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Impact of selected crop rotation practices on the incidence of insect pests in Paddy Fields at Dinhata, West Bengal, India

Gobinda Chandra Roy[1], Kaushik Chakraborty[2] and Siddharthasankar Banerjee[3*]

[1]Department of Zoology, Dinhata College, Coochbehar 736 135, West Bengal, India
[2]Department of Zoology, Raiganj University, Uttar Dinajpur 733 134. West Bengal, India
[3*]Department of Zoology, Burdwan Raj College, Purba Burdwan 713 104, West Bengal, India

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ABSTRACT

To evaluate the influence of crop rotation practices on the prevalence of four significant paddy insect pests, studies for three consecutive years (2012-2014) were conducted at Dinhata, Coochbehar, and West Bengal, India. Grossly 26 types of crop rotation practice and four major insect pests were distinguished in this area. The pests are yellow stem borer (YSB), brown plant hopper (BPH), gall midge (GM) and paddy bug (PB) correspondingly. Paddy-green manure, maize-paddy, jute-paddy, vegetable-paddy and pulses-paddy are more commonly practiced out of the all renowned crop rotational practices. Incidence of pest number (individuals/hill) and the extent of crop damage viz., dead heart (DH) + white head (WH) for YSB, damaged leaf area (DAL%) for BPH, silver shoot (SS%) for GM and unfilled grains (UG%) for PB under five selected crop rotation practices were compared with that of the result of monoculture field having two or three paddy crops in a year. Side by side incidence of pest population was also noted in fallow-paddy circumstance. Damage due to pest infestation was determined after assessing the number of infested hills (for YSB and GM), infested leaf (for BPH) and shockingly filled grains (for PB). Maximum number of pest individuals (7.14 YSB/5 hills, 19.68 BPH/hill, 14.81 GM/10 hills and 3.12 PB/hill) and the level of damage (7.16% DH +4.18% WH, 29.04% DAL, 40.1% SS and 40.31% UG) were noted in field having three consecutive paddy crops in a year. The least pest incidence (1.80 YSB/5 hills, 4.68 BPH/hill, 2.15 GM/10 hills and 0.98 PB/hill) with lowest level of damage (2.18% DH +2.50 WH, 10.14% DAL, 5.01% SS and 16.12% UG) was registered in field where paddy was grown after green manure production. Maximum yield (q/ha) with highest cost: benefit value (C: B) was registered in green manure-paddy (33-35q/ha) as the least was scored from the field with three successive paddy crop in a year (23-25q/ha).

Key words: *Pest incidence, Extent of damage, Crop rotation and Yield generation.*

Introduction

Integrated pest management (IPM) has been recognized to be a sustainable method for pest prevention, monitoring and control. Modern rice-IPM indulges the insect pest management by cultural methods with least toxic insecticidal input (Ganwar *et al.,* 1986). Cultural control is considered as the first line of defense against insect pests (Ganwar *et al.,* 1994). It includes multifaceted techniques like obliteration of crop residues (Dhaliwal *et al.,* 1996, 1998), intercropping (Lal *et al.,* 1985), crop rotation (Krishnaiah *et al.,* 1983), field scouting (Mathur, 1994), alteration of planting dates and suitable tillage methods. Paddy insect pest control by crop rotations as a part of cultural control depends upon the philosophy to put back a crop that is susceptible to a serious pest with another crop that is not vulnerable on a rotating basis (Arora *et al.*, 1998). Pests on the whole grow up within a cropping system and multiply where only one or two crops are continuously grown over the time (Hokkanem, 1991). However, due to continuous adoption of the paddy-wheat rotation in *Indo-Gangetic* plain of the northern parts of India significant yield reductions in both the crop yield and soil fertility was noted. Ongoing acquisition of adaptability of the pest to the rotational practice may be one of the major causes pertaining to yield reduction. Thus selection of crop particulars in a rotation practice at a scrupulous zone is dynamic and therefore may be altered with time. A farmer is the ultimate manager of any technology at the field level. In adopting suitable crop rotation at a particular area, farmers should have a sound understanding of the diverse aspects of crop and the economics of crop rotation of this zone (Upper Gangetic Zone). The skillfulness and comprehension of farmers are of prime importance in acquiring, adopting and inventing innovative thoughts suitable to this farming eco-system (Wasnik, 1995; Sriram and Palaniswamy, 2000).

