SC; T_2: Sumi Alfa 5 EC; T_3: Neem seed karnel.

Among the three varieties, at early stage the lowest number of bean pod borer (13.00) and aphid (7.18) was found from V_3 variety (BARI Seem 7) on the other hand the highest number of bean pod borer (18.06) and Aphid (7.75) was found from V_1 variety (IPSA Seem-1). At mid stage the lowest number of bean pod borer (14.19) and Aphid (7.52) was found from V_3 varietyon the other hand the highest number of bean pod borer (22.56) and Aphid (8.395) was found from V_1 variety. At late stage the lowest number of bean pod borer (15.56) and Aphid (8.75) was found from V_3 varietyon the other hand the highest number of bean pod borer (27.38) and Aphid (10.19) was found from V_1 variety.
At early stage the highest number of healthy pod (91.24), lowest number of infested pod (9.36) and the lowest infestation percentage (9.31 %) were found from V_3 variety (BARI Seem 7) on the other hand the lowestnumber of healthy pod (76.00), highest number of infested pod (11.63) and the highest infestation percentage (13.27 %) were found from V_1 variety (IPSA Seem-1). At mid stage the highest number of healthy pod (139.70), lowest number of infested pod (18.67) and the lowest infestation percentage (11.79 %) were found from V_3 varietyon the other hand the lowest number of healthy pod (114.30), highest number of infested pod (19.85) and the highest infestation percentage (17.36 %) were found from V_1 variety. At late stage the highest number of healthy pod (75.20), lowest number of infested pod (12.00) and the lowest infestation percentage (13.76 %) were found from V_3 variety on the other hand the lowest number of healthy pod (62.75), highest number of infested pod (12.98) and the highest infestation percentage (17.14 %) were found from V_1 variety.

At early stage the maximum weight of healthy pod (755.70 g), infested pod (59.27 g) and the minimum infestation percentage (7.27 %) were found from V_3 variety (BARI Seem 7) on the other hand the minimum weight of healthy pod (631.90 g), infested pod (90.17 g) and the maximum infestation percentage (12.49 %) were found from V_1 variety (IPSA Seem-1). At mid stage the maximum weight of healthy pod (1170.12 g), infested pod (131.60 g) and the minimum infestation percentage (10.11 %) were found from V_3 variety on the other hand the minimum weight of healthy pod (970.46 g), infested pod (167.6 g) and the maximum infestation percentage (14.73 %) were found from V_1 variety. At late stage the maximum weight of healthy pod (529.0 g), infested pod (69.97 g) and the minimum infestation percentage (11.68 %) were found from V_3 variety on the other hand the minimum weight of healthy pod (458.10 g), infested pod (88.27 g) and the maximum infestation percentage (16.16 %) were found from V_1 variety.

At total growing stage the highest number of healthy pod (306.14), infested pod (40.03) and the lowest infestation percentage (11.71 %) were found from V_3 variety on the other hand the lowest number of healthy pod (253.01), infested pod (44.11) and the highest infestation percentage (14.86 %) were found from V_1 variety. At total growing stage the maximum weight of healthy pod (2454.82 g), infested pod (260.84 g) and the minimum infestation percentage (9.61 %) were found from V_3 variety on the other hand the minimum weight of healthy pod (2060.46 g), infested pod (346.04 g) and the maximum infestation percentage (14.38 %) were found from V_1 variety.

In case of variety the maximum number of inflorescence per plant (38.44), number of flower per inflorescence (15.59), number of pod per inflorescence (10.39), pod length (11.59 cm), number of pod per plant (399.39), Yield per plot (10.57 kg) and Yield per hectare (17.61 t/ha) recorded from V_3 (BARI Seem 7) variety. On the other hand, the minimum number of inflorescence per plant (34.06), number of flower per inflorescence (12.76), number of pod per inflorescence (8.29), pod length (10.12 cm), number of pod per plant (282.43), Yield per plot (7.73 kg) and Yield per hectare (12.90 t/ha) recorded from V_1 (IPSA Seem-1) variety.

Among the four treatments, at early stage the lowest number of bean pod borer (12.83) and Aphid (4.52) was found from T_1treatment (Voliam Flexi 300 SC) on the other hand the highest number of bean pod borer (16.92) and Aphid (10.17) was found from T_0treatment (Control). At mid stage the lowest number of bean pod borer (15.47) and Aphid (5.80) was found from T_1treatment on the other hand the highest number of bean pod borer (19.92) and Aphid (9.77) was found from T_0treatment. At late stage the lowest number of bean pod borer (19.81) and Aphid (7.22) was found from T_1treatment on the other hand the highest number of bean pod borer (23.86) and Aphid (12.08) was found from T_0treatment.

