Project ID : 732

Competitive Research Grant

Sub-Project Completion Report

on

Validation of Integrated pest management (IPM) technologies in the farmers fields against major insect pests of soybean at Noakhali region

Project Duration

June 2017 to September 2018

Oil Seed Research Centre
Bangladesh Agricultural Research Institute
Joydebpur, Gazipur-1701

Submitted to
Project Implementation Unit-BARC, NATP-2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

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Acronyms

AEZ	Agro Ecological Zone
ANOVA	Analyses of Variance
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
Bt	*Bacillus Thuringiensis*
Co PI	Co- Principal Investigator
CRG	Competitive Research Grant
DAE	Department of Agricultural Extension
DMRT	Duncan's Multiple Range Test
GAP	Good Agricultural Practices
HP	Hand Picking
IPM	Integrated Pest Management
MBCR	Marginal Benefit Cost Ratio
NATP	National Agricultural Technology Project
NGO	Non Government Organization
OFRD	On-Farm Research Division
ORC	Oilseed Research Centre
PCR	Project Completion Report
PI	Principal Investigator
PSO	Principal Scientific Officer
CSO	Chief Scientific Officer
RCBD	Randomized Complete Block Design
SDGs	Sustainable Development Goals

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Executive Summary

Soybean (*Glycine max* L.) is one of the most important crops in Bangladesh and is extensively cultivated especially in Noakhali region. Several major insect pests attacking soybean crop in Bangladesh and cause a considerable loss of about 25% and insect damage is a limiting factor for successful production of soybean. But the farmers of this region do not take proper attention for managing the insect pests due to lack of IPM technologies which are available in the Oilseed Research Centre, BARI, Gazipur. Therefore, farmers can reduce pest damage (80%) by adopting eco-friendly IPM technologies. The project activities will be helpful for adoption of suitable IPM technologies by the farmers with increasing sustainable crop production.

PIU- BARC, NATP: Phase-2 approved TK. 1500000/- (Fifteen lakh only) to implement the project **Validation of Integrated Pest Management(IPM) technologies in the farmers' fields against major insect pests of soybean at Noakhali region"** for June 2017 to September 2018 where around 12 lakh and 3 lakh TK allocated for 1st and 2nd year, respectively. The goal of the project was to increase soybean production, reduce poverty and nutritional deficiency through adoption of IPM strategies. The Oilseed Research Centre of BARI implemented the project.

Two farmers trainings were conducted among the selected 30 farmers for capacity building and improved knowledge on modern soybean cultivation and application of IPM technique in the soybean field for managing major insect pests. One laptop computer and one digital camera and other inputs were purchased following the PPR-2008. BARI Soybean-5 was used for conducting research activities in Noakhali, Laxmipur and Oilseed Research Centre, BARI, Gazipur. Necessary data of IPM and non IPM fields were recorded at different crop growth stages for differentiation and validation of the results. Five major insect pests namely, hairy caterpillar, common cutworm, leaf roller, stem fly and pod borer were recorded and found to attack soybean crop in the fields and caused about 20% yield loss. IPM technique reduced the highest pests infestation (80-82%) in soybean crop and produced the highest seed yield (2.25 t/ha) with the highest MBCR (2.75). About 90% of the total allotted fund was released and spent for project activities. An eco-friendly IPM technique, especially for use of sex pheromone trap against *Spodoptera* was a new dimension of pest management and validated in the farmers' fields and demonstrated with the farmers participation. The soybean production was increased (30%) through application of IPM component. One field day on IPM technologies was conducted at Charmartin, Laxmipur for demonstration of results. The farmers, DAE, BADC, NGO personnel and local representative in these locations participated in the field day. They were very much pleased and impressed to see the results of the IPM compared to non IPM fields for managing insect pests of soybean. Farmers'income has been increased and they were benefited economically adopting eco-friendly IPM technologies.

CRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. **Title of the CRG sub-project:Validation of integrated pest management (IPM) technologies in the farmers' fields against major insect pests of soybean at Noakhali region**

2. **Implementing organization:**Bangladesh Agricultural Research Institute (BARI)

3. **Name and full address with phone, cell and E-mail of PI/Co-PI (s):**

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4. **Sub-project budget (Tk):**
   a. Total: **Taka 1500000/- (Fifteen lakhs only)**
   b. Revised (if any):

   _____

5. **Duration of the sub-project:**
   a. Start date (based on LoA signed): 29 May2017

      _____

   b. End date:30 September 2018

6. **Justification of undertaking the sub-project:**

Soybean (*Glycine max* L.) is one of the most important crops in Bangladesh and it is grown for oil and protein in both the rabi and kharif seasons. Seeds of soybean contain about 42% protein and 20% oil and provide 60% of the world supply of vegetable protein and 30% of the edible oil (Fehr, 1989). In Bangladesh, this crop is comparatively new but soybean oil is very much popular as edible oil. However, recently the crop gained popularity in the poultry industry and its cultivation in expanding day by day. In the greater Noakhali region (Noakhali and Laxmipur districts) soybean is the major oilseed crop and is extensively cultivated. Cultivation of soybean covered about 55,000 hectares of land and produced about 90,000 metric ton of seeds during the period 2015-2016 in Bangladesh (Anonymous, 2018 Krishi diary 2018). One of the major constraints to the successful soybean production in Bangladesh is the damage caused due to insect pests. Several major insect pests namely, hairy caterpillar, common cut worm, leaf roller and pod borer attack soybean crop in Bangladesh and cause a considerable loss (Biswas, 2008) and it is a limiting factor for successful production of soybean. But the farmers of this region cultivate soybean in traditional methods. They do not take proper attention for managing the insect pests due to lack of IPM technologies which are

available in the Oilseed Research Centre. So farmers get very low yield (1.0-1.3t/ha) whereas the potential yield of soybean is 1.8-2.5t/ha (Biswas *et al*. 2012).

Therefore, huge yield gap between the farmers' field and research plots exists. Farmers can minimize this yield gap (80%) by adopting improved cultivation technologies including IPM. On the other hand, farmers use pesticides indiscriminately for managing the soybean insect pests which cause environment pollution. But at present good IPM technologies are available for eco-friendly management of these pests of soybean. The proposed project will be helpful in adoption of suitable IPM technologies by the farmers with increased sustainable crop production.

7. Sub-project goal: Increase soybean production; reduce poverty and nutritional deficiency through adoption of IPM strategy.

8. Sub-project objective (s):

i) To validate IPM technologies in the farmers' fields for creating awareness

ii) To popularize IPM technologies among the farmers

iii) To increase yield of soybean by applying IPM technologies in the fields

9. Implementing location (s): Noakhali and Laxmipur districts

10. Methodology in brief:

The project activities were done atthree locations namely, Farmers' fields of Subarna Char, Noakhali, and Char Martin, Laxmipur and research field and laboratory of Oilseed Research Centre, BARI, Joydebpur, Gazipur. The land (0.50 ha) and farmers (15) selection in each location were completed during November-December, 2017 and January 2018 in the project areas at Subarnachar, Noakhali and Char martin, Laxmipur. Two farmer trainings were conducted among the fifteen (15) selected farmers in each location for capacity building and improve knowledge on modern soybean cultivation and application of eco-friendly IPM technique in the soybean field. Contractual support staff (Part time accountant) was recruited and some inputs were purchased during one year period following the appropriate legal procedures and with the help of procurement consultant of NATP-2 Project Implementation Unit.

Two types of research activities (Field trials) were executed under this project. The first experiment was survey and record of the number of insect pests with their incidence, nature and amount of damage with the crop stages in the unsprayed plot of research and farmers fields. The data were recorded from randomly selected 10 plants per plot in 4 replications.The data were compiled, analyzed and the report was prepared.

The second experiment was validation of integrated pest management (IPM) component like use of sex pheromone trap, perching, netting, hand picking and application of bio-pesticides in the farmers' fields of Subarna Char, Noakhali, and Char Martin, Laxmipur against the major insect pests of soybean and to validate the performance of the different IPM technologies in these locations. Field visit, data collection and arrangement of field day were conducted during March-May 2018 in the projected areas. Necessary data were recorded and analyzed statistically and cost benefit ratios were calculated. The report was prepared.

11.Results and discussion:

Experiment No. 01

SURVEY AND DOCUMENTATION OF INSECT PESTS OF SOYBEAN IN NOAKHALI AND LAXMIPUR DISTRICTS

One of the major constraints to the successful soybean production in Bangladesh is the damage caused by insect pests. Several major insect pests namely, hairy caterpillar, common cut worm, leaf roller and pod borer attack soybean crop in Bangladesh and insect damage is limiting factor for successful production of soybean. Research experiences reveal that 15 - 20 percent of the total soybean production is lost directly or indirectly by the attack of insect pests every year (Biswas, 2012). The farmers of this region do not take proper attention for managing the insect pests and thus the farmers get very low yield (1.0-1.3t/ha) where the potential yield of soybean is 1.8-2.5t/ha. On the other hand, farmers use insecticides indiscriminately for managing the soybean insect pests which cause phytotoxicity of the plants, human health hazards and environment pollution.

In order to evolve economically feasible, ecologically sound and socially acceptable pest management strategies, detailed information on the pest complex, their status and sequence of appearance during the crop period, losses and type of damage are of great importance (Jayanthi*et al*. 1993). In Bangladesh, check lists of insect pests of soybean from their succession in relation to crop stages was not sufficient. Only the list of some insect pests of soybean in Bangladesh was recorded by several scientists (Sardar and Debnath 1984, Kaul and Das 1986, Ali 1988, Begum 1995, Biswas *et al.* 2001, Atwal and Dhaliwal (2007), Biswas 2008, Biswas and Das, 2011). Therefore, the present research work was undertaken to record the insect pests of soybean, their nature and extent of damage, incidence, infestation and time of appearance with the crop stages.

Materials and Methods

The field research and experiment was conducted in the farmers' fields of Subarna Char, Noakhali and Char Martin, Laxmipur during 2017-18 in Young Meghna Estuarine Floodplain (AEZ-18f). Laboratory research was conducted in the laboratory of Oilseed Research Centre, BARI, Gazipur during 2017-2018 crop season. Before setting the experiment, farmers training was conducted for 15 selected farmers on improved soybean cultivation with emphasis on IPM techniques for eco-friendly pest management in both the regions. The survey was conducted from about one hectare soybean field cultivated by the farmers with the supervision of scientists of Oilseed Research Centre, BARI, Joydebpur, Gazipur. Each experimental plot measured 30 m X 20 m. The seeds of soybean were sown in the plots on 3rd week of January, 2018. There were four replications and plots were selected following a Randomized Complete Block Design. The rows and plants were spaced 30 cm and 10 cm apart, respectively. The recommended agronomic practices for raising the crop were maintained following the work of Mondal and Wahhab (2001).