But due to the improper scientific knowledge in the area of experimentation, farmers do follow irregular seedling transplantation dates of paddy and adopt a variety of crop rotation practices unsystematically to economize the yield. Nearly 15 insect pests are reported to ravage the paddy field in this region (Chakraborty *et al.*, 2010). Out of which 4 are found economically more detrimental .No experiment even of preliminary in nature relating to the impact of crop rotation practices on the incidence of paddy insect pest population was carried out at Dinhata, Coochbehar and West Bengal, India. In this contemplation and in order to suggest the best suitable crop rotation practice(s) for paddy insect pest suppression in this locality, an experiment for three consecutive years were carried out on some selected crop practices. Five rotational practices which are preferential by the farmers are taken in consideration.

Materials and Methods

Geographic location and agro-climatic environment - Experiment was conducted at Dinhata [26.13 ^{o} (N) – 89.47^{o} (E)], Coochbehar, West Bengal, India. It has an average elevation of 36 metres (118 feet). The region belongs to upper *Gangetic* zone. The climate of this zone is sub-tropical humid in nature. The season of this area is broadly classified in three groups, viz- dry and warm (March-May), wet and warm (June-October), dry and cool (November-February) correspondingly. The monsoonal rain by and large sets in the middle of June and recedes by middle of September. The average annual rain fall varies from 2000 to 3000 mm, the highest rainfall occurs during the rainy months of June to September amounting to more than 80% of the total rain fall. The mean maximum temperature is typically high 38.9 ^{0}C in April and low 7.1^{0}C in the early part of January. The relative humidity at 8:30 hours is 58% and 88% in March and July respectively. The relative humidity in the afternoon at 17:30 hours is 48% and 84% in March and November in that order.

Experimental layout -The soil of the experimental field was sandy loam with pH value 6.5 and Ec value 0.28 mS/cm. Field N, P_2O_5 and K_2O was 292,78 and 378 kg/ha respectively. Each plot was 50 x 50 m by size. Five selected crop rotation practices (I-V) were adopted. Side by side field with two (VI) and three (VII) paddy crops was also painstaking. Field with single paddy (fallow-paddy) in a year (VIII) was considered as control. The detail of crop sequence in different crop rotation practices is described. All the crop rotation practices were carried out during three following season of 2012-2014. There were three replications for each of the three experiment years.

First crop: Choice for first crop differed significantly. Paddy (MTU 7029/MTU-1010), Jute (JRO-524/ *Navin*), Maize (*Kisan*), vegetables (brinjal: *Muktakeshi*), pulses (lentil: *Subrata*) and green manure (*Sesbania aculeata*) was considered as first crop in different plots. All the crops were raised following the standard course of action of national protocol.

Second crop (paddy var. *Swarna mashuri*): 30-day mature seedlings of *Swarna mashuri* (MTU 7029) were transplanted with 2 seedlings / hill and at 15x10 cm spacing.

Third crop: For only one crop rotation practice (serial number VII) paddy cultivar IET-4786 was adopted as third crop.

Fertilizer input and other essential field management in all the plots were done in due course of time following the national protocol with minor modifications. No insecticide was applied.

Assessment on pest incidence: Evaluation on pest incidence was done after counting both the number of adult individuals and the extent of infested tillers for the specific pest.

Counting on adult individuals: Field population of the pest was made on the whole on diagonally selected hills from each paddy plot. However the number of the hills taken for examination varied depending on the pest concerned. For YSB, BPH, GM and PB the number of hill(s) were 5,1,10 and 1 correspondingly.

