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Validation of Integrated Pest Management Practices for Rice Insect in North-west Region of Bangladesh

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ABSTRACT

Integrated Pest Management (IPM), developed by the Bangladesh Rice Research Institute (BRRI) for management of rice insect pests, was demonstrated and validated through intensive investigation in farmer's fields of Pirganj and Taraganj in Rangpur district during 2012–2014 in two T. Aman and Boro seasons. A portion of each farmer's field kept under the respective farmers' supervision without any intervention, which was treated as control treatment (T_4). The other portion was managed with three treatment combinations ie, T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application and T_3=Perching only. BRRI dhan52 and BRRI dhan58 were used in Aman and Boro seasons respectively. RCB design was followed with eight replications for data analysis. The insect infestation was monitored fortnightly by visual counting from 20 hills and also 20 complete sweeps. The insect infestation, yield and yield contributing characteristics were analysed by one way analysis of variance by Tukeys' post hoc test. The objective of this studies were to validate and demonstrate the IPM techniques in farmers' field. Yellow stem borer, rice leaf roller, long horned cricket, grasshopper, green leafhopper, brown planthopper, white-backed planthopper and gall midge were found as pests in both the locations. However, insect infestation was below the economic threshold level (ETL). No significant differences were observed for insect infestation among the treatments. Natural enemies eg, spider, ladybird beetle, dragon fly, damsel fly, carabid beetle and staphylinid beetle were noticed in both the locations. In some seasons and also locations some natural enemies were not found particularly where indiscriminate/continuous insecticide was used. Thus, it was indicated that indiscriminate/continuous use of insecticide has the detrimental effect on the population of natural enemies. Also, refrained from insecticide application at early crop stages (30-40-day after transplanting) natural enemy populations increased, which might reduce insect population below the ETL. Significantly lower yield was observed at farmers managed fields in both the locations. Therefore, it was found that indiscriminate/continuous use of insecticide had no effect on yield and yield contributing characters of rice, when insect infestation below the ETL. So, farmers could avoid continuous/indiscriminate use of insecticide, which might ultimately save production cost and the environment from insecticidal pollution as well.

Key words: Validation, perching, sweeping, insect pest and natural enemies

INTRODUCTION

Rice, the staple food over half of the world's population, is grown on over 158 million hectares and produced over 465 million tons in 2012. Of which, Bangladesh harvested over 11.6 million hectares and produced 34 million tons milled rice in 2012 (IRRI, 2014). Insect pest of rice is one of the limiting factors to produce sustainable rice production. During 2011 and 2012, about 20 to 24 thousand tons formulated (active ingredient, 1900-2400 tons) insecticide were used in Bangladesh (BCPA, 2013 and personal com.). More than half of the amount of those insecticides was applied against rice pests. Synthetic chemical like insecticides are hazardous and harmful for non-target organism (eg Travisi *et al.*, 2006; Ahmed *et al.*, 2002; Ahmed *et al.*, 2011). Global harvest loss due to pests about 42% of attainable production in 2004 and it highlighted the paradox between increase of crop losses over time and the growth of chemical pesticide uses (Hassan and Bakshi, 2005). Researchers and experts believe that if present trends continue chemical pesticides will not be a sustainable solution for either an economist or for an environmentalist. Integrated Pest Management (IPM) is seen as to a way to achieve sustainable production at least for an environmentalist. Hence, IPM is getting importance for rice production too, which has been started since 1981 in Bangladesh. Entomologists of Bangladesh Rice Research

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Institute (BRRI) has recommended several IPM techniques for rice insect pest management at farmers level, which has been supposed to disseminate by the Department of Agricultural Extension (DAE). At present, the Plant Protection Wing of DAE implemented IPM programme by farmers' school, trained NGO's for rice and other crops eg vegetables (Hassan and Bakshi, 2005). After three and half decades, an attempt has been taken by the BRRI entomologists to see whether those IPM recommendations are still working or are needed to be refined. Therefore, the present study under taken to validate different IPM practices/techniques against rice insect pests in Bangladesh particularly in northern parts from where most of the rice produced.