Observation on species of insect pests with their population per plant was recorded from seedling to matured stage of the crop from 10 randomly selected samples of the plants in each plot. The time of appearance of the pests was observed and recorded. The nature of damage and feeding behaviour of the insects were carefully observed and their photographs were taken in the crop fields and in the laboratory. The recordings of data included visual observations, hand tens, and hand picking of insects from the standing crops during 7:00-10:00 a.m and 4:00-6:00 p.m at weekly intervals. Some insects were also collected by aspirators for laboratory studies. The collected insects were preserved in the insect box and vial having 75% alcohol for identification. Relative population of insect was counted as suggested by Biswas *et al.* (2001). The collected insects were also reared in the laboratory at an ambient temperature (24-34^0 C) in cages and preserved in the insect boxes. The insects (specimens) were identified following Maxwell-Lefroy (1909), Borror*et al.* (1975), Fletcher (1985), Nair (1986), Singh (1990), Atwal and Dhaliwal (2007), Biswas (2008), Biswas and Das (2011).

The insects were graded as major and minor on the basis of their population density per plant, nature and extent of damage to the crop and the yield reduction. The insect pests were also grouped as stem feeders, leaf feeders, leaf roller, sap sucker and borer on the basis of their feeding behaviour.

Results and Discussion

Pest complex of soybean

Thirty species of insect pests belonging to eight orders and 15 families were found to infest at the different growth stages of soybean crop in Noakhali and Laxmipurdistricts, Bangladesh during rabi season of 2018(Table 1). Of these, only five species namely, hairy caterpillar, *Spilarctiaobliqua* (Walker); leaf roller, *Lamprosemaindicata* F.; common cutworm, *Spodopteralitura* F.; pod borer, *Helicoverpaarmigera* (Hubner) and stem fly, *Ophiomyiaphaseoli* (Tryon)were considered as the major pests while the rests were of minor importance on the basis of population densities per plant, nature and extent of damages and yield reductions. The population density per plant of major and minor insects and their rate of infestation on soybean plant is presented in Table 2. The population density per plant of major insects namely, *S.obliqua,L. indicata*, *.S. litura*, *H. armigera*, *O. phaseoli* and *B .tabaci* ranged from 0.25-0.35, 1.50-2.00, 1.20-1.50,0.30-3.50, 0.30-0.40 and 3.00-3.50, respectively in 2018. Similarly, percent plant infestation by the major insects namely, *S.obliqua,L. indicata*, *.S. litura*, *H. armigera*, *O. phaseoli* and *B* .tabaci ranged from 30-40, 60-70, 80-90, 20-25, 35-40 and 80-90, respectively in 2018. Most of the number of major and minor pests per plant of soybean with their infestation rate was found high at Noakhali in 2018 (Table 8). About 100 percent plant was infested by leaf roller, white fly, leaf hopper and leaf beetle observed through the study period. The higher insect population and their infestation in 2018 would be due to the higher temperature, lower relative humidity and rainfall in 2018, which provided suitable conditions for the population build-up of the insect pests. The insect population and their infestation severity depends on temperature, relative humidity and rainfall in those districts.

Among the minor pests, green stink bug (*Nezaraviridula*L.), semilooper (*Plusiaorichalcea*Fab.), Black cutworm (*Agrotisipsilon*(Hufn.) , leaf miner (*Stomopteryx* spp.), Green grasshopper (*Attractomorphacrenulata*F.) Pod bug (*Eusarcocoris*sp.) and aphid (*Aphis cracraccivora*) became occassionally important and caused serious damage to the soybean crop. Aphid, jassid and whitefly are also important as vectors for transmission of viral (YMV) diseases (Biswas 2008). Severe infestation of stemfly (*Ophiomyiaphaseoli* (Tryon) and*Melanagromyzasojae*) was observed (about 90% plant infestation) in the farmers fields at Sbarnachar, Noakhali.

On the basis of feeding behaviour, 11 species were grouped as sap sucker, 12 as leaf eater, 1 as leaf roller and eater, and the remaining five such as, *Helicoverpaarmigear*, as pod borer and eater, *Stomopteryx* sp. as leaf miner, *Agrotis* sp. as stem cutter, *Ophiomyiaphaseoli and Melanagromyzaobtusa* as stem or shoot borers.

Nature of damage of the important pests

The nature of damage of the major insect pests is presented in Fig 1(a-e). The 1st and 2nd instar larvae of *S. obliqua* damaged the soybean leaves and shoots and gregariously occurred in the same plants and leaves. Later on, 3rd and onward instars dispersed and moved from one plant to another and fed on the older leaves, stems, shoots, flowers and pods causing serious damage to the plant. The yellowish green larvae of leaf roller rolled the leaves of soybean plants and several may be webbed together and feed inside. Damaged leaves became silvery-brown papery. About 2-3 larvae remained in a single folded leaf. The pale green larvae of *S. litura* damaged the leaves and shoots by feeding voraciously. Infested leaves had irregular holes, growth of the plant was arrested, flower and pod formation was hindered. Very small larvae of the stem fly pest bore into the stem through the petiole. They feed on cortex and pith of the stem causing tunneling of the stems. The green larvae of *H. armigera* feed on leaves and tender shoots firstly; later on they bore pods and feed inside. The green stink bugs suck sap from the tender shoots, leaves, and pods resulting distorted leaves and pods.

Succession of the pests

The succession of the major insect pests of soybean crop during 2017 - 2018 at Noakhali region is presented in Fig 2. Soybean crop was first attacked by leaf beetle, *Monoleptasignata*, *Cyrtozemiacognata*, epilachna beetle, pumkin beetle, *Aulacophorai*sp., black cutworm, *Agrotisipsilon*, leaf hopper, *Aphannussordidus*, jassids, *Empoasca*spp. at the seedling stage and their infestation continued up to pod formation stage of the crop during February 2018. After 2-3 weeks, leaf roller, *Lamprosemaindicata* F. common cutworm, *Spodopteralitura*F. hairy caterpillar, S. *obliqua* , pod borer, *Helicoverpaarmigera*Hubner, green stink bug, *Nezaraviridula*L., rice bug and other pentatomid bugs were frequently observed from flowering to maturity of the crop and recorded during February to April 2018.The bugs were also important which suck sap from the tender part of the stems, leaves and pods. The white fly and aphids were noticed from vegetative to pre-maturity of the crop and act as vectors of yellow mosaic virus (YMV) and leaf curled viruses that seriously affected the plant growth and yield of soybean crop in both the years. Stem fly was observed from seedling to pod formation stage of the crop while pod borer damage was recorded at the flowering and pod pre-maturity stage in both the years (Fig 2).

The most damaging insects were hairy caterpillar, leaf roller, common cutworm, pod borer and stem flies and these were found to damage during vegetative, flowering and pod formation stages (30-65 DAS) of the crop. The yield loss caused by these pests has been estimated more than 25% in Bangladesh. In the soybean field infestation of insect pests like stem flies, bugs, jassids and white fly were frequently observed. Stem flies (*Ophiomyiaphaseoli* and *Melanagromyzasojae*) were the major pests of soybean and about 30-40% loss was occurred due to attack of these pests recorded in the farmers fields at Subarnachar, Noakhalidistrictsofthis country. About 10-20% pod was damaged by pod borer at the pod formation to prematurely of the crop. About 100 % soybean plant and 70% leaf were infested by leaf roller and common cutworm and hairy caterpillar (Table 2).

The insect pests of soybean were recorded in Bangladesh by several scientists. Alam (1976) listed only four species of insect pests attacking the soybean. Of these, leaf roller (*L. indicata* F.) and mealy bug (*Pseudococcuscorymbatlus*) were important.Sardar and Debnath (1984) recorded 15 species of insects of soybean crop in Bangladesh. Of these, bean bug, leaf roller, hooded hopper caused serious damage. Kaul and Das (1986) recorded 14 species of insect pests attacking soybean in Bangladesh. Of these, hairy caterpillar, cutworm, leaf roller (*L. indicata* F.) and bug (*N.viridula*L.) were recorded as major pests. The survey report of Ali (1988) in the northern Bangladesh revealed 47 species of insect pests in different stages of soybean crop in that area. Of these, 12 species were considered as serious pests. Begum (1995) listed 9 species of insects in soybean, Das (1998) recorded two major pests namely, hairy caterpillar and stem fly, and Biswas (2008) recorded 35 species of insect pests attacking soybean at Gazipur all of which were also recorded in this study. Biswas (2001, 2013) reported that leaf roller (*L. indicata*) and hairy caterpillar (*S. obliqua*) were the major pests of soybean and about 80% plant and about 60% leaf were infested by the attack of these pests.

The succession of appearance of the insect pests on soybean showed that the population of different pest species occurred in an overlapping manner and the crop was under the continuous attack of one or more insects. Most of the major and minor pests appeared in the crop during vegetative to flowering stages (30-50 days after sowing) and the maximum infestation occurred during flowering and pod formation stages of the crop in 2018. Although most of the insects recorded from soybean crop during the study period have been considered as minor, it is not unlikely that any one of the minor pests may attain the status of a major pest depending upon the environmental conditions and changing cropping pattern.

Table 1. Insect pests recorded from soybean crop ecosystems at Noakhali region, Bangladesh, during crop season of 2018.

Common Name	**Scientific Name**	**Order**	**Family**	**Feeding behaviour**
Hairy caterpillar*	*Spilarctiaobliqua* (Walker)	Lepidoptera	Arctiidae	Leaf feeder
Hairy caterpillar	*Anarsiaephippias* (Mullar)	Lepidoptera	Arctiidae	Leaf feeder
Common cutworm*	*Spodopteralitura*Fab.	Lepidoptera	Noctuidae	Leaf feeder& cutter
Leaf roller*	*Lamprosemaindicata*F.	Lepidoptera	Pyralidae	Leaf roller &feeder
Stem fly*	*Ophiomyiaphaseoli*(Tryon.)	Diptera	Agromyzidae	Stem borer
Shoot fly	*Melanagromyzasojae* Mach	Diptera	Agromyzidae	Shoot borer
White fly	*Bemisiatabaci*Genn.	Diptera	Aleyrodidae	Sap sucker
Pod borer*	*Helicoverpaarmigera*(Hub)	Lepidoptera	Noctuidae	Pod feeder
Black cutworm	*Agrotisipsilon* (Hufn.)	Lepidoptera	Noctuidae	Stemcutter
Leaf miner	*Stomopteryx*spp.	Lepidoptera	Gelechiidae	Miner &feeder
Semilooper	*Plusiaorichalcea*(Fab.)	Lepidoptera	Noctuidae	Leaf feeder
Green grasshopper	*Attractomorphacrenulata*F.	Orthoptera	Acrididae	Leaf feeder
Green stink bug	*Nezaraviridula* L.	Hemiptera	Pentatomidae	Sap sucker
Stink bug	*Dolycorisindicus*Stal.	Heteroptera	Pentatomidae	Sap sucker
Pod bug	*Eusarcocoris*sp.	Heteroptera	Pentatomidae	Sap sucker
Coreid bug	*Leptocorisa*spp.	Heteroptera	Coreidae	Sap sucker
Aphid	*Aphis craccivora* (Koch)	Homoptera	Aphididae	Sap sucker
Leaf hopper	*Aphannussordidus* F.	Homoptera	Jassidae	Sap sucker
Jassid	*Empoasca*sp.	Homoptera	Jassidae	Sap sucker
Mealy bug	*Pseudococcusfilamentosus*	Homoptera	Coccidae	Sap sucker
Brown hopper	*Nilaparvatalugens*	Homoptera	Jassidae	Sap sucker
Thrips	*Frankliniellaschultzei*	Thysanoptera	Thripidae	Sap sucker
Black weevil	*Cyrtozemia cognate*Marsal	Coleoptera	Curculionidae	Leaf feeder
Grey weevil	*Myllocerus discolor*Boh.	Coleoptera	Curculionidae	Leaf feeder
Weevil	*Tenymecusindicus*Fst.	Coleoptera	Curculionidae	Leaf feeder
Pumkin beetle	*Aulacophora*sp.	Coleoptera	Chysomelidae	Leaf feeder
Leaf beetle	*Monoleptasignata*Olv.	Coleoptera	Chysomelidae	Leaf feeder
Black beetle	*Oulema*sp.	Coleoptera	Chysomelidae	Leaf feeder
Flea beetle	*Phyllotrata*sp.	Coleoptera	Chysomelidae	Leaf feeder
Epilachna beetle	*Epilachna 12-punctata*	Coleoptera	Chysomelidae	Leaf feeder