At early stage the highest number of healthy pod (85.12), lowest number of infested pod (9.57) and the lowest infestation percentage (10.11 %) were found from T_1treatment (Voliam Flexi 300 SC) on the other hand the lowest number of healthy pod (79.43), highest number of infested pod (11.98) and the highest infestation percentage (13.11 %) were found from T_0treatment (Control). At mid stage the highest number of healthy pod (127.2), lowest number of infested pod (18.82) and the lowest infestation percentage (14.79 %) were found from T_1treatment on the other hand the lowest number of healthy pod (121.6), highest number of infested pod (20.33) and the highest infestation percentage (16.71 %) were found from T_0treatment. At late stage the highest number of healthy pod (70.51), lowest number of infested pod (10.96) and the lowest infestation percentage (13.45 %) were found from T_1treatment on the other hand the lowest number of healthy pod (66.07), highest number of infested pod (13.72) and the highest infestation percentage (17.20 %) were found from T_0(control) treatment.

At early stage the maximum weight of healthy pod (694.30 g), minimum weight of infested pod (74.05 g) and the minimum infestation percentage (9.64 %) were found from T_1treatment (Voliam Flexi 300 SC) on the other hand the minimum weight of healthy pod (676.30 g), maximum weight of infested pod (79.78 g) and the maximum infestation percentage (10.55 %) were found from T_0treatment (Control). At mid stage the maximum weight of healthy pod (1081.02 g), minimum weight of infested pod (142.30 g) and the minimum infestation percentage (11.63 %) were found from T_1treatment on the other hand the minimum weight of healthy pod

(1027.12 g),maximum weight of infested pod (155.30 g) and the maximum infestation percentage (13.13 %) were found from T_0treatment. At late stage the maximum weight of healthy pod (510.6 g), minimum weight of infested pod (73.21 g) and the minimum infestation percentage (12.54 %) were found from T_1treatment on the other hand the minimum weight of healthy pod (474.90 g), maximum weight of infested pod (86.42 g) and the maximum infestation percentage (15.39 %) were found from T_0treatment.

At total growing stage the highest number of healthy pod (280.17), lowest number of infested pod (40.73) and the lowest infestation percentage (12.24 %) were found from T_1treatment on the other hand the lowest number of healthy pod (268.10), highest number of infested pod (46.03) and the highest infestation percentage (14.56 %) were found from T_0 treatment. At total growing stage the maximum weight of healthy pod (2285.92 g), minimum weight of infested pod (289.56 g) and the minimum infestation percentage (11.24 %) were found from T_1treatment on the other hand the minimum weight of healthy pod (2178.32 g), maximum weight of infested pod (319.50 g) and the maximum infestation percentage (12.79 %) were found from T_0treatment.

In case of treatment the maximum number of inflorescence per plant (36.42), number of flower per inflorescence (14.48), number of pod per inflorescence (9.74), pod length (11.16 cm), number of pod per plant (354.73), Yield per plot (9.46 kg) and Yield per hectare (15.77 t/ha) recorded from T_1 (Voliam Flexi 300 SC) treatment. On the other hand, the minimum number of inflorescence per plant (35.74), number of flower per inflorescence (13.87), number of pod per inflorescence (9.17), pod length (10.62 cm), number of pod per plant (327.99), Yield per plot (8.65 kg) and Yield per hectare (14.42 t/ha) recorded from T_0 (Control) treatment.

Among all the treatment combinations, at early stage the lowest number of bean pod borer (5.00) and Aphid (3.25) was found from V_3T_1 treatment combination (BARI Seem 7 + Voliam Flexi 300 SC) on the other hand the highest number of bean pod borer (27.50) and Aphid (15.25) was found from V_1T_0 treatment combination (IPSA

Seem-1 + no pesticide). At mid stage the lowest number of bean pod borer (6.00) and Aphid (3.25) was found from V_3T_1 treatment combination on the other hand the highest number of bean pod borer (34.00) and Aphid (14.33) was found from V_1T_0treatment combination. At late stage the lowest number of bean pod borer (8.25) and Aphid (4.00) was found from V_3T_1 treatment combination on the other hand the highest number of bean pod borer (38.50) and Aphid (17.25) was found from V_1T_0treatment combination.