MATERIALS AND METHODS

Eight experiments were conducted in farmers' fields of Pirganj and Taraganj of Rangpur district by the Entomology Division of BRRI under Integrated Agricultural Productivity Project (IAPP) during T. Aman 2012, T. Aman 2013, Boro 2012-13 and Boro 2013-14. Locations and fields for the component treatments were selected based on land type, variety cultivated and transplanting time. The field size for each farmer was 0.18-0.20 ha. One portion of each farmer's field was remained under the respective farmers' supervision without any intervention, which treated as control treatment (T_4). The other portion was managed with three treatment combinations ie, T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching only. Eight field experiments were conducted (four farmers' fields at each upazila) at Taraganj and Pirganj of Rangpur district in each season. The crop was grown in all the farmers' fields using same seedling age and other agronomic practices. Each experiment was conducted in completely randomized design and one farmer's field was treated as a replication. The insect infestation (eg number of arthropods ie insect pests and natural enemies and damage) was monitored fortnightly by visual counting of 20 hills and also number of arthropods from 20 complete sweeps. BRRI dhan52 and BRRI dhan58 were grown during T. Aman and Boro season respectively. The insect infestation, natural enemies, yield and yield contributing characteristics were compared by one way analysis of variance using Tukeys' post hoc test.

RESULTS

Insect pest and natural enemy status during T. Aman 2012. Yellow stemborer (YSB), rice leaf roller (RLR), long-horned cricket (LHC), green leafhopper (GLH), grasshopper (GH), mealy bug (MB) and case worm (CW) were found in Taraganj from fortnightly hill and sweep counting (Figs. 1 and 2). However, rice insect infestation was below the economic threshold level (ETL) during all the seasons both in Taraganj and Pirganj. Mealy bug and caseworm were absent in Pirganj, whereas rice bug were not found in Taraganj. No significant differences were observed for insect infestation among the treatments for both the locations. However, few damages [eg dead heart (DH) and onion shoot (OS)] were seen from hill counting at Pirganj and Taraganj (Fig. 1).

Among the natural enemies, spiders (SPD), ladybird beetle (LBB), damsel fly (Dam fly), dragon fly (Drag fly), carabid beetle (CBB) and staphylinid beetle (STB) were found in Taraganj. More or less similar natural enemy species were found in Pirganj (Fig. 3). From 20 hill counts, LBB and STB were not found in the fields of Pirganj, where continuously insecticide was used. Similarly, STB and CBB were not found at Taraganj in the same treated fields. From 20 sweeping count results showed that spider and LBB population were the highest number in T_2 (Perching+ sweeping + need based insecticide application) treated fields both in Pirganj and Taraganj, where no insecticide was applied (Fig. 4). Thus the findings indicates that refraining from insecticide use will help to conserve natural enemies in the rice field.