Counting on the incidence of damage- The population of the insect pests in each plot was recorded in terms of their respective damage produced to plant parts, at weekly intervals starting as of 05 days after seedling transplantation (DAT) till the yellow maturing stage of paddy. At the time of recording data, only fresh damage was considered. Infestation by YSB from each plot was recorded in terms of numerical abundance of DH and WH during vegetative and reproductive growth stages of paddy plant respectively. The damage by BPH was assessed in consideration of flat leaf area damage (%) on 20 randomly selected hills. Damage by GM was recorded on silver shoots (SS %) at the tillering growth stage. Damage by PB was assessed from 20 panicles selected diagonally from each plot at maturation stage and the percentage of incompletely filled grains was determined.

Assessment on soil chemistry -Assessment on some selected soil physio-chemical properties before and after of each crop rotation practice was done by standard methods, i.e., soil particle size distribution by International pipette method, soil texture by USDA system, Soil PH by Potentiometric method and total nitrogen (%) by modified Kjeldahl method respectively.

Assessment on yield economics - Cost benefit value of each of the rotation practice was calculated depending on the market value of the final produce (both grain and straw). System production was determined after adding the cultivation cost of the crop preceding the paddy.

Methods of statistical analysis - The data obtained at each type of investigation were analyzed statistically by the calculation of variance and by various graphical representations (Singh *et al.,* 2002).

Results

Extent of suppression of major insect pest population under six selected crop rotation practices were carried out in the field of local paddy cultivar *Swarna mashuri* (MTU 7029) during three consecutive crop seasons at Dinhata, W. B., India. Crop sequence in some selected crop rotation practices are given in Table 1.

Table 1. Crop sequence in some selected crop rotation practices.

Type	Crop sequence*	Crop category	Variety	Time of seedling transplantation	Time of harvesting	Crop duration
R-I	A	green manure	*Sesbania rostrata*	May- June	Within 45 days	45 days
	B	paddy	MTU-7029	July-Aug.	Nov-Dec	3 months
R-II	A	maize	Kisan	April- May	June-July	2 months
	B	paddy	IET-4786 (*Shatabdi*)	Dec-Jan	April- May	4 months
R-III	A	Jute	JRO-524	April-May	Aug-Sep	3-4months
	B	paddy	MTU-7029	Aug	Nov-Dec	3 months
R-IV	A	vegetable	Brinjal(*Muktakeshi*)	Oct-Nov	Dec-Jan	1-2 months
	B	paddy	IET-4090	Jan-Feb	April-May	2 months
R-V	A	paddy	MTU-7029	July-Aug	Nov-Dec	3 months
	B	paddy	IET-4786	Dec-Jan	April-May	4months
R-VI	A	pulses	Lentil (*Subrata*)	Oct-Nov	March	4 months
	B	paddy	MTU-7029	July-Aug	Nov-Dec	3 months
R-VII	A	paddy	MTU-1010	April-May	Aug	3 months
	B	paddy	MTU-4786	July-Aug	Nov-Dec	3 months
	C	paddy	IET-4786	Dec-Jan	April-May	4 months
R-VIII	A	fallow	-	-	-	-
	B	paddy	MTU-7029.	July-Aug	Nov-Dec	3 months

Crop sequence (*): A-first crop, B- second crop, C-third crop, (-): no crop in field

In consideration of major crop rotation practices:

Major types of crop rotation practices adopted by farmers in the plots are showing in Table 2. A total of 26 types of crop rotation practices with reference to paddy as one of the major crop component were observed in this area. Relative adoptability of a particular rotation practice was assessed on 550 farmers. Out of the total rotation practices, six types of rotation were mostly practiced by the farmers. Cultivation of three paddy crops in a year was most common. Rotational cultivation of paddy with maize / lentil or jute or wheat ranked afterwards. Paddy in rotation with pulses and vegetables shared about 16% and 10% of the total cultivated field respectively. Least number of farmers adopted paddy-paddy cultivation practice.