At early stage the highest number of healthy pod (97.05), lowest number of infested pod (5.50) and the lowest infestation percentage (5.36 %) were found from V_3T_1 treatment combination (BARI Seem 7 + Voliam Flexi 300 SC) on the other hand the lowest number of healthy pod (62.00), highest number of infested pod (18.80) and the highest infestation percentage (23.27 %) were found from V_1T_0 treatment combination (IPSA Seem-1 + no pesticide). At mid stage the highest number of healthy pod (144.90), lowest number of infested pod (12.00) and the lowest infestation percentage (8.28 %) were found from V_3T_1 treatment combination on the other hand the lowest number of healthy pod (89.00), highest number of infested pod (27.20) and the highest infestation percentage (30.56 %) were found from V_1T_0treatment combination. At late stage the highest number of healthy pod (77.87), lowest number of infested pod (6.75) and the lowest infestation percentage (7.97 %) were found from V_3T_1 treatment combination on the other hand the lowest number of healthy pod (54.00), highest number of infested pod (17.20) and the highest infestation percentage (24.15 %) were found from V1 T_0(IPSA Seem-1 + no pesticide) treatment.

At early stage the maximum weight of healthy pod (808.00 g), minimum weight of infested pod (43.75 g) and the minimum infestation percentage (5.14 %) were found from V_3T_1 treatment combination (BARI Seem 7 + Voliam Flexi 300 SC) on the other hand the minimum weight of healthy pod (498.90 g), maximum weight of infested pod (123.30 g) and the maximum infestation percentage (19.82 %) were found from V_1T_0 treatment combination (IPSA Seem-1 + no pesticide). At mid stage the maximum weight of healthy pod (1225.00 g), minimum weight of infested pod (207.40 g) and the minimum infestation percentage (14.48 %) were found from

V_3T_1 treatment combination on the other hand the minimum weight of healthy pod (746.20 g),maximum weight of infested pod (102.90 g) and the maximum infestation percentage (12.12 %) were found from V_1T_0treatment combination. At late stage the maximum weight of healthy pod (568.5 g), minimum weight of infested pod (51.77 g) and the minimum infestation percentage (8.35 %) were found from V_3T_1 treatment combination on the other hand the minimum weight of healthy pod (389.90 g), maximum weight of infested pod (118.80 g) and the maximum infestation percentage (23.35 %) were found from V_1T_0treatment combination.

At total growing stage the highest number of healthy pod (319.82), lowest number of infested pod (33.65) and the lowest infestation percentage (9.52 %) were found from V_3T_1 treatment combination on the other hand the lowest number of healthy pod (208.20), highest number of infested pod (58.80) and the highest infestation percentage (22.02 %) were found from V_1T_0 treatment combination. At total growing stage the maximum weight of healthy pod (2602.50 g), minimum weight of infested pod (302.92 g) and the minimum infestation percentage (10.42 %) were found from V_3T_1 treatment combination on the other hand the minimum weight of healthy pod (1635.00 g), maximum weight of infested pod (402.40 g) and the maximum infestation percentage (19.75 %) were found from V_1T_0treatment combination.

In case of combined treatment the maximum number of inflorescence per plant (38.97), number of flower per inflorescence (16.02), number of pod per inflorescence (10.88), pod length (12.05 cm), number of pod per plant (423.99), Yield per plot (11.52 kg) and Yield per hectare (19.20 t/ha) recorded from V_3T_1 (BARI Seem 7 + Voliam Flexi 300 SC) treatment combination. On the other hand, the minimum number of inflorescence per plant (31.50), number of flower per inflorescence (11.75), number of pod per inflorescence (7.45), pod length (9.85 cm), number of pod per plant (234.68), Yield per plot (6.42 kg) and Yield per hectare (10.70 t/ha) recorded from V_1T_0 (IPSA Seem-1 + no pesticide) treatment. The relationship between percent pod infestation by number and yield (t/ha) is negatively co-related.