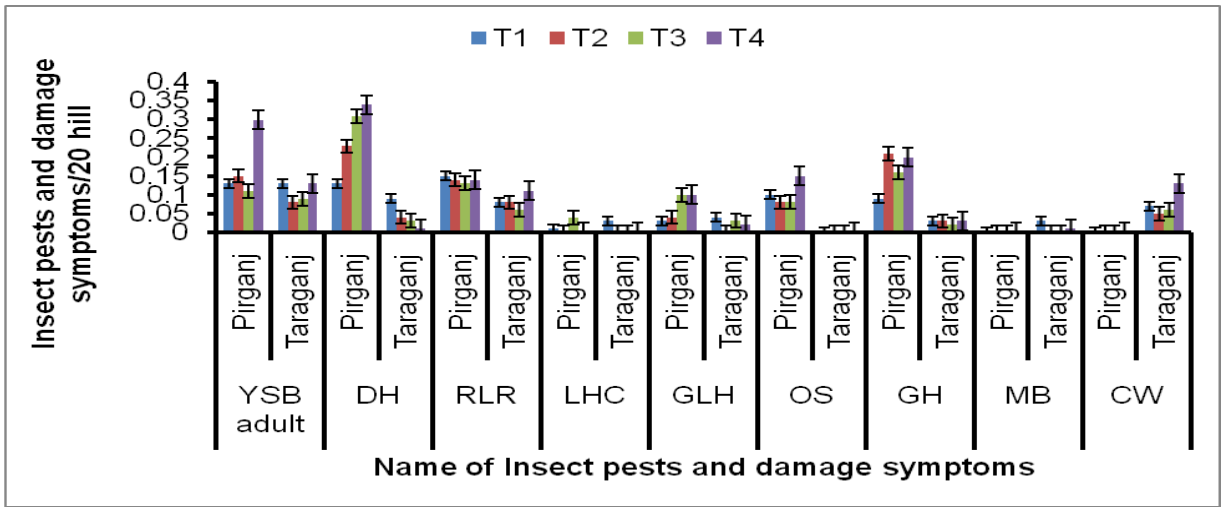

Fig. 1. Rice insect pests and their damage from 20 hill counts during T. Aman 2012 at Pirganj and Taraganj, Rangpur. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice. DH=Dead heart, OS=Onion shoot.

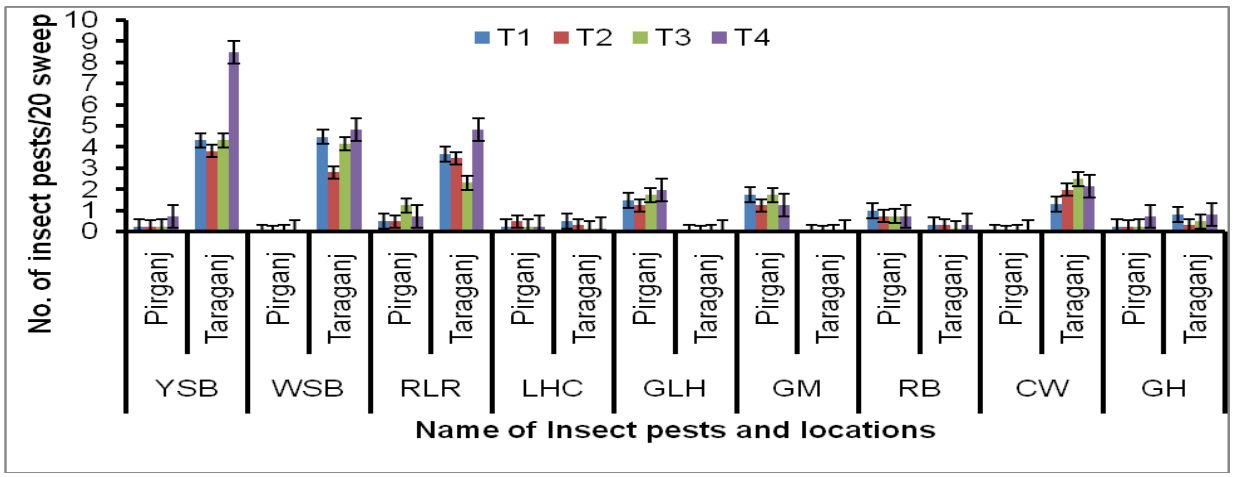

Fig. 2. Number of rice insect pest from 20 complete sweeps during T. Aman 2012 at Pirganj and Taraganj, Rangpur. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice.