*Major pest

- Observation of 10plants/plot, In-situ counting of insect

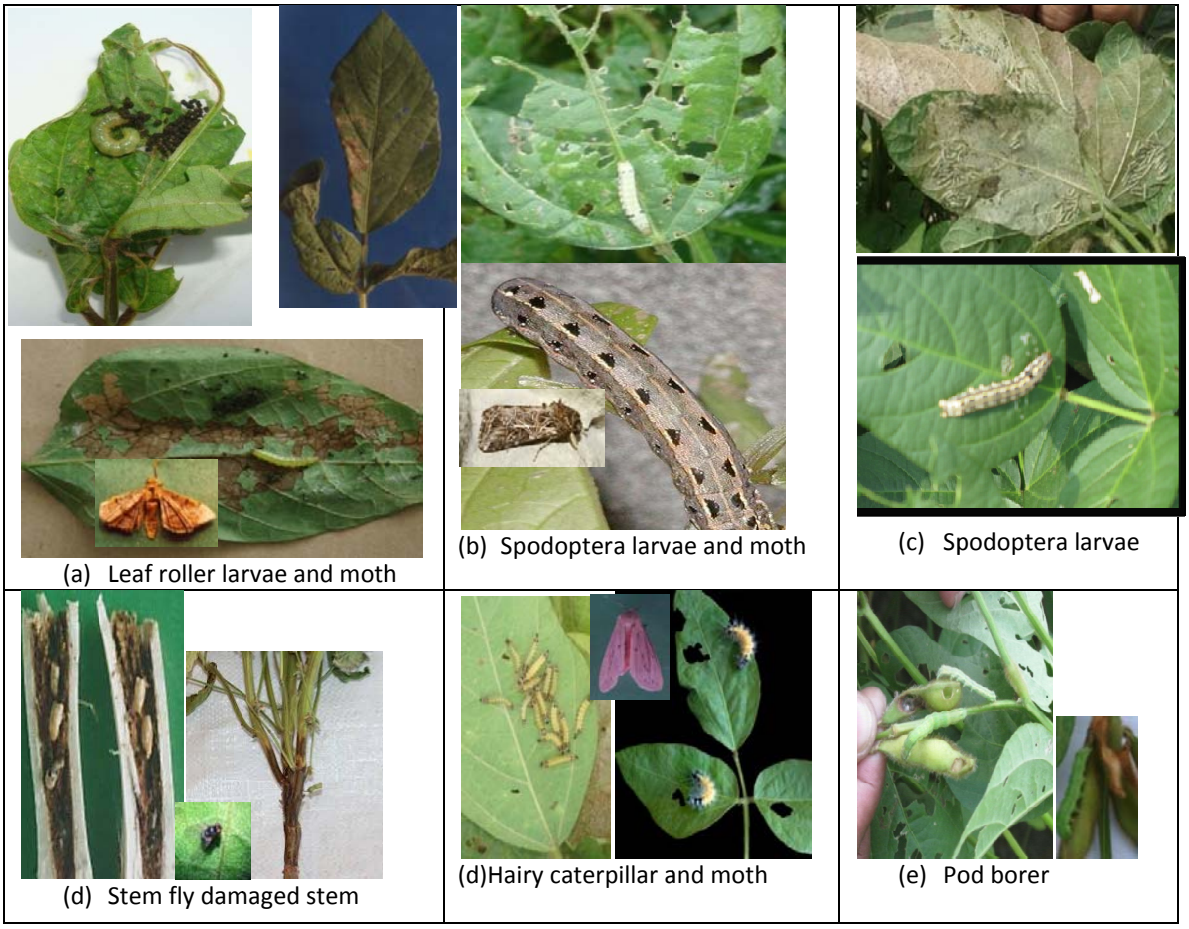

Fig.1(a-e).The major insect pests with nature of damage of soybean in Noakhali and Gazipur recorded in 2017-2018.

Table 2. Population density per plant and per cent infestation of some important insect pests of soybean crop during 2018 at Noakhali region.

Name of insects	No. of insect /plant	Per cent plant infestation	Stage of severe infestation
	2018	2018	
Hairy caterpillar *(S.obliqua)*	0.25-0.35	30-40	F-P
Leaf roller	1.50-2.00	60-70	V-F
Common cutworm	1.20-1.50	80-90	V-F
Stem fly	1.00-1.50	35-40	S-P
Pod borer	0.30-0.35	20-25	F-M
White fly	2.00-2.50	80-90	V-P
Green stink bug	0.30-0.50	30-40	V-P
Leaf hopper	3.00-4.00	80-100	V-P
Semilooper	0.20-0.25	20-30	V-P
Leaf beetle	2.00-3.00	80-90	S-F
Green grasshopper	0.20-0.25	15-20	V-M
Flower thrips	3.00-4.00	65-85	F
Grey weevil	0.10-0.20	10-15	V-P
Jassid	2.00-3.00	95-100	V-P
Aphid	3.00-4.00	20-30	V-P
Leaf miner	1.50-2.50	50-80	V-P
Mealy bug	1.50-4.50	10-20	V-P
Black beetle	3.00-4.00	20-25	S-P
Flea beetle	4.00-5.00	20-25	S-P

Data were recorded on average of 40 soybean plants.
Observation of 10plants/plot, In-situ counting of insect

V- Vegetative, S-Seedling, F-Flowering, P-Pod formation, M-Maturity

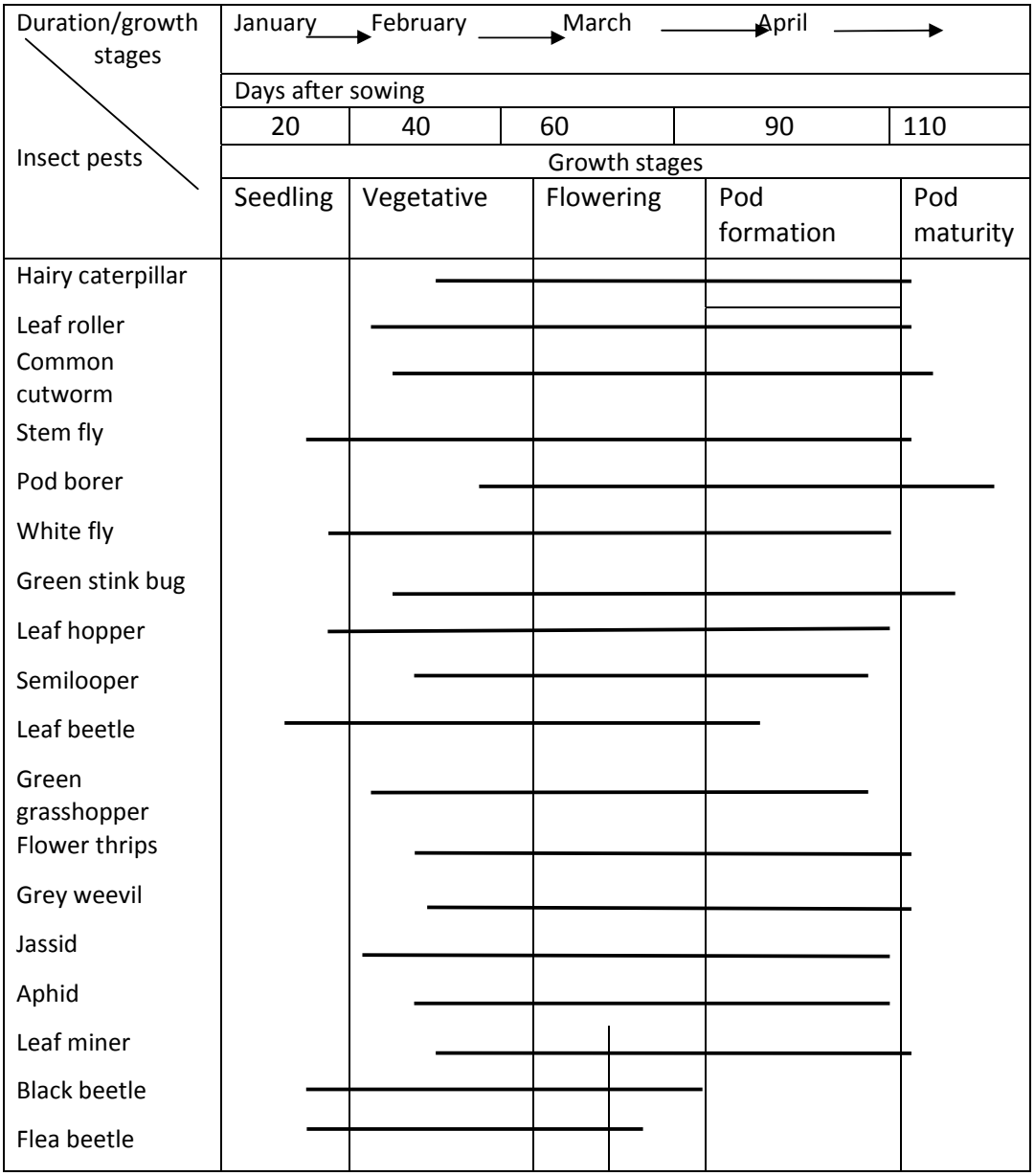

Fig 2. Succession of important insect pests of soybean in relation to crop stages during 2018 in Noakhali and Laxmipur Districts.

The duration of occurrence of each species on the crop is shown by horizontal lines.

Experiment No. 02

VALIDATION OF INTEGRATED PEST MANAGEMENT PACKAGES AGAINST THE MAJOR INSECT PESTS OF SOYBEAN

One of the major constraints to the successful soybean production in Noakhali region, Bangladesh is the damage caused by insect pests. Several major insect pests namely, hairy caterpillar, common cut worm, leaf roller and pod borer attack soybean crop in Bangladesh and insect damage is a limiting factor for successful production of soybean. Research experiences reveal that 15 - 20 percent of the total soybean production is lost directly or indirectly by the attack of insect pests every year (Biswas, 2012). The farmers of this region do not take proper attention for managing the insect pests and thus the farmers get very low yield (1.0-1.3t/ha) whereas the potential yield of soybean is 1.8-2.5t/ha. Now IPM technologies for managing the pests are available in the Oilseed Research Centre, BARI. Therefore farmers can minimize this yield gap (80%) and reduceinsecticides by adopting eco-friendly IPM technologies.