In contemplation of pest population and extent of damage

Pest incidence was estimated by paddy hill observation. Significant variation of insect number under different crop rotation practice was noted. Maximum and minimum number of YSB individuals was noted in VII (7.14 individuals/5 hill) and I (1.80 individuals/5 hill) crop rotation practices. Incidence of BPH population was maximum and minimum in VII (19.68) individuals/hill) and I (4.68 individuals/hill) crop rotation practices respectively. VIII (14.81 individuals/10 hill) and I (2.15 individuals/10 hill)

Table 2. Major types of crop rotation practices adopted by farmers in the regions

Sl. No.	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Farmers Adopted (%)
1			Paddy (MTU-7029)*						Paddy (IET-4786)				11
2			Paddy (MTU-7029)				Paddy (IET-4786)				Paddy (GS-I)		8
3			Paddy (*Khitish*)				Paddy (MTU-1010)				Lentil (*Subrata*)		3
4			Paddy(*Khitish*)				Paddy(MTU-1010)				Potato(*Kufri Ashoka*)		3
5			Jute (JRO-524,*Navin*)								Pulses (*Lentil*)		4
6			Jute (JRO-524)				Paddy (IET-4786)						4
7			Jute (JRO-524)				Brinjal (*Muktakeshi*)						2
8			Paddy (MTU-7029)				Paddy (IET-4786)				Wheat (HW-2025)		4
9			Paddy (MTU-7029)				Paddy (GS-I)				Mustard (*Bhagirathi*)		5
10			Jute (JRO-524)				Paddy (IET-4786)				Khesari (Normal)		2
11			Bhendi (*Pusa Sawani*)				Paddy(MTU-7029)				Tomato(*Pusa Ruby*)		2
12			Jute (JRO-524)				Paddy(MTU-7029)				Cabbage(*Pusa drum head*)		2
13			Maize (*Kisan*)				Paddy (IET-4786)						2
14			Bhendi(*Pusa Anamika*)				Paddy(*Niranjan*)				Lentil (*Subrata*)		3
15			Jute (JRO-524)				Paddy (MTU-7029)						5
16			Bhendi (*Pusa Sawani*)				Paddy(IET-4786)						7
17			Jute (JRO-524)				Paddy(IET-4786)						4
18			Paddy (MTU-7029)				Paddy(IET-4786)				Tomato(*Pusa hybrid-1*)		5
19			Green manure (*Sesbania rostrata*)				Paddy(MTU-7029)						5
20			Brinjal (*Desi*)				Paddy (MTU-7029)				Potato(*Kufri Red*)		4
21			Brinjal (*Desi*)				Paddy (MTU-7029)				Tomato(*Pusa Ruby*)		2
22			Paddy (MTU-7029)								Mustard (*Pusa Agran*)		5
23			Jute (JRO-524)				Tori (*Agrani*,B-54)				Paddy(IET-4786)		1
24							Paddy (*Pankaj*)				Mustard (*Bhagirathi*)		3
25			Green manure (*Sesbania aculeata*)				Paddy (MTU-7029)				Paddy(IET-4786)		2
26											Paddy (MTU-7029)		2

*Name in the parenthesis indicates the variety adopted for cultivation, Blocks of the months filled with grey color indicates the no crop in the field rotational practice supported maximum and minimum number of GM population. PB population was found maximum in VII (3.12 individuals/hill) rotation practice at the same time as the minimum was registered in II (00.98 individuals/hill) rotation practice. Plots with three paddy crops in year (VII) have registered 7.10 YSB/5hill, 17.62BPH/hill, 13.91GM/10 hill and 3.12 PB/hill respectively. While plots with two paddy crops in year (VI) have registered 6.28 YSB/5 hill, 19.68 BPH/hill, 8.10GM/10 hill and 1.92 PB/hill, respectively. Cultivation of single paddy crop in a year after a fallow period in a year has registered 7.14 YSB/5 hill, 14.14BPH/hill, 14.81GM/10 hill and 1.12 PB/hill respectively (Table 3).