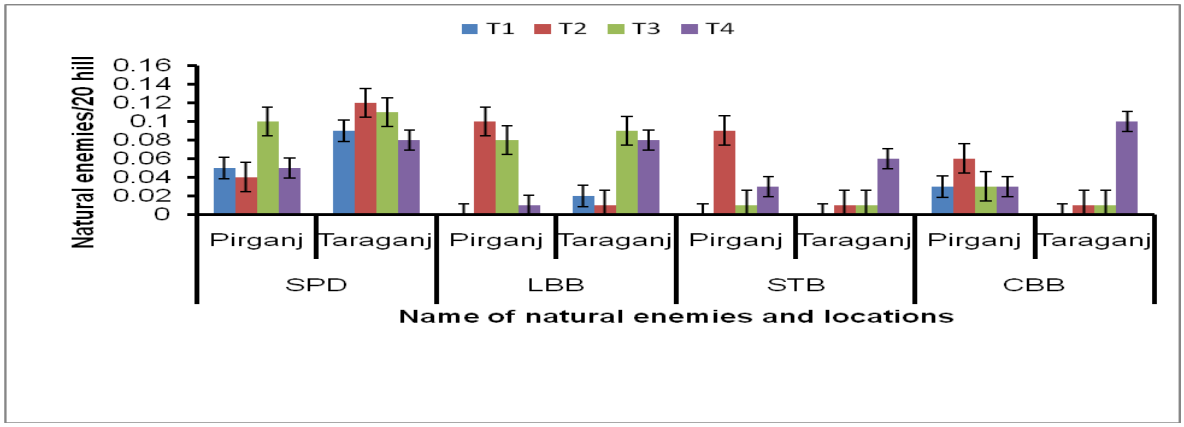

Fig. 3. Natural enemies of rice insect pests from 20 hill counts during T. Aman 2012 at Pirganj and Taraganj, Rangpur. Error bars indicate standard errors. T_1=Prophylactic use of insecticide,T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice.

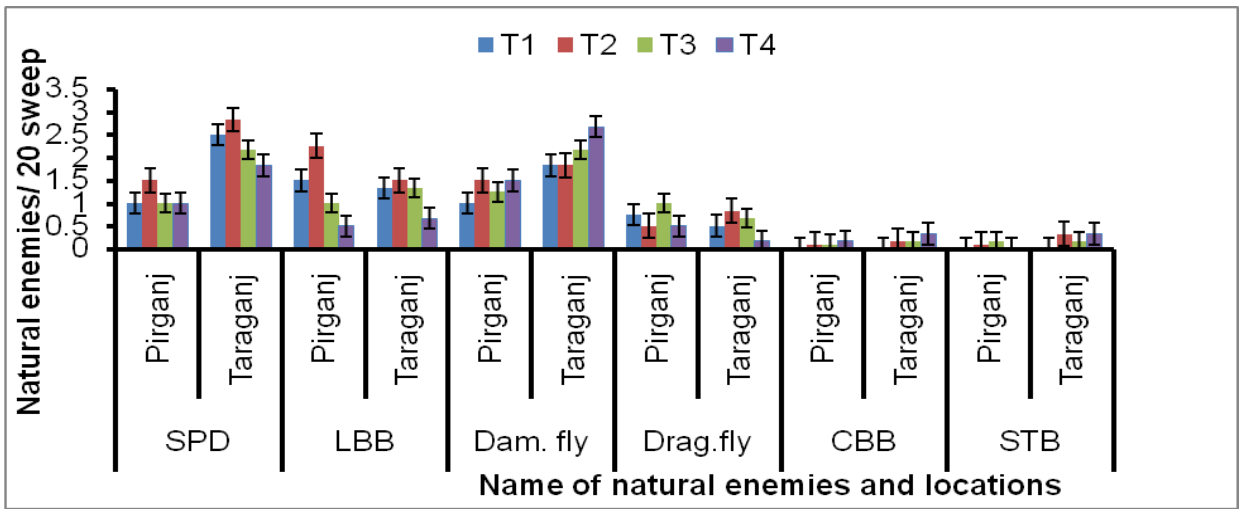

Fig. 4. Natural enemies of rice insect pests from 20 complete sweep during T. Aman 2012 at Pirganj and Taraganj, Rangpur. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice.