Conclusion

From the above discussion it can be concluded that BARI seem 7 variety is better than other two varieties due to the lower infestation rate (9.61 %) and higher number of pods (399.39) per plant. The voliam flexi 300 SC is better than other treatment because it can control the major insect pest and lower the infestation rate (11.24 %) of the country bean. The interaction effects of BARI Seem 7 and Voliam flexi 300 SC is better than all other treatment combination due to the minimum infestation (10.42 %) and maximum yield (19.20 t/ha) of country bean.

Recommendation

Due to some limitations a little number of varieties were used in this experiment. So, more varieties can be included withmore pesticidetreatments for the further studies to find out the more profitable yield of country bean. However, further study of this experiment isalso needed in different locations of Bangladesh for accuracy of the results obtained from the present experiment.

CHAPTER VI
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APPENDICES

Appendix I. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from February, 2014 to October, 2014

Month	Air temperature (^{0}C)		R. H. (%)	Total rainfall (mm)
	Maximum	Minimum		
February,14	28.10	12.70	79	32
March,14	34.40	17.60	70	61
April, 14	37.30	21.40	66	137
May, 14	36.20	23.25	72	245
June, 14	36.42	25.50	81	315
July, 14	34.25	27.20	80	329
August, 14	33.22	24.36	78	163
September,14	32.18	21.26	76	134
October, 14	30.21	18.24	73	116

Source: Bangladesh Metrological Department (Climate and weather division) Agargaon, Dhaka

Appendix II. Results of morphological, mechanical and chemical analysis of soil of the experimental plot

A. Morphological Characteristics

Morphological features	Characteristics
Location	Central Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow redbrown terrace soil
Land Type	Medium high land
Soil Series	Tejgaon
Topography	Fairly leveled
Flood Level	Above flood level
Drainage	Well drained

B. Mechanical analysis

Constituents	Percentage (%)
Sand	28.78
Silt	42.12
Clay	29.1

C. Chemical analysis

Soil properties	Amount
Soil pH	5.8
Organic carbon (%)	0.95
Organic matter (%)	0.77
Total nitrogen (%)	0.075
Available P (ppm)	15.07
Exchangeable K (%)	0.32
Available S (ppm)	16.17

Source: Soil Resource Development Institute (SRDI)

AppendixIII.Analysis of variance of data on number of major insect pests plant^{-1} of country bean at early stage of pod development

Treatments	Degrees of freedom	Mean square of plant height at	
		Larva of bean pod borer (No./plant)	Aphid (No./plant)
Factor A (Variety)	2	77.359**	77.359**
Factor B (treatment)	3	28.542**	28.542**
Interaction (A X B)	6	229.151**	229.151**
Error	22	5.761	5.761
** : Significant at 1% level of probability; * : Significant at 5% level of probability			

Appendix IV. Analysis of variance of data on number of major insect pests plant^{-1} of country bean at midstage of pod development

Treatments	Degrees of freedom	Mean square of plant height at	
		Larva of bean pod borer (No./plant)	Aphid (No./plant)
Factor A (Variety)	2	210.484**	2.324**
Factor B (treatment)	3	34.602**	28.474**
Interaction (A X B)	6	392.107**	50.501**
Error	22	8.015	0.379
** : Significant at 1% level of probability ; * : Significant at 5% level of probability			

Appendix V. Analysis of variance of data on number of major insect pests plant^{-1} of country bean at latestage of pod development

Treatments	Degrees of freedom	Mean square of plant height at	
		Larva of bean pod borer (No./plant)	Aphid (No./plant)
Factor A (Variety)	2	423.391**	6.859**
Factor B (treatment)	3	25.046**	55.338**
Interaction (A X B)	6	543.541**	62.281**
Error	22	8.015	2.004
** : Significant at 1% level of probability ; * : Significant at 5% level of probability			

Appendix VI. Analysis of variance of data on number of pods plant^{-1}of country bean at early stage ofpod development

Treatments	Degrees of freedom	Mean square of plant height at	
		Healthy pod	Infested pod
Factor A (Variety)	2	722.173**	18.204**

Factor B (treatment)	3	27.858**	8.714**
Interaction (A X B)	6	523.778**	88.882**
Error	22	6.061	0.640
** : Significant at 1% level of probability ; * : Significant at 5% level of probability			

Appendix VII. Analysis of variance of data on weightof pods plant^{-1}of country bean at earlystage of pod development

Treatments	Degrees of freedom	Mean square of plant height at	
		Healthy pod	Infested pod
Factor A (Variety)	2	48316.548**	3104.680**
Factor B (treatment)	3	633.833**	72.999**
Interaction (A X B)	6	53765.878**	3889.211**
Error	22	79.509	4.535
** : Significant at 1% level of probability ; * : Significant at 5% level of probability			