Extent of damage corroborates to the incidence of insect pest population. Higher the incidence of pest population higher would be the incidence of damage. Incidence of DH and WH due to YSB infestation was maximum in VII crop rotation. The minimum incidence of DH and WH was registered in I rotation. Development of DAL was maximum and minimum under VIII and I rotation practice respectively. Generation of SS was maximum in VIII while it was minimum in I. I and VIII rotation practice has registered 14.25% and 22.78% UG respectively due to PB infestation. Plots with three paddy crops in year (VII) have registered 8.72% DH, 6.62%WH, 36.18% DAL, 38.11% SS and 40.31% UG respectively. While plots with two paddy crops in a year (VI) have registered 8.48% DH, 6.46%WH, 29.06% DAL, 31.41% SS and 37.33% UG respectively. Cultivation of single paddy crop in a year after a fallow period in a year has registered 7.16% DH, 4.18% WH, 38.34% DAL, 40.10% SS and 22.78% UG respectively (Table 3).

In contemplation of the incidence of soil fertility

Fertility status of the soil after three years of experiment is enlisted in Table 4. Among the different sequences, rotation practice VII followed by VI was found more exhaustive. The soil nutrient was absorbed in high level resulting comparatively low soil fertility after three years of consecutive experiment. Cropping sequence we have established best. Adoption of I rotation practice restores soil fertility and side by side increases the N content of the soil for the improved assimilation to the later crop. Result of II and IV crop rotational practice are next to I and is of moderate in nature in consideration of restoration of soil fertility.

In deliberation of yield generation

Yield in different rotation practices in different con-

Table 3. Incidence of major insect pests and the extent of damage under some selected crop rotation practices

Crop rotation practices	YSB			BPH		GM		PB	
	A	B		A	B	A	B	A	B
	No./ 5 hill	DH / 50 hill	WH/ 50 hill	No./ hill	DAL (%)	No./ 10 hill	SS (%)	No./ hill	UG (%)
Green manure-Paddy	1.80 (1.52)	2.18 (1.64)	2.50 (1.73)	4.68 (2.28)	10.14 (3.26)	2.15 (1.63)	5.01 (2.35)	1.78 (1.51)	14.25 (3.84)
Fallow-Paddy	7.14 (2.76)	7.16 (2.77)	4.18 (2.16)	14.14 (3.83)	38.34 (6.23)	14.81 (3.91)	40.10 (6.37)	1.12 (1.27)	22.78 (4.82)
Maize-Paddy	6.10 (2.57)	6.40 (2.63)	5.40 (2.43)	12.10 (3.55)	31.14 (5.62)	6.12 (2.57)	16.71 (4.15)	2.74 (1.80)	32.21 (5.72)
Jute-Paddy	3.98 (2.12)	2.19 (1.64)	2.74 (1.80)	6.14 (2.58)	18.14 (4.42)	4.70 (2.28)	10.18 (3.27)	1.02 (1.23)	12.47 (3.60)
Vegetable-Paddy	3.98 (2.12)	3.34 (1.96)	2.86 (1.83)	5.74 (2.50)	17.98 (4.30)	5.40 (2.43)	11.14 (3.41)	1.35 (1.36)	18.68 (4.38)
Paddy-Paddy	6.18 (2.58)	8.48 (3.00)	6.46 (2.64)	19.68 (4.49)	29.04 (5.44)	8.10 (2.93)	31.41 (5.65)	1.92 (1.56)	37.33 (6.15)
Pulses-Paddy	3.98 (2.12)	3.96 (2.11)	4.98 (2.34)	5.91 (2.53)	20.10 (4.54)	8.40 (2.98)	14.13 (3.82)	0.98 (1.22)	16.12 (4.08)
Paddy-Paddy-Paddy	7.10 (2.76)	8.72 (3.04)	6.62 (2.67)	17.62 (4.26)	36.18 (6.06)	13.91 (3.79)	38.11 (6.21)	3.12 (1.90)	40.31 (6.39)
CD(P=0.05)	0.12	0.23	0.41	0.49	0.75	0.65	0.58	0.27	0.87