Plant characteristics, yield component and yield during T. Aman 2012. There was no significant differences among the treatment for tiller, leaf and panicle number per hill and also plant height at the experimental field of Taraganj and Pirganj. Significantly lower yield was observed at T_4 in Taraganj but no differences were observed at Pirganj (Table 1). However, mealy bug infestation was observed in Taraganj due to water shortage at farmers' practiced field, which might affect the yield. Farmers of Pirganj followed the BRRI recommended practices and found no yield difference. Moreover, no significant difference in yield was observed in other three treatment fields in both the locations. In T_1 treated fields, insecticide (Carbofuran 5G @ 10.0 kg/ha) was applied five times but no yield advantage was observed. In T_2 and T_3 only perching and sweeping were done fortnightly without using any insecticide but no yield reduction was observed (Table 1).

Insect pest and natural enemy status during T. Aman 2013. Yellow stem borer (YSB), RLR, LHC, GH, GLH, brown planthopper (BPH) and white-backed planthopper (WBPH) were found from fortnightly sweeping and hill counting at Taraganj (Figs. 5 and 6). Gall midge (GM) and rice bug (RB) were not found at Taraganj during sweeping. On the other hand, dead-heart or whitehead symptom was not observed at Pirganj during hill counting. No significant differences were observed for insect infestation among the treatments in both locations.

Among the natural enemies, SPD, LBB, dragon fly, damsel fly and CBB were found both in Taraganj and Pirganj (Figs. 7 and 8). From 20 hill counting, CBB was not found in both the locations of Pirganj and Taraganj, where continuously insecticide was used. Similarly, CBB was not observed at Taraganj from sweeping count in the same treated fields. The lowest natural enemies were observed both at Pirganj and Taraganj in T_1 treated fields, where insecticides were used continuously. Spiders and damsel fly population found in the highest number in treatment T_3 at Pirganj. Also, LBB and damsel fly were found in the highest number in treatment T_2 and spiders in treatment T_3 at Taraganj from sweeping count, where no insecticide was applied (Fig. 8). Thus the findings indicates that continuous use of insecticide has the detrimental effects on natural enemies in the rice field.

Table 1. Impact of IPM practices on plant characteristics, yield component and yield in T. Aman 2012 at Taraganj and Pirganj, Rangpur.

Treatment	Plant height (cm) (Mean ± SE)	Leaf/ hill (no.) (Mean ± SE)	Tiller/hill (no.) (Mean ± SE)	Panicle/hill (no.) (Mean ± SE)	Yield (t/ha) (Mean ± SE)
Taraganj					
T_1 = Prophylactic use of insecticide	117.87± 1.06	77.10 ± 1.43	15.28 ± 0.28	9.72 ± 0.40	6.01 ± 0.09a
T_2 = Perching + sweeping + need based insecticide application	116.05± 0.94	74.58 ± 1.10	14.83 ± 0.23	9.95 ± 0.31	5.99 ± 0.98a
T_3 = Perching	117.17± 0.82	74.92 ± 1.22	14.98 ± 0.24	9.62 ± 0.30	5.73 ± 0.08a
T_4 = Farmers practice	114.47± 0.90	73.25 ± 1.22	15.00 ± 0.30	9.28 ± 0.30	5.37 ± 0.08b
F value	*2.53*	*1.64*	*0.50*	*0.71*	*11.96*
P≤	*NS*	*NS*	*NS*	*NS*	*0.01*
Pirganj					
T_1 = Prophylactic use of insecticide	120.23± 0.60	68.7 ± 0.77	11.79 ± 0.13	8.15 ± 0.12	5.96 ± 0.16
T_2 = Perching + sweeping + need based insecticide application	120.08± 0.14	66.66 ± 0.60	11.58 ± 0.16	8.28 ± 0.11	5.70± 0.26
T_3 = Perching	119.21± 0.41	68.09 ± 0.98	11.91 ± 0.20	8.23 ± 0.13	5.97 ± 0.01
T_4 = Farmers' practice	119.38± 0.48	67.15 ± 0.62	11.85 ± 0.14	7.98 ± 0.10	5.73 ± 0.21
F value	*8.93*	*1.13*	*3.33*	*1.30*	*8.93*
P≤	*NS*	*NS*	*NS*	*NS*	*NS*

Value means within a column followed by the same letter (s) are not significantly different (P <0.05; Tukey's post hoc test).