Common cutworm (*Spodopteralitura*), leaf roller (*Lamprosemaindicata* Fab.), hairy caterpillar (*Spilarctiaobliqua* Walk.), and pod borer (*Helicoverpaarmigera*) are the major and serious pests of soybean and acting as limiting factors for successful cultivation of this crop in recent years (Biswas, 2013). The green larvae of leaf roller fold and roll the leaves from tip downwards and then feed inside. The pest infests 70-90% soybean plants resulting in about 10% loss of yield (Singh, 1990). The hairy caterpillar and common cut worm defoliate the leaves and feed voraciously and cause a great economic loss. Chemical insecticides cannot control insects properly. Besides this, misuse and overuse of the insecticides causes phytotoxicity of the plant creating environmental pollution and human health hazards(McIntyre *et al*. 1989). So, use of Integrated Pest Management (IPM) component namely, hand picking, perching technique, clean cultivation, pheromone trap and bio-controlling agents etc. is a good approach. Use of sex pheromone is a new dimension of a specific insect pest management. Sex pheromone of spodoptera attracts the adult male moth of this insect. The sex pheromone traps are available in the Entomology Division, BARI, Gazipur and The Ispahahi Biotech Lab at Konabari, Gazipur. Bio-control agents (natural enemies) play an important role in biological control of the pests. *Braconhabetor* is an aggressive parasitic wasp. Female wasp at first injects venom and thus paralyzes insect larvae. It lays its eggs on the host larvae: multiply therein and thus destroys the pests. Thus the parasitoids play an important role for pest control. Suitable eco-friendly management technique against these pests is scanty. Therefore, the study was undertaken to find out and validate the most effective management option for managing these pests in the farmers fields for adoption of the IPM technologies.

Materials and Methods

The experiment was conducted in the farmers fields of Subarna Char, Noakhaliand Char Martin, Laxmipur, during 2017-18 in Young Meghna Estuarine Floodplain (AEZ-18f) and research field and laboratory of Oilseed Research Centre (ORC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, during December to June, 2017-18. Before setting the experiment farmers training was conducted for 15 selected farmers on improved soybean cultivation with emphasis on IPM techniques for eco-friendly pest management in both the districts. Seeds of the variety BARI soybean-5 were sown on 3rd week of January 2018 in 60m X 50m farmer's plots and research plot of ORC, BARI, Gazipur following RCB design with 4 replications. Fertilizers and other intercultural operations were done uniformly as per recommendation of Annual Research Report (2016-17), Oilseed Research Centre, BARI, Gazipur. Four treatments were used in this experiment. The treatments are IPM package-1 : Hand picking of infested leaf with larvae + Perching with bamboo sticks+ use of sex pheromone for trapping *Spodopteralitura* moth @ 30 traps/hectare+ release of *Braconhabetor* @ 1 bunker/ week/ha and IPM package-2 :Hand picking of infested leaf with larvae + use of sex pheromone of *S. litura* + spraying of Spinosad (Success 2.5 SC @ 1.2 ml/litre + Bt (*Bacillus thuringiensis*) @ 0.4 g/L, package-3: Farmers practice : application of Nitro 505 EC

(Cypermethrin+Chlorpyriphose)@ 2ml/L)/@ 2 ml/L and Virtako 40 WG/Voliam flexi (Chlorantraniliprole+Thiomethoxam)@ 0.15 g/L, and Untreated control (water spray only).

Number of *Spodoptera* moth was collected from the pheromone trap every day and every7 days intervals from 1st week of March to the last week of April, 2018. Total number of *Spodoptera* moth was counted each of eight pheromone traps and recorded. Number of larvae of the major insects was counted per plant from the different treatments at 7 days intervals during March –April in 4 frequencies. Numbers of total and infested plants and leaves per randomly selected two rows per plot were recorded. Numbers of total and infested leaves per plant in different treatments from randomly selected two rows per plot were recorded. Total number of plant per square meter was counted and recorded. Percent plant and leaf infestations were calculated by counting infested and healthy plants and leaves per plot in all the treatments. The percent insect population and their plant and leaf infestations and infestation reduction over untreated control were calculated on the basis of a formulae given below:

Percent population or infestation reduction over untreated = X_1-X_2/X_1 x100

Where, X_1 = Mean population of infestation in untreated plots

X_2= Mean population of infestation in treated plots

The crop was harvested on the last week of April, 2018 in both the locations. Yield contributing post harvest data like plant height, number of branches, number of pods per plant, number of seed/pod, pod length, number and weight of seed per plant, hundred seed weight and finally yield Kg/plot were recorded. Yield data Kg/plot were recorded and converted to t/ha. Data were analyzed statistically following Gomez and Gomez (1984). Analysis of Variance (ANOVA) was done following MSTATE-C and mean separation was done using Duncan's Multiple Range Test (DMRT). Marginal Benefit cost ratio (MBCR) of the treatments was also recorded and calculated.

Results and Discussion

Leaf roller (*Lamprosemaindicata*)

Incidence of leaf roller larvae was observed in the soybean crop during the first week of March at the early vegetative stage and continued up to the 3rd week of April, 2018 in both Subarnachar , Noakhali and Charmartin , Laxmipur. The highest larval population (0.75/plant in Noakhali and 0.70/plant in Laxmipur) was recorded on the last week of March at the reproductive stage of the crop and then gradually declined(Fig.3a). Leaf roller population was slightly higher in Noakhali than Laxmipur (Fig. 3a).

Percent plant infestation by leaf roller was observed in the soybean crop during the first week of March, 2018 and continued up to the 3rdweek of April, 2018 in both the locations. The highest plant infestation (80-85%) was recorded on the last week of March and then gradually declined (Fig.3b). Almost similar infestation trend was observed in case of percent leaf infested by leaf roller in both the locations (Fig 3c).

Common cutworm (*Spodopteralitura*)

Spodoptera larvae and their infestations were observed in the soybean crop during the second week of March, 2018 at the vegetative stage and continued up to the last week of April. Initially the larval population was low and then it increased gradually and the highest larval population (1.10/plant in Noakhali and 1.00/plant in Laxmipur) was recorded on the first week of April at the reproductive stage of the crop and then gradually declined (Fig. 3d).

Percent plant infestation by *Spodoptera* was observed in the soybean crop during the second week of March, 2018 and continued up to the 3rd week of April, 2018 in both the locations. The highest plant infestation (90-85%) was recorded on the first week of April, 2018 and then gradually declined (Fig. 3e). Almost similar infestation trend was observed in case of percent leaf infested by *Spodoptera* in both the locations (Fig. 3f).

Hairy caterpillar (*Spilarctiaobliqua*)

Hairy caterpillar and its infestations were observed in the soybean crop during the second week of March, 2018 at the vegetative stage and continued up to the last week of April. Initially the larval population was low and then it increased gradually and the highest larval population (0.90/plant in Noakhali and 0.85/plant in Laxmipur) was recorded in the first week of April at the reproductive stage of the crop and then gradually declined (Fig.3g).

Percent plant infestation by hairy caterpillar was observed in the soybean crop during the second week of March, 2018 and continued up to the 3rdweek of April, 2018 in both the locations. The highest plant infestation (95% in Noakhali and 90% in Laxmipur) was recorded on the first week of April,2018 and then gradually declined (Fig. 3h). Almost similar infestation trend was observed in case of percent leaf infested by hairy caterpillar in both the locations (Fig. 3i). Biswas *et al.* (2001) reported that leaf roller (*L. indicata*) and hairy caterpillar (*S. obliqua*) were the major pests of soybean and about 80% plant and about 60% leaf were infested by the attack of these pests. Almost similar information was recorded by Biswas (2001, 2010, 2012 and 2013) and Biswas and Das (2011) in Bangladesh.

Stem fly (*Ophiomyiaphaseoli*)

Incidence of stem fly infestation on soybean crop at Subarnachar, Noakhali was observed in the 1st week of March, 2018 and it increased gradually and the highest infestation was recorded in the last week of April, 2018 and then decreased gradually (Fig. 3j.). The infested stems were dissected longitudinally and observed a barrel shaped yellowish pupae in the stem pith region. The severity of stem damage was much higher (50-55%) stem infestation in Subarnachar, Noakhali, than Charmartin, Laxmipur (20-25%) due to favorable weather condition prevailed in this region.

Pod borer (*Helicoverpaarmigera*)

Percent pod infestation by pod borer was observed in the soybean crop during the third week of March, 2018 and continued up to the fourth week of April, 2018 in both the locations. The highest pod infestation (4% in Noakhali and 3.5% in Laxmipur, was recorded in the second week of April,2018 and then gradually declined (Fig.3k). Almost similar information was recorded by Ali (1981), Biswas (2001and 2013) and Biswas and Das (2011) in Bangladesh.

Number of insect per plant and percent population reduction over untreated of major insects of soybean crop in IPM and non IPM packages in 2018 at Subarnachar, Noakhali are presented in Table 3. Result revealed that the lowest number of *Spodoptera* larva, leaf roller and hairy caterpillar was found in the IMP Package-2 (0.24-0.25/plant) followed by IPM Package-1 (0.28-0.30/plant) due to the use of sex pheromone traps and other IPM techniques like hand picking of larvae, perching techniques and use

of bio-pesticides in the soybean crop (Table3). While the highest number of these insect pests was recorded in the untreated plots (1.00-1.50 larvae/plant). Comparatively the higher number of the major insects pests larvae was recorded from the farmers plots than IPM plots. Significantly the highest number of larvae (1.00-1.50 larvae/plant) of these major insect pests was recorded from the untreated plots (Table 3).

Numbers of insect per plant and percent population reduction over untreated of major insects of soybean crop in IPMand non IPM packages in 2018 atCharmartin, Laxmipur are presented in Table 4. Result revealed that the lowest numbers of *Spodoptera* larva, leaf roller and hairy caterpillar were found in the IMP Package-2 (0.22-0.23/plant) followed by IPM Package-1 (0.25-0.28/plant) due to the use of sex pheromone traps and other IPM techniques like hand picking of larvae, perching techniques and use of bio-pesticides in the soybean crop (Table 4). While the highest number of these insect pests was recorded in the untreated plots (1.10-1.40 larvae/plant). Comparatively the higher number of the major insects pests larvae was recorded from the farmers plots than IPM plots. Significantly the highest number of larvae (1.10-1.40 larvae/plant) of these major insect pests was recorded from the untreated plots (Table 4).

The significantly highest population reduction over untreated control plots of common cutworm, leaf roller and hairy caterpillar was 83.33%, 75.00% and 76.00%, respectively recorded from IPM Package-2 followed by IPM package-01 and farmers' insecticides treated plots at Subarnachar, Noakhali (Table 3). Similarly the significantly highest population reduction over untreated control plots of common cutworm, leaf roller and hairy caterpillar was 84.28%, 78.18% and 80.00%, respectively recorded from IPM Package-2 followed by IPM package-01(82.14%, 76.36% and 74.00%, respectively) and farmers' insecticides treated plots at Char martin, Laxmipur (Table 4).