Figure in the parenthesis are the square root transformed values; A-first crop, B- second crop secutive years are showing in Fig. 1. Among the different rotational practices P-IV gave significantly higher yield (average 34.51 q/ha) in terms of paddy equivalent, gross and net returns as well as benefit: cost ratio. This was followed by P-I, P-VII and P-II in descending order. None of the sequence except P-I performed as like the P-IV which recorded highest paddy equivalent yield than rest of the crop rotation was well thought-out. Cost: Benefit (C: B) value of P-IV was statistically at par with the P-I cultivation. Production of paddy after a fallow period in P-I even if considerably increased, but in gross such rotation in true sense is noneconomic. Maize followed paddy cultivation in P-V was found economically prudent resulting considerable higher yield (27-28q/ha) in terms of paddy equivalent and thus can be adopted. Plots with three paddy crops in year (VII) have registered 8.72% DH, 6.62%WH, 36.18% DAL, 38.11% SS and 40.31% UG respectively. Despite the fact that plots with two paddy crops in year (VI) have registered 8.48% DH, 6.46%WH, 29.06% DAL, 31.41% SS and 37.33% UG

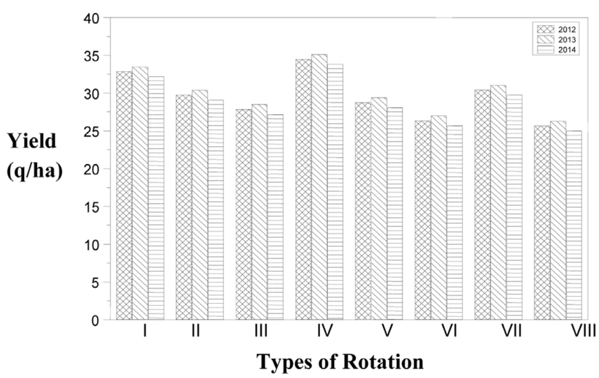

Fig. 1. Showing yield in different rotation practices in different year.

respectively. Cultivation of single paddy crop in a year after a fallow period in a year has registered 7.16% DH, 4.18%WH, 38.34% DAL, 40.10% SS and 22.78% UG correspondingly.

Discussion

Achievement of crop rotation in pest suppression depends on the host range of the particular insect, capability of migration and grossly the amount of available field nitrogen (Singh *et al.,* 2002; Fischer, 1998; Tan, 1986). Due to monophagy, chances of survivability of adult YSB under crop rotation practice are very low. Further subsequent developmental stage of hibernated larvae in the paddy stubble can easily be checked due to the absence of next paddy crop. But adult YSB is reported to cross a considerable distance in search of suitable paddy plant. Corn worm, can be controlled by crop rotation. Cultivation of green manure acts as a chief N source for the succeeding paddy cultivation. Decomposed leaf litter has an additional benefit on the following cultivation for providing N as a matrix of slow releaser. In the absence of food YSB could survive up to a period of six months with an extended larval period in the field stubbles (Heinrichs *et al.,* 1984). Interruption due to cultivation of paddy altered with other crops especially the green manure or jute with proper plowing helps to check the subsequent outbreak of the stem borer. If corn is grown with the alternation of a corn rootworm non host, hatching larvae will starve and die (Kuhlmann *et al.,* 1988). Suitable crop management reduced the incidence of stem borers in maize, millet, and sorghum (Adesiyun, 1983; Gahukar, 1989). Adoption of crop rotation practice at community level covering a

Table 4. Fertility status of the soil after three years of experiment

Types of crop rotation		Soil nutrient status								
		N			P_2O_5			K_2O		
		X	Y	Z	X	Y	Z	X	Y	Z
Green manure-Paddy	1	275.12	289.70	105.30	27.01	28.10	104.03	88.19	91.12	103.32
Fallow-Paddy	8	239.15	238.12	99.60	24.76	23.24	93.86	86.61	85.05	98.20
Maize-Paddy	5	231.03	230.45	99.74	24.69	24.14	97.77	80.55	81.23	100.84
Jute-Paddy	2	269.67	272.77	101.15	25.73	26.21	101.86	85.33	86.82	101.75
Vegetable-Paddy	3	248.99	248.33	99.73	24.87	24.66	99.16	81.27	81.78	100.63
Paddy-Paddy	6	225.09	223.50	99.30	24.47	24.10	98.49	80.25	79.57	99.15
Pulses-Paddy	4	257.03	261.22	101.63	25.08	26.22	104.55	80.13	82.05	102.40
Paddy-Paddy-Paddy	7	219.67	216.23	98.43	22.11	21.11	95.48	74.44	72.17	96.95

X: Before crop rotation, Y: After crop rotation, Z: % of change of nutrient status wide range can thus check YSB menace. This finding was confirmed by the reports that 30% of *Chilo partellus* oviposition in maize/sorghum/cowpea-intercropping systems was on cowpea, and the number of larvae reaching host plants from cowpea decreased with distance (Ampong-Nyarko *et al.,* 1994a; 1994b).