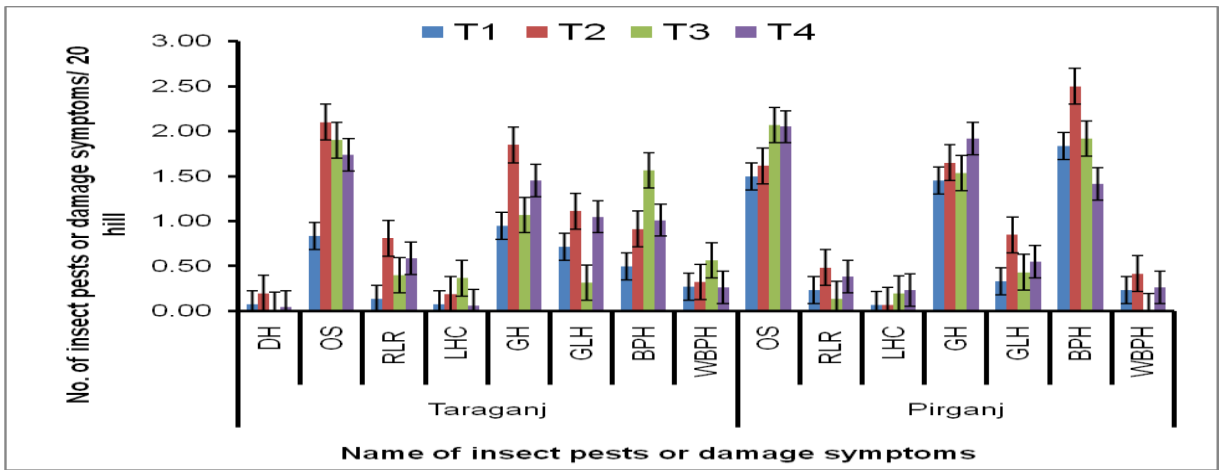

Fig. 5. Insect pests and their damages per 20 hills during T. Aman 2013 at Pirganj and Taraganj. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers, practice.

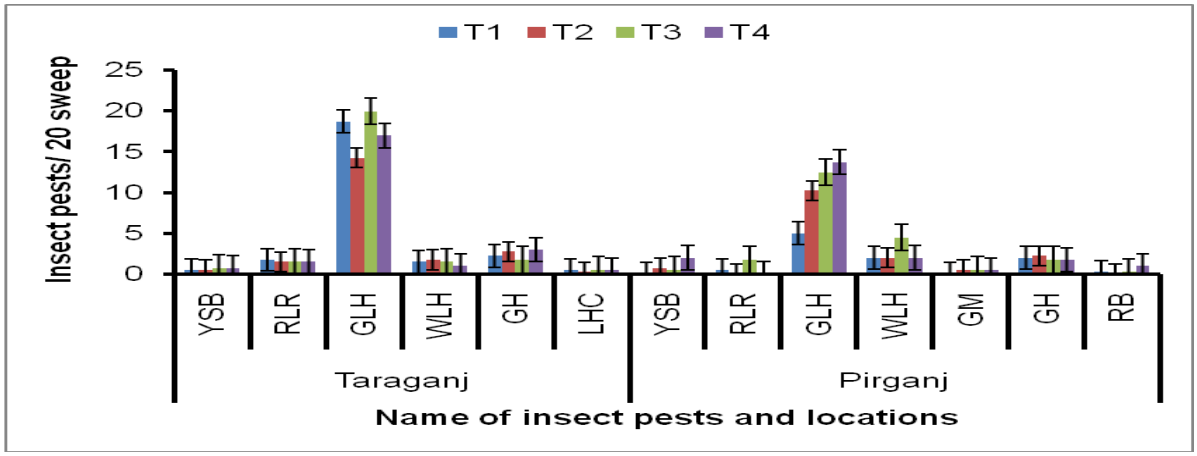

Fig. 6. Insect pests per 20 complete sweeps during T. Aman 2013 at Pirganj and Taraganj. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice.