Percent plant and leaf infestation and infestation reduction over untreated of major insects of soybean in IPM and non IPM packages in 2018 at Subarnachar, Noakhali are presented in Table 5.The significantly lowest percent plant (15.55-16.50%) and leaf infestation (14-16%) were recorded in the IPM package 2 treated plots (Table 5). While the significantly highest percent plant (85%) and leaf (80.45) were recorded in the untreated plots followed by farmers plots (Table 5). IPM package-2 reduced 82% plant and leaf Infestation (82%) over untreated followed by IPM package-1 (80-82% infestation) in Noakhali and Laxmipur districts (Tables 5 and 6). Almost similar trends of percent plant and leaf infestation reduction over untreated and caused by the major insects were observed in IPM and non IPM soybean plots (Tables 5 and 6)).

Initially the *Spodoptera* moth captured by the sex pheromone traps was low during the first week of March,2018. Number of moth captured increased gradually and the highest number of moth captured (16 moth /trap/day) was recorded in the third week of March and then decreased gradually (Fig.4a). The highest number of *Spodoptera* adult (98/trap) captured in the sex pheromone trap weekly observed during 3rd week of March 2018. The highest total number of *Spodoptera* adult moth (680/trap) captured in the sex pheromone trap during March-April, 2018 at the flowering and pod formation stages of the crop and then declined gradually (Fig.4b). A total of 3034 *Spodoptera*adults moths were captured in the 8 sex pheromone traps during March and April 2018(Fig.4b). *Spodoptera* moths was captured by the pheromone traps during night.

The soybean crop was sown in the last week of January and harvested on the last week of April and first week of May, 2018 in Noakhali and Laxmipur . The crop duration in different locations ranged from 89 to 96 days (Table 7.) Efficacy of different IPM and non IPM packages on the yield and yield contributing characters of soybean during 2018 at Subarnachar, Noakhaliis presented in Table 8. The yield contributing characters namely, average plant height, number of branches per plant, number of pods per plant, pod length, number of seeds per plant, hundred seed weight and the highest seed yield were recorded and significantly the highest from IPM package-2 treated plot followed by IPM package-1 treated plot (Table 8).

Efficacy of different IPM and non IPM packages on the yield and yield contributing characters of soybean during 2018 at Charmartin, Laxmipuris presented in Table 9. The yield contributing characters namely, average plant height, number of branches per plant, number of pods per plant, pod length, number of seeds per plant, hundred seed weight and the highest seed yield were recorded and significantly the highest from IPM package-2 treated plot followed by IPM package-1 treated plot (Table 9).

Economics of different IPM and non IPM packages against major pests of soybean in 2018 at Subarnachar, Noakhaliis presented in Table 10. The highest seed yield (2.20 t/ha) was obtained from IPM Package-2 followed by IPM Package-1(2.10 t/ha) and the farmers practice (Table 10). The seed yield was significantly high among the IPM packages and non IPM i.e. farmers treated plots. The significantly lowest seed yield was obtained from untreated control plots(1.40 t/ha) (Table 10). In case of Marginal Benefit Cost Ratios, the highestM BCR was 2.50 calculated from the IPM package-1 treated plots followed by IPM Package-2 (2.20) and the farmers practiced plots (1.75) (Table 10). Almost similar information was recorded by Biswas (2010, 2011, 2012 and 2013).

Economics of different IPM and non IPM packages against major pests of soybean in 2018 at Charmartin, Laxmipur are presented in Table 11. The highest seed yield (2.25 t/ha) was obtained from IPM Package-2 followed by IPM Package-1(2.15 t/ha) and the farmers practice (Table 11). The seed yield was significantly high among the IPM packages and non IPM i.e. farmers treated plots. The significantly lowest seed yield was obtained from untreated control plots(1.40 t/ha) (Table 11). The pest management cost was higher in IPM package-2 than IPM package-1 and farmers practiced plot. In case of Marginal Benefit Cost Ratios, the highest MBCR was 2.75 calculated from the IPM package-1 treated plots followed by IPM Package-2 (2.40) and the farmers practiced plots (1.75) (Table 11). Almost similar information was recorded by Biswas (2010, 2011, 2012 and 2013).

Summary of the Results

IPM package -2 (HP+SexPheromone+Perching + Bt+ Spinosad (Success 2.5 SC @ 1.2 ml/litre) reduced the highest population of common cutworm (83%), leaf roller (75%) and hairy caterpillar (76%) and also reduced the highest plant and leaf infestation (80-82%) in soybean crop and produced the highest seed yield (2.25 t/ha).The highest MBCR was 2.75 calculated from IPM package-1(HP+SexPheromone+Perching +Bio-control agent) followed by IPM package -2 (2.40) and farmers practice(1.75) (Table 11) . The result revealed that IPM techniques of pest management reduced pest infestation, management cost and also reduced environmental pollution by reducing use of chemical pesticides in these regions. Farmers were trained on application techniques of IPM component and they gathered knowledge about this method.

Farmers of Subarna Char, Noakhaliand Char Martin, Laxmipur were very pleased and highly impressed observing the demonstrated results i.e. attraction of *Spodoptera*moth in the sex pheromone trap on soybean crop. They were very satisfied to see the result and techniques of IPM method for managing insect pests of soybean crop and they were finally benefited economically and ecologically. These technologies will be helpful to the farmers for soybean cultivation in an eco-friendly way.

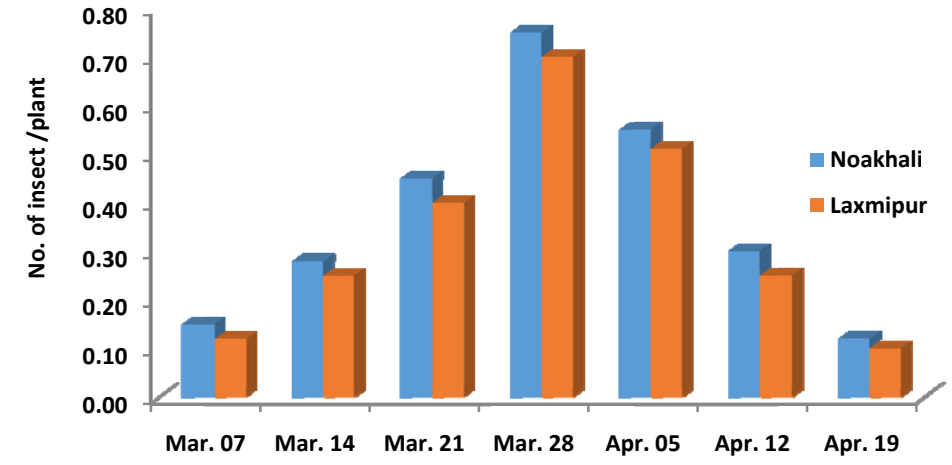

Fig.3a. Incidence of Leaf roller larva/plant in soybean crop at Subarnachar, Noakhali and Charmartin, Laxmipur during 2018

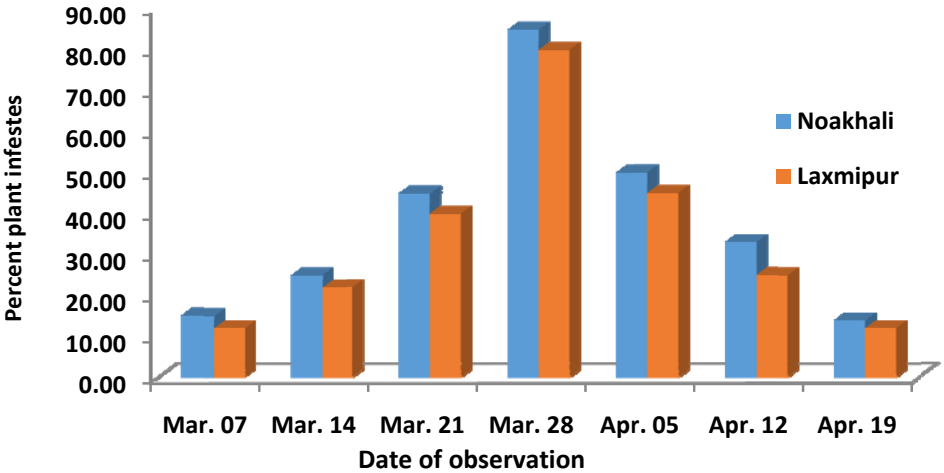

Fig.3b. Percent plant infestation by leaf roller in soybean crop at Subarnachar, Noakhali and Charmartin, Laxmipur in 2018

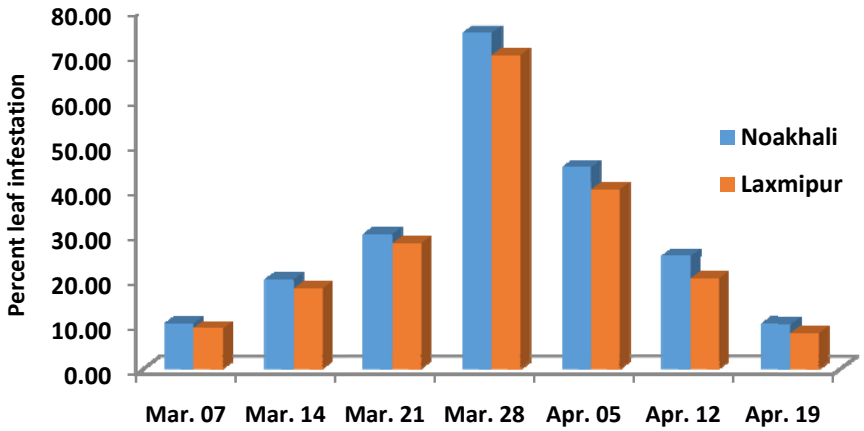

Fig.3c. Percent leaf infestation by leaf roller in soybean crop at Subarnachar, Noakhali and Charmartin, Laxmipur in 2018

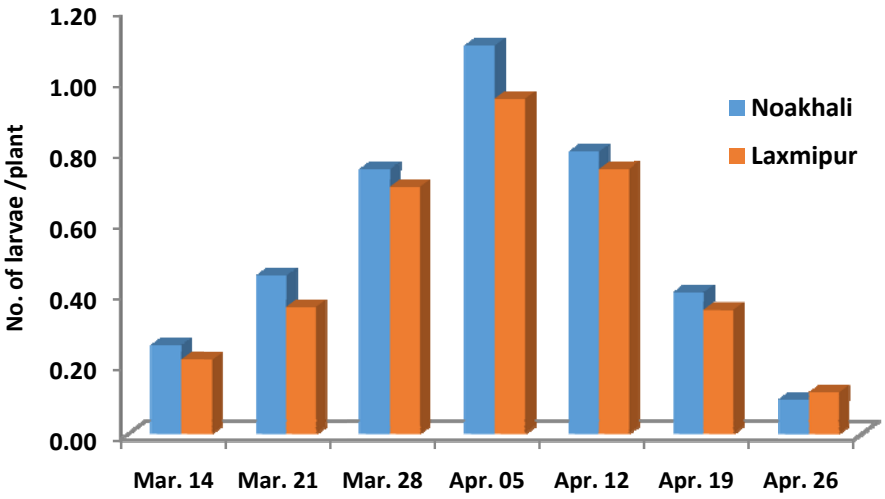

Fig. 3d. Incidence of *Spodoptera* larvae/plant at Subarnachar, Noakhali and Charmartin , Laxmipur in 2018