Appendix VIII.Analysis of variance of data on number of pods plant^{-1} of country bean at midstage ofpod development

Treatments	Degrees of freedom	Mean square of plant height at	
		Healthy pod	Infested pod
Factor A (Variety)	2	2146.170**	4.434**
Factor B (treatment)	3	66.450**	4.117**
Interaction (A X B)	6	1639.634**	121.683**
Error	22	6.848	1.313
** : Significant at 1% level of probability ; * : Significant at 5% level of probability			

Appendix IX.Analysis of variance of data on weight of pods plant^{-1} of country bean at mid stage ofpod development

Treatments	Degrees of freedom	Mean square of plant height at	
		Healthy pod	Infested pod
Factor A (Variety)	2	136496.026**	4102.684**
Factor B (treatment)	3	5932.459**	391.357**
Interaction (A X B)	6	134207.168**	5307.265**
Error	22	860.697	121.259
** : Significant at 1% level of probability ; * : Significant at 5% level of probability			

Appendix X. Analysis of variance of data on number of pods plant^{-1} of country bean at latestage ofpod development

Treatments	Degrees of freedom	Mean square of plant height at	
		Healthy pod	Infested pod
Factor A (Variety)	2	475.570**	2.883**
Factor B (treatment)	3	37.287**	12.696**
Interaction (A X B)	6	160.404**	77.387**
Error	22	6.061	0.640
** : Significant at 1% level of probability ; * : Significant at 5% level of probability			

Appendix XI.Analysis of variance of data on weight of pods plant^{-1} of country bean at latestage ofpod development

Treatments	Degrees of freedom	Mean square of plant height at	
		Healthy pod	Infested pod
Factor A (Variety)	2	15646.262**	1151.108**
Factor B (treatment)	3	2538.363**	323.747**
Interaction (A X B)	6	12085.473**	2598.231**
Error	22	364.203	23.473
** : Significant at 1% level of probability ; * : Significant at 5% level of probability			

Appendix XII. Analysis of variance of data on total number of pods plant^{-1} of country bean at pod development stage

Treatments	Degrees of freedom	Mean square of plant height at	
		Healthy pod	Infested pod
Factor A (Variety)	2	8979.853**	40.185**
Factor B (treatment)	3	369.125**	67.619**
Interaction (A X B)	6	5739.370**	840.028**
Error	22	42.606	0.909
** : Significant at 1% level of probability ; * : Significant at 5% level of probability			

Appendix XIII. Analysis of variance of data on total weight of pods plant^{-1} of country bean at pod development stage

Treatments	Degrees of freedom	Mean square of plant height at	
		Healthy pod	Infested pod
Factor A (Variety)	2	507078.962**	23560.149**
Factor B (treatment)	3	22976.052**	2049.900*

Interaction (A X B)	6	493515.017**	34442.686**
Error	22	2855.935	289.734
** : Significant at 1% level of probability ; * : Significant at 5% level of probability			

Appendix XIV. Analysis of variance of data on yield contributing characteristics of country bean at latestage of pod development

Treatments	Degrees of freedom	Mean square of plant height at			
		No. of inflorescence Plant^{-1}	No. of Flower inflorescence^{-1}	No. of pod inflorescence^{-1}	Pod length
Factor A (Variety)	2	58.324**	24.190**	13.451**	6.504*
Factor B (treatment)	3	0.722	0.786	0.780	0.466*
Interaction (A X B)	6	10.424**	1.224**	0.747*	0.106**
Error	22	0.601	0.554	0.581	0.011
** : Significant at 1% level of probability ; * : Significant at 5% level of probability					

Appendix XV. Analysis of variance of data on yield contributing characteristics of country bean at late stage ofpod development

Treatments	Degrees of freedom	Mean square of plant height at		
		No. of podPlant^{-1}	Yield plot^{-1} (kg)	Yield hectare^{-1} (ton)
Factor A (Variety)	2	40856.623**	24.514**	68.083**
Factor B (treatment)	3	1266.412	1.217**	3.387**
Interaction (A X B)	6	2953.432*	3.684**	10.233**
Error	22	1085.353	0.171	0.476
** : Significant at 1% level of probability ; * : Significant at 5% level of probability				