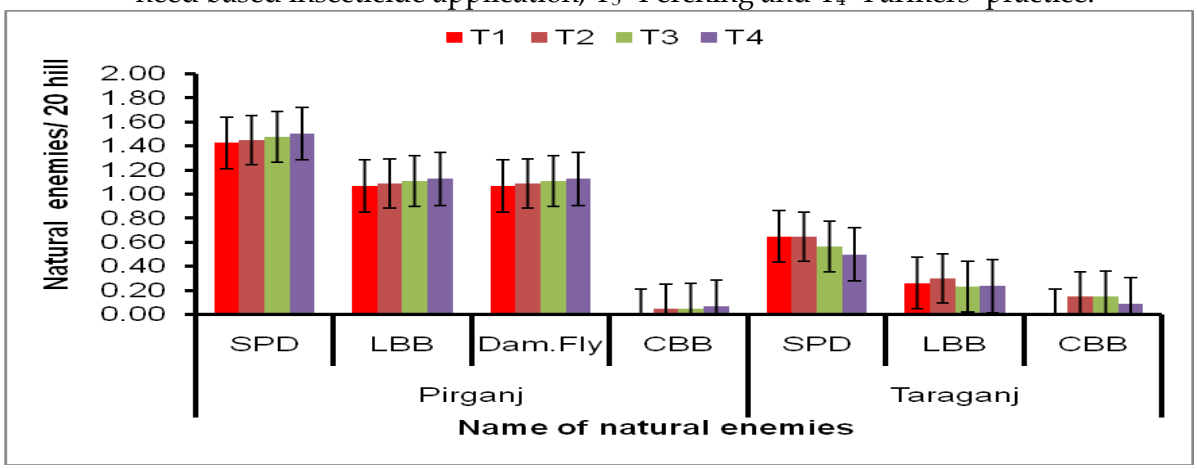

Fig. 7. Natural enemy per 20 hills during T. Aman 2013 at Pirganj and Taraganj. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice.

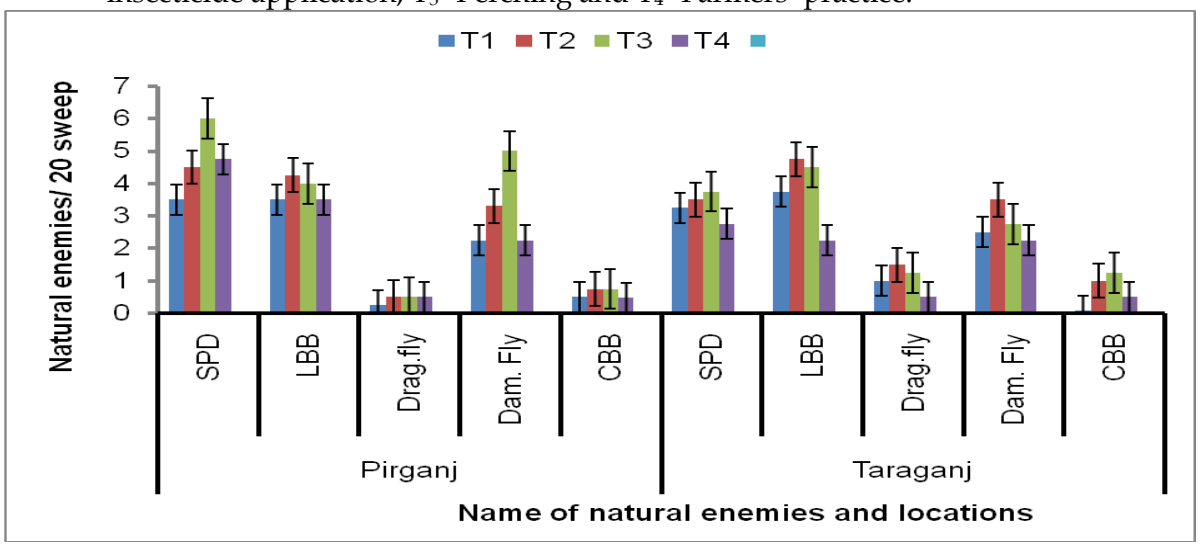

Fig. 8. Natural enemy per 20 complete sweeps during T. Aman 2013 at Pirganj and Taraganj. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice.