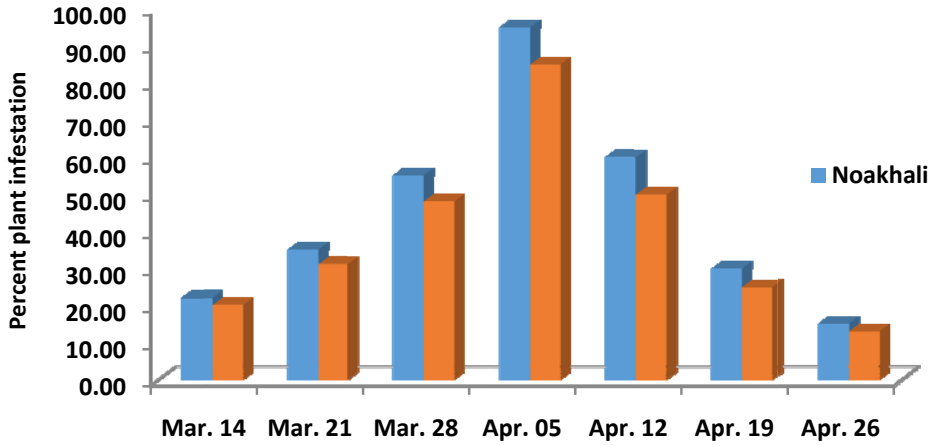

Fig.3e. Percent plant infestation by *Spodoptera* in soybean crop at Subarnachar, Noakhali and Charmartin, Laxmipur in 2018

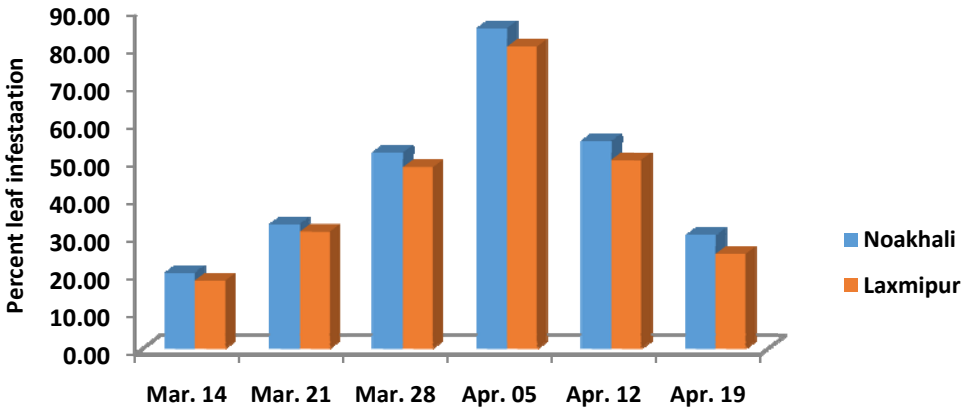

Fig. 3f. Percent leaf infestation by *Spodoptera* larvae in soybean crop in Noakhali, Laxmipur and Gazipur during 2018.

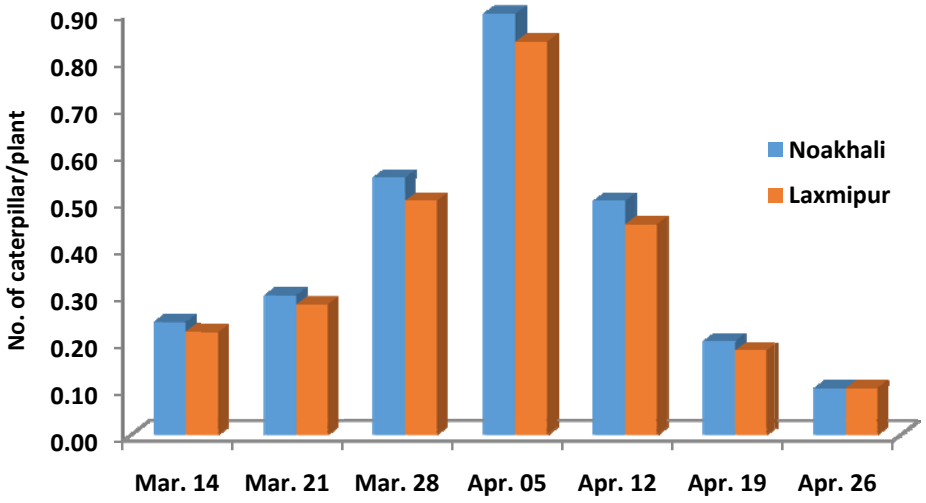

Fig. 3g. Incidence of *S. obliqua* larva /plant at Subarnachar, Noakhali and Charmartin , Laxmipur in 2018

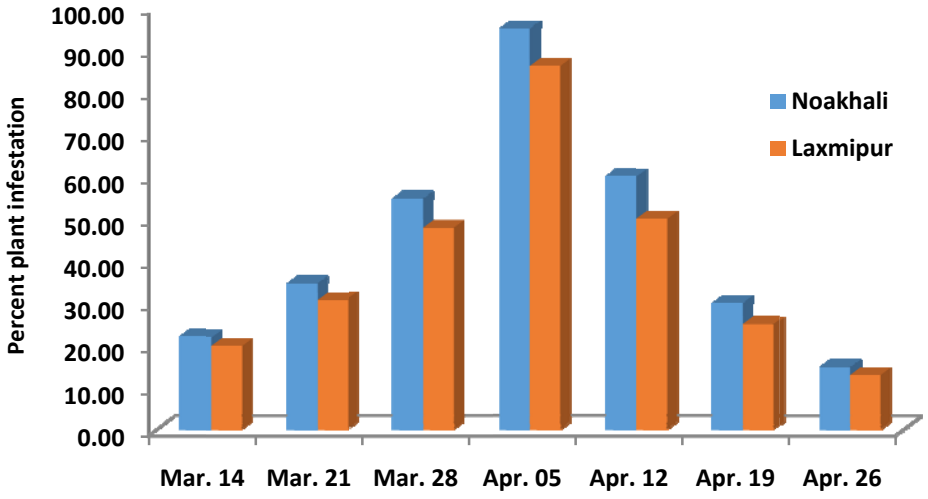

Fig.3h. Percent plant infestation by *S. obliqua* on soybean crop at Subarnachar, Noakhali and Charmartin, Laxmipur in 2018

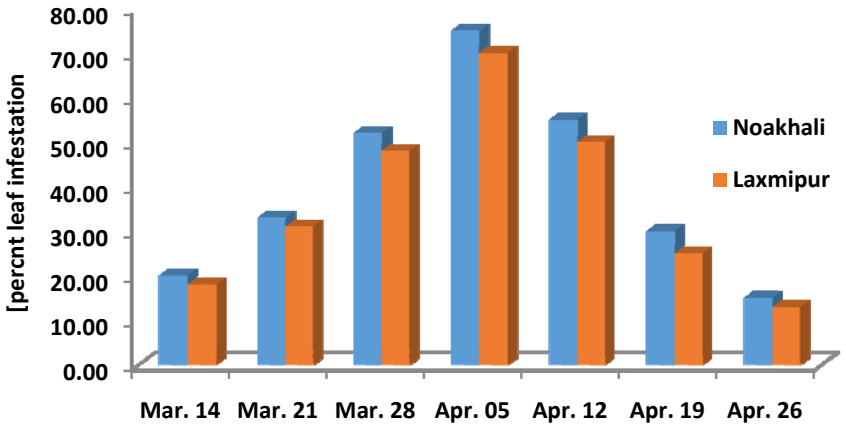

Fig. 3i. Percent leaf infestation by *S. obliqua* in soybean crop in Noakhali, Laxmipur and Gazipur during 2018.

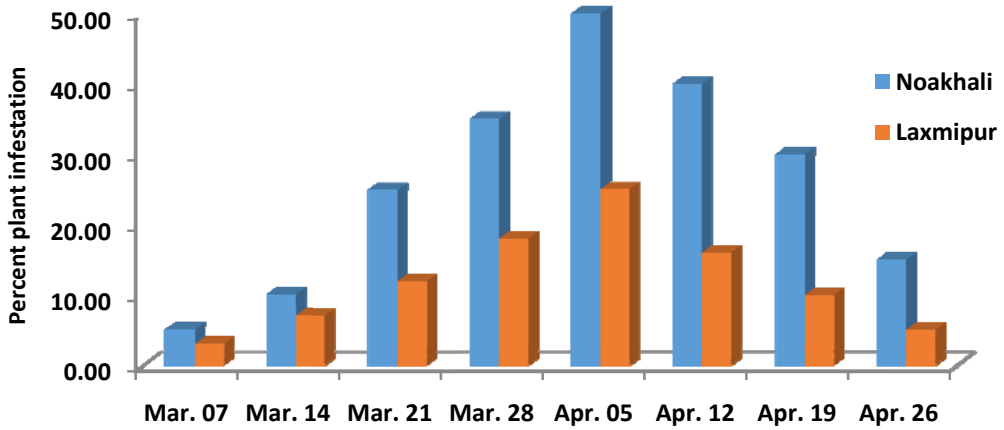

Fig.3j. Percent plant infestation by Stem fly (*O. phaseoli)* on soybean crop at Subarnachar, Noakhali and Charmartin, Laxmipur in 2018

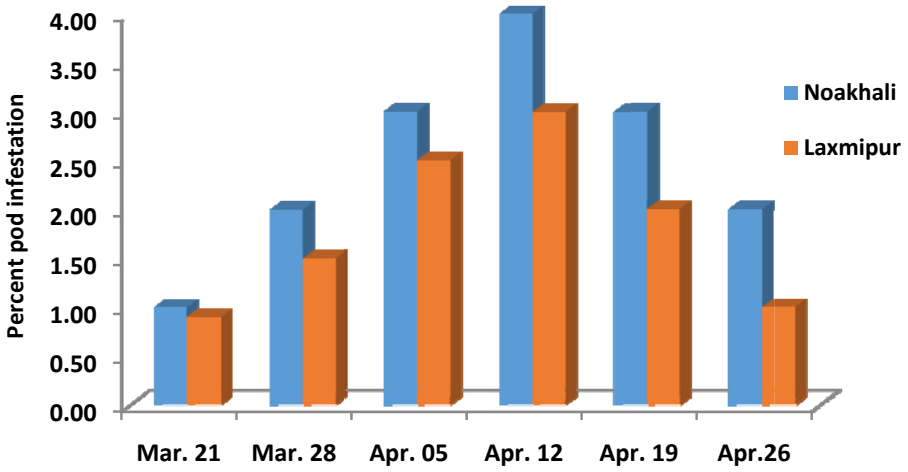

Fig. 3k. Percent pod infestation by Pod borer in soybean crop in Subarnachar, Noakhali and Charmartin, Laxmipur in 2018