BPH, GM and PB, in contrast are reported to perpetuate on substitute host plants. Further, BPH is a first-rate flyer and cross a long distance in search of suitable food plant. To get the best population suppression of BPH suitable crop rotation together with the light trapping at early growth stage of paddy is crucial to destroy the immature nymphal morphs. GM is a week flyer. Paddy plant to a certain extent compensates the infestation by GM at early growth stage by generating fresh tillers. Infestation by GM at late growth stage of paddy is more crucial. Suitable crop rotation practice together with the management of the weedy vegetation nearby to the field efficiently checks the migration of GM at late growth stage and thus minimizes the tiller damage. PB is an aerial feeder and affects the developing grain at late growth stage. Impact of crop rotation on the incidence of PB was relatively low.

Field Nitrogen (N) dictates insect pest incidence (Swaminathan *et al.,* 1985; Yein *et al.,* 1988). Cultivation of green manure acts as a slow N releasing source for the consequent paddy cultivation. Decomposed leaf litter has a supplementary benefit on the following crop growing for providing N as a matrix of slow releaser. Intermission due to farming of paddy altered with other crops especially the green manure or jute with suitable plowing helps to check the ensuing pest frequency.

The economic gain from the use of intercrops depends on the sense of balance between a lowered cost of control of stem borers and the increased cost of maintaining an intercropped field, along with any decrease in yield of the main crop from better plant antagonism. Net profit can be increased if the intercrop favorably changes the balance between income and costs. Economic data assessing the financial returns as well as the biological effects are therefore most constructive in making decisions on the use of intercrops and trap plants for stem borer control. An effective control option would be to trim down the first generation of adult population by destroying the larvae in mature stalks (Ingram, 1958).

Significant decline of population of YSB, BPH, GM and PB were registered when paddy was grown after green manure. These crop rotation practices like green manure- paddy, pulses- paddy, jute-paddy not only lowers pest incidence in the second crop and increase the yield but also increases the soil fertility by increasing a quantity of essential macro element like nitrogen assimilation.

Thakur (1991) and Padhi (1993) distinguished higher benefit: cost value in rice sweet potato rotation disregarding the activity of the pests. The least pest incidence with lowest level of damage was registered in field where paddy was grown after green manure production. Maximum yield (q/ha) with highest cost: benefit (C: B) was registered in green manure-paddy (33-34 q/ha), jute-paddy (30-31 q/ha), pulses-paddy (33-35 q/ha), maize-paddy (28-29 q/ha), paddy-paddy (25-27 q/ha) and paddy-paddy-paddy (29-30 q/ha) in a year. Green manure-paddy (33-34 q/ha) and pulses-paddy (33-35 q/ha) was consequently establish economically practical to suppress YSB incidence and accordingly to augment the yield. Similar sort of reduction of pest incidence was also encountered due to crop rotation practice in brown plant hopper(BPH), gall midge (GM) and PB.

Manage of insect pests by suitable cultural process hideously involves proper cultivation practices for a given locality. This requires a methodical knowledge of life history, behavior and ecology of a particular pest species as well as of its host(s). The most vulnerable growth stage(s) in the life cycle must be determined and accordingly befitting management practices should be developed. Thus, it is evident that the incidence of paddy pests has been the lowest in case of green manure-paddy cultivation followed by jute-paddy rotations in ascending order. Nevertheless, in general the effect of the crop rotation has been significant. From now, suitable crop rotation practice may be adopted by the farmers depending on the relative opportunity and befitting the local ecological state of affairs.

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