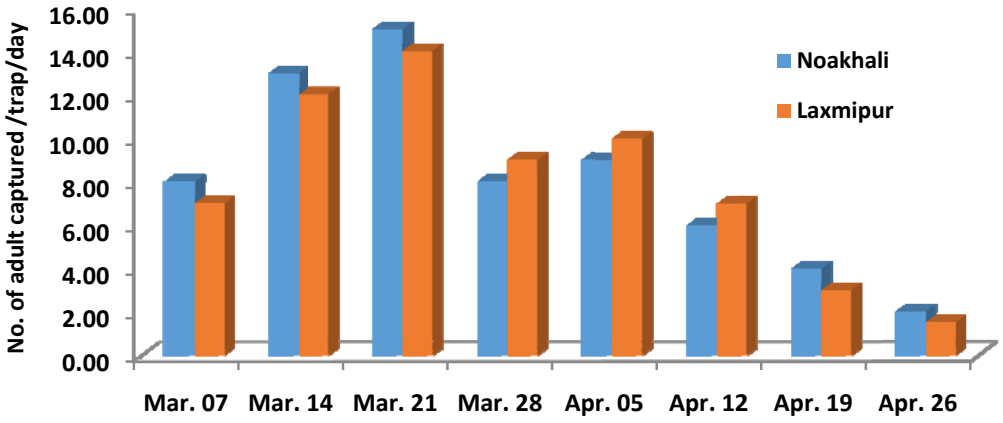

Fig.4a. Mean no. of *S. litura* adult captured in the pheromone trap/day at Subarnachar, Noakhali and Charmartin, Laxmipur in 2018

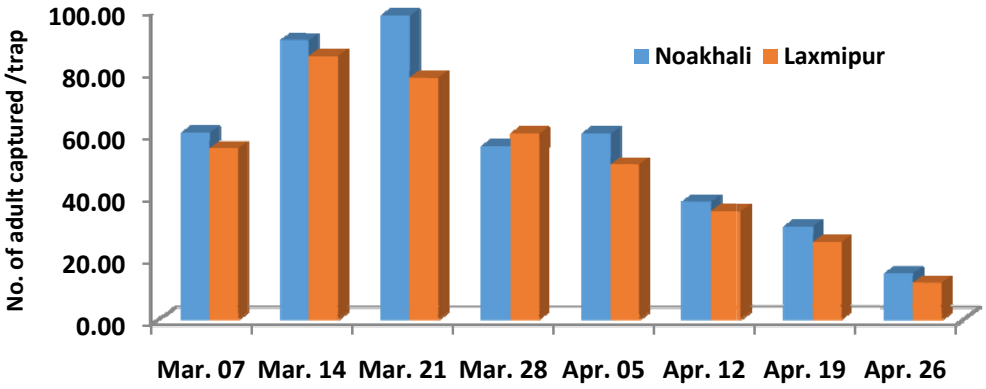

Fig.4b. Total no. of *S. litura* adult captured in the pheromone trap at Subarnachar, Noakhali and Charmartin, Laxmipur in 2018

Table 3. Number of insect per plant and percent population reduction over untreated of major insects of soybean crop in IPM and non IPM packages in 2018 at Subarnachar, Noakhali

Management package	No. of larvae /plant			Percent population reduction over untreated		
	Common cutworm	Leaf roller	Hairy caterpillar	Common cutworm	Leaf roller	Hairy caterpillar
IPM Package-1	0.30 c	0.28 b	0.30 b	80.00 a	72.00 a	70.00 a
IPM Package-2	0.0.25 c	0.25 c	0.24 c	83.33 a	75.00 a	76.00 a
Farmers practice	0.45 b	0.27 b	0.28 c	70.00 b	73.00 a	72.00 a
Untreated	1.50 a	1.00 a	1.00 a	-	-	-
Level of significance	*	*	*	*	NS	NS
CV%	15	22	20	6	5	6

Package 1= HP+Pherm.+Bracon Package 2= HP+Pherm.+Bt Package 3= Chlorpyriphos
Means of 4 observations. Data were recorded on average of 10 plants /plot.
Means followed by the same letters in a column do not differ significantly at 5% level by DMRT.

Table 4. Number of insect per plant and population reduction over untreated of major insects of soybean crop in IPM and non IPM packages in 2018 at Charmartin, Laxmipur.

Management package	No. of larvae /plant			Percent population reduction over untreated		
	Common cutworm	Leaf roller	Hairy caterpillar	Common cutworm	Leaf roller	Hairy caterpillar
IPM Package-1	0.25 c	0.26 b	0.28 b	82.14 a	76.36 a	74.00 a
IPM Package-2	0.22 c	0.23 c	0.22 c	84.28 a	78.18 a	80.00 a
Farmers practice	0.42 b	0.28 b	0.29 c	70.00 b	74.00 a	73.00 a
Untreated	1.40 a	1.10 a	1.10 a	-	-	-
Level of significance	*	*	*	*	NS	NS
CV%	15	22	20	6	5	6

Package 1= HP+Pherm.+Bracon Package 2= HP+Pherm.+Bt Package 3= Chlorpyriphos
Means of 4 observations. Data were recorded on average of 10 plants /plot.
Means followed by the same letters in a column do not differ significantly at 5% level by DMRT.

Table 5. Percent plant and leaf infestation and infestation reduction over untreated of major insects of soybean in IPM and non IPM packages in 2018 at Subarnachar, Noakhali

Treatments	Percent plant infestation	Percent leaf infestation	Percent plant infestation reduction over untreated	Percent leaf infestation reduction over untreated	Seed yield (t/ha)
IPM Package-1	16.50b	15.55b	80.74a	80.67a	2.10a
IPM Package-2	15.75b	14.37b	81.61a	82.14a	2.20a
Farmers practice	18.33b	16.75b	78.60a	79.17a	**1.90b**
Untreated	85.67a	80.45a	-	-	1.40c
Level of significance(0.05)	*	*	NS	NS	*
CV%	**25.41**	**22.45**			**5.25**

Means of 4 observations. Data were recorded on average of 10 plants /plot.
Means followed by the same letters in a column do not differ significantly at 5% level by DMRT.

Table 6. Percent plant and leaf infestation and infestation reduction over untreated of major insects of soybean in IPM and non IPM packages in 2018 at Charmartin, Laxmipur.

Treatments	Percent plant infestation	Percent leaf infestation	Percent plant infestation reduction over untreated	Percent leaf infestation reduction over untreated	Seed yield (t/ha)
IPM Package-1	15.50b	14.55b	82.12	82.14	2.15a
IPM Package-2	14.75b	13.37b	82.98	83.58	2.25a
Farmers practice	19.33b	17.75b	77.70	78.21	1.95b
Untreated	86.67a	81.45a	-	-	1.40c
Level of significance	*	*			*

Means of 4 observations. Data were recorded on average of 10 plants /plot.
Means followed by the same letters in a column do not differ significantly at 5% level by DMRT.

Table 7. Date of sowing, harvesting and duration of the soybean crop in Noakhali and Laxmipur districts during 2018

Locations	Date of sowing	Date of harvest	Crop duration (days)
Noakhali	22-01-18	27-04-18	95
Laxmipur	25-01-18	01-05-18	96

Table 8. Efficacy of different IPM and non IPM packages on the yield and yield contributing characters of soybean during 2018 at Subarnachar, Noakhali

Treatments	Plant height cm	No. of branches /plant	No. of pods/plant	No. of seeds/pod	100 seed wt(g)	Seed yield (t/ha)
IPM Package-1	30.45a	1.95a	42.56ab	2.00b	11.70a	2.10a
IPM Package-2	31.00a	2.00a	43.00a	2.40a	12.10a	2.20a
Farmers practice	30.00a	1.80a	38.15b	1.90b	11.60a	**1.90b**
Untreated	27.80a	1.60b	30.25c	1.70c	10.15a	1.40c
Level of significance	NS	*	*	*	NS	*

Means of 4 observations. Data were recorded on average of 10 plants /plot.
Means followed by the same letters in a column do not differ significantly at 5% level by DMRT.

Package 1= HP+Pherm.+Bracon+Perching, Package 2= HP+Pherm.+Spinosad+Bt, Package 3= Farmers practice (use of insecticides Virtako/ Nitro.

Table 9. Efficacy of different IPM and non IPM packages on the yield and yield contributing characters of soybean during 2018 at Charmartin, Laxmipur.

Treatments	Plant height cm	No. of branches /plant	No. of pods/plant	No. of seeds/pod	100 seed wt(g)	Seed yield (t/ha)
IPM Package-1	31.00a	2.00a	42.70ab	2.10b	11.75a	2.15a
IPM Package-2	31.50a	2.10a	44.00a	2.50a	12.15a	2.25a
Farmers practice	30.10a	1.85b	38.25b	1.95b	11.70a	**1.95b**
Untreated	28.50a	1.65c	30.50c	1.75c	10.25a	1.40c
Level of significance	NS	*	*	*	NS	*

Means of 4 observations. Data were recorded on average of 10 plants /plot.
Means followed by the same letters in a column do not differ significantly at 5% level by DMRT.

Package 1= HP+Pherm.+Bracon+Perching, Package 2= HP+Pherm.+Spinosad+Bt, Package 3= Farmers practice (use of insecticides Virtako/ Nitro.

Table 10. Economics of different IPM and non IPM packages against major pests of soybean in 2018 at Subarnachar, Noakhali.

Treatments	Yield (t/ha)	Increased yield over untreated (t/ha)	Cost of IPM & spray (Tk/ha)	Addition Income (Tk/ha)	Net income (TK./ha)	MBCR
IPM Package-1	2.10a	0.70	8000.00	28000.00	20000.00	**2.50**
IPM Package-2	2.20a	0.80	10000.00	32000.00	22000.00	2.20
Farmers Practice	1.90b	0.50	8000.00	20000.00	12000.00	1.50
Untreated	1.40c	-	-	-		

Means followed by the same letters in a column do not differ significantly at 5% level by DMRT.

Package 1= HP+Pherm.+Bracon+Perching, Package 2= HP+Pherm.+Spinosad+Bt, Package 3= Farmers practice (use of insecticides Virtako/ Nitro.

Table 11. Economics of different IPM and non IPM packages against major pests of soybean in 2018 at Charmartin, Laxmipur.

Treatments	Yield (t/ha)	Increased yield over untreated (t/ha)	Cost of IPM & spray (Tk/ha)	Addition Income (Tk/ha)	Net income (TK./ha)	MBCR
IPM Package-1	2.15a	0.75	8000.00	30000.00	22000.00	**2.75**
IPM Package-2	2.25a	0.85	10000.00	34000.00	24000.00	2.40
Farmers Practice	1.95b	0.55	8000.00	22000.00	14000.00	1.75
Untreated	1.40c	-	-	-		

Means followed by the same letters in a column do not differ significantly at 5% level by DMRT.

Cost of sex pheromone trap= TK. 95.00/trap, Cost of Bracon = Tk. 150 per container, , Cost of Bt powder = Tk5000/- per Kg. , Cost of Nitro 505 EC= Tk1800/litre., Cost of Spinosad (Success) 2.5 SC = Tk4500/- per Litre. Cost of Chlorpyriphos 20 EC = Tk 800/L. Cost of Virtako 40 WG (Chlorantraniliprole+Thiomethoxam)= Tk1400/-/100 g Price of soybean seed= Tk40 /kg, Cost of labour=Tk 450/- per labour/day. Three labours and 1 litre of Nitro @ 2 ml/I being required for 1 hectare of crop field sprayed once.One machine spray volume = 10 litre required 200 sqm field spraying once. Other variable costs were same in all the treatments. Three labours required for hand picking of insects/infested leaves of one hectare of crop field. MBCR= Net income/ Management cost

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5a.Farmers Training at subarnachar, Noakhali

5b. Farmers Training at Charmartin, Laxmipur

5c. Laboratory equipments

5d. Laboratory equipments

5e. Laboratory equipments

5f. Laptop and Camera

5g. Soybean sowing at Joydebpur

5h.Soybean sowing at Noakhali

5i.Soybean sowing at Laxmipur

Fig. 5(a-i). Training, procurement and sowing activities of soybean crop in Noakhali, Laxmipur and Gazipur districts during January, 2018.

6a.Field at Subarnachar, Noakhali

6b.Field at Subarnachar

6c. Field at Martin, Laxmipur

6d. Trap Setting in soybean field in Noakhali

6e. Trap Setting in soybean field in Noakhali

6f. Observation & field data collection in Noakhali

6g.Hand picking & sweeping techniques Laxmipur

6h.Spraying bio-pesticides in soybean fields, Laxmpur

6i. Observation & field data collection in Laxmipur

6j.Perching, Bracon release & trap setting in soybean field, Laxmipur

6k. Spodoptera moth counting

6l.Spodoptera moth in trap

Fig. 6(a-l).Major IPM activities of soybean crop in Noakhali and Laxmipur districts

Field day activities on IPM in soybean crop

7a. Field day activities on IPM in Laxmipur

7b. Field day activities on IPM in Laxmipur

7c. Field day activities on IPM in Laxmipur Charmartin ,Laxmipur

7d*Spodoptera* moth in trap in soybean field at

7e Farmer observing spodoptera in the pheromone trap in Laxmipur

7f Soybean pod observing in IPM field, Laxmipur

7g Soybean pod in plant & seeds

Fig. 7(a-g) A field day activities on IPM in soybean crop at Charmartin, Laxmipur, in 2018.

Impact of field day on IPM technology at Subarnachar, Noakhali and Charmartin, Laxmipur

A field day was conducted at Charmartin, Laxmipur district on soybean crop to show the results of IPM technologies to the farmers for managing major insect pests of soybean in the field(Fig.7(a-g). Dr. Md. Shakhawath Hossain, Director, Oilseed Research Centre, other scientists of OFRD and scientific assistant, local leaders, entrepreneurs, farmers, and NGO personnel were present in this field day occasion. About 100 people were present there. To see the direct demonstrated results on IPM components especially attracting a huge number of Spodopteraetc. has moth captured by the sex pheromone trap and other IPM component namely perching, net sweeping, release of *Bracon* parasitoids and spray of bio pesticides (Success and Bt) reduced significantly insect population and their infestation. On the other side, farmers' practices plots which was sprayed with only insecticides did not show good result compared to IPM plots. The farmers and visitors were very pleased to see the miracle results of IPM technologies i.e. attraction of *Spodoptera*moth in the sex pheromone trap on soybean crop. So, if the sex pheromone trap may be available to the farmers. Insecticides spray will not need for insect control in soybean crop in this region. And thus the crop could be protected from insect pests in an eco-friendly manner and production cost will be reduced. Therefore, IPM technologies should be disseminated other areas of the country and thus the safe crop production will be ensured and the farmers will be benefited economically and safe food will be produced and environment will be saved. These technologies will be helpful to the farmers'soybean cultivation.

Conclusion and recommendation

IPM techniques of pest management reduced pest infestation, management cost and also reduced environment pollution by reducing use of chemical pesticides in these regions. Farmers of Subarna Char, Noakhaliand at Char Martin, Laxmipur were trained on application techniques of IPM component and they gathered knowledge about this method. They were very pleased and highly impressed observing the demonstrated results i.e. attraction of *Spodoptera*moth in the sex pheromone trap on soybean crop. They were very satisfied to see the result and techniques of IPM method for managing insect pests of soybean crop and they were finally benefited economically and ecologically. These technologies will be helpful to the farmers for soybean cultivation. Therefore, IPM technologies should be disseminated in other areas of the country and thus the safe crop production will be ensured and the farmers will be benefited.

12. Research highlight/findings (Bullet point – max 10 nos.):

- Thirty species of insect pests were identified to infest soybean crop in Noakhali region
- Five species namely, hairy caterpillar (*Spilarctiaobliqua),* leaf roller (*Lamprosemaindicata),* common cutworm (*Spodopteralitura),* pod borer(*Helicoverpaarmigera)*and stem fly(*Ophiomyiaphaseoli*)were considered as the major pests based on damage severity
- Most of the major insects appeared and infested in the crop (about 100%) during vegetative to flowering stages (30-50 DAS) causing about 30% yield loss in 2018
- Validation of IPM technologies revealed that Hand picking+Perching+ Sex Pheromone trap +Bio-control agent reduced the highest insect population and their infestation (80-90%)
- Soybean yield increased about 30% through adoption of IPM technologies compared to untreated and farmers practiced fields in an eco-friendly way.

- IPM technique reduced production cost (30%) and produced pesticides free soybean seeds and net profit was calculated Tk. 25000-30000/per hectare.

- Field day (60 framers) of IPM techniques revealed that farmers of Noakhali and Laxmipur were very pleased, satisfied and highly impressed to see IPM results i.e. capture of *Spodoptera*moth in the sex pheromone trap @ 20 moth/trap/day on soybean crop.

- These technologies will be helpful to the farmers for soybean cultivation both the economically and in an eco-friendly way.

B. Implementation Position

1. Procurement:

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
a)Office equipment					
01.Laptop Computer	01	25000	100%	100%	Procured
02. Digital Camera	01	60000	100%	100%	Procured
(b) Lab &field equipment	-	-	-	-	-
(c) Other capital items					

2. Establishment/renovation facilities: N/A

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	

3. Training/study tour/ seminar/workshop/conference organized:

Description	Number of participant			Duration (Days/ weeks/ months)	Remarks
	Male	Female	Total		
(a) Training (Farmers)	24	6	30	one day	Two farmers trainings on IPM
(b) Workshop/Field day	40	20	60	one day	One field day on IPM was arranged

C. Financial and physical progress

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	218671.5	218671.5	218671.5	0	100	
B. Field research/lab expenses and supplies	718210	707962	707121	841	98.62	
C. Operating expenses	184104	183974.5	182815.5	1159	98.62	
D. Vehicle hire and fuel, oil & maintenance	100000	100000	100000	0	100	
E. Training/workshop/seminar etc.	75000	75000	75000	0	100	
F. Publications and printing	75000	15000	15000	0	20	
G. Miscellaneous	44015	32169	32169	0	73.08	
H. Capital expenses	85000	85000	85000	0	100	
Total	**1500000**	**1417777**	**1415777**	**2000**	**94.38**	

D. Achievement of Sub-project by objectives: (Tangible form)

Specific objectives of the sub-project	**Major technical activities performed in respect of the set objectives**	**Output(i.e. product obtained, visible, measurable)**	**Outcome(short term effect of the research)**
To record the major insect pests of soybean	Survey and documentation of major insect pests of soybean and estimation of extent of damage	Thirty (30) species of insect pests were recorded in soybean crop. Six major insect species were recorded with their damage potential.	Six major insect species were identified with their damage potential Pest succession was identified.
To validate IPM technologies in the farmers fields for creating awareness	Two IPM packages with farmers practice were evaluated and validated in the soybean fields	About 80% insect population with their infestation was reduced by applying IPM technologies.	Eco-friendly IPM technologies demonstrated and adopted by the farmers.
To popularize IPM technologies among the farmers	Field day on IPM packages (Hand Picking+Sex Pheromone +Perching +Bio-control agent) and non IPM insecticides used fields were arranged and demonstrated.	The farmers and visitors were very pleased to see the results of IPM technologies in the sex pheromone trap on soybean crop.	Soybean insect pests managed in an eco-friendly IPM insecticides application reduced.
Increase yield of soybean by applying IPM technologies in the fields	Cultivation of soybean crop following IPM packages was demonstrated	Farmers got about 30% more yield of soybean in an eco-friendly way.	Increased soybean production andfarmers income and reduce poverty through adaption of IPM strategy

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology (Booklet)	01	-	Major insect pests of soybean, their damage severity and Integrated Management
Journal publication	-	-	-
Information development	01	-	Popularization of IPM technologies among the farmers for soybean production in Noakhali region
Other publications, if any	-	-	-

F. Technology/Knowledge generation/Policy Support (as applied):

i. Generation of technology (Commodity & Non-commodity) N/A

ii. **Generation of new knowledge that help in developing more technology in future**

Farmers of Noakhali region received training on application techniques of IPM component for soybean pests management and they gathered knowledge about this method in an eco-friendly way.

iii. Technology transferred that help increased agricultural productivity and farmers' income

IPM technologies of pest management in soybean crop reduced pest infestation (80%), management cost (30%), increased soybean production 20-30% and also reduced environment pollution by reducing use of chemical pesticides in these regions. Farmers of Subarna Char, Noakhaliand at Char Martin, Laxmipur received IPM training and trained on application techniques of IPM component and they gathered knowledge about this method. They were very pleased and highly impressed showing the demonstrated results i.e. attraction of *Spodoptera*moth in the sex pheromone trap on soybean crop. They were very satisfied to see the result and techniques of IPM method for managing insect pests of soybean crop.They were finally benefited economically by increased soybean production 20-30% and farmers income increased about 20% thus reduce poverty through adaption of IPM strategyin an eco-friendly way.

These technologies will be helpful to the farmers for soybean cultivation. Therefore, IPM technologiesneed to be disseminated other areas of the country and thus the safe crop production will be ensured and the farmers will be benefited both the economically and eco-friendly way.

iv. Policy Support

Reducing of chemical pesticides in crop production and increasing crop production following Integrated Pest Management (IPM), Good Agriculture Practices (GAP) and organic agriculture which are supported to Agricultural policies 2015, Seventh Five Years Plan (2016-2020)and Sustainable Development Goals(SDGs, Goal-2) in Bangladesh.

G. Information regarding Desk and Field Monitoring

i) **Desk Monitoring[description & output of consultation meeting, monitoring workshops/seminars etc.):N/A**

ii) **Field monitoring (Time and No. of visit, team visit and output**

Monitoring team	Date(s) of visit	Total visit till date (No.)	Remark
Technical Division/ Unit, Dr. Abdus Salam PSO & Dr. Md. Harunur Rashid, PSO, Crop Division, BARC	01/02/18	01 (One)	
PIU-BARC, NATP-2	-	-	
Internal Monitoring Director (Research), Director (Oilseed), CSO (OFRD), BARI	10/04/18 20/04/18	02 (two)	
Others Visitor (if any) Local leader/representative	05/03/18	02 (two)	

H. Lesson Learned/Challenges (if any)

i) Farmers awareness was increased on adoption of IPM techniques (sex pheromone traps) of soybean pests. They were very pleased and impressed observing IPM activities.
ii) Adoption of IPM techniques by the farmers reduced pest infestation, management cost and use of chemical pesticides in the regions.
iii) These IPM technologies should be disseminated to the other soybean growing areas of the country.

I. Challenges (if any)

i) Natural calamities like high rainfall in October and April hampered crop production
ii) In farmers' training, payment allowance in bank cheque was a problem
iii) Transfer of PI and Co-PI from one place to others division or centres
iv) Budget calculation of GOB and RPA fund sometimes created complexity

Signature of the Principal Investigator
Date ……..
Seal

Counter signature of the Head of the organization/authorized representative
Date ……..
Seal