Plant characteristics, yield component and yield during T. Aman 2013. There was no significant differences among the treatment for tiller, leaf and panicle number per hill and also plant height at the experimental fields of Taraganj and Pirganj. Significantly

lower yield was observed in treatment T_4 of the Pirganj and Taraganj farmers did not use perching or sweeping and also did not use line sowing. Lack of appropriate water and weed management, inappropriate insecticide use at early stage might negatively affect the yield in farmers practiced plots at both the locations of Pirganj and Taraganj. Moreover, no significant differences in yield were observed from the other treatments (T_1, T_2 and T_3) at both the locations. In treatment T_1, insecticide (Carbofuran 5G @ 10.0 kg/ha) was applied five times but no yield advantage was both at Taraganj and Pirganj (Table 2). Most observed. In treatment T_2 and T_3, only perching and sweeping were carried out in fortnightly or when necessary without using any insecticide but no yield reduction was observed. Therefore, it was found in both the locations in T. Aman season that continuous use of insecticide had no effect on yield and yield contributing characters of rice when insect infestation below the ETL. So, farmers should avoid continuous/indiscriminate use of insecticide, which could finally save production cost and also save the environment from insecticidal pollution.

Table 2. Impact of IPM practices on plant characteristics, yield component and yield in T. Aman 2013 at Taraganj and Pirganj, Rangpur.

Treatment	Plant height (cm) (Mean ± SE)	Leaf/hill (no.) (Mean ± SE)	Tiller/hill (no.) (Mean ± SE)	Panicle/hill (no.) (Mean ± SE)	Yield (t/ha) (Mean ± SE)
Taraganj					
T_1 = Prophylactic use of insecticide	110.20 ± 0.89	63.44±1.64	14.03±0.30	10.49 ± 0.18	5.32 ± 0.70a
T_2 = Perching + sweeping + need based insecticide application	110.61 ± 0.80	66.05±1.50	14.39±0.28	10.74 ± 0.24	5.42 ± 0.73a
T_3 = Perching	110.54 ± 0.79	69.70±1.95	14.60±0.34	10.79 ± 0.19	5.26 ± 0.67a
T_4 = Farmers' practice	108.99 ±0.87	69.20±1.43	14.55±0.32	9.79 ±0.18	4.80 ± 0.63b
F value	*7.22*	*7.08*	*0.56*	*7.51*	*17.12*
P≤	*NS*	*NS*	*NS*	*NS*	0.05
Pirganj					
T_1 = Prophylactic use of insecticide	116.70 ± 0.11	71.78±3.03	16.52±0.84	10.05 ± 0.13	5.53 ± 0.15a
T_2 = Perching + sweeping + need based insecticide application	117.10 ± 0.13	73.15±3.14	16.35±0.80	10.30 ± 0.12	5.44 ± 0.06a
T_3 = Perching	116.70± 0.09	71.52±2.56	16.27±0.74	10.10 ± 0.09	5.34 ± 0.07a
T_4 = Farmers' practice	115.95 ± 0.10	69.63±2.40	15.93±0.67	9.85 ± 0.09	4.84 ± 0.11b
F value	*2.23*	*6.75*	*0.93*	*3.38*	*16.32*
P≤	*NS*	*NS*	*NS*	*NS*	0.05

Value means within a column followed by the same letter (s) are not significantly different (*P* <0.05; Tukey's post hoc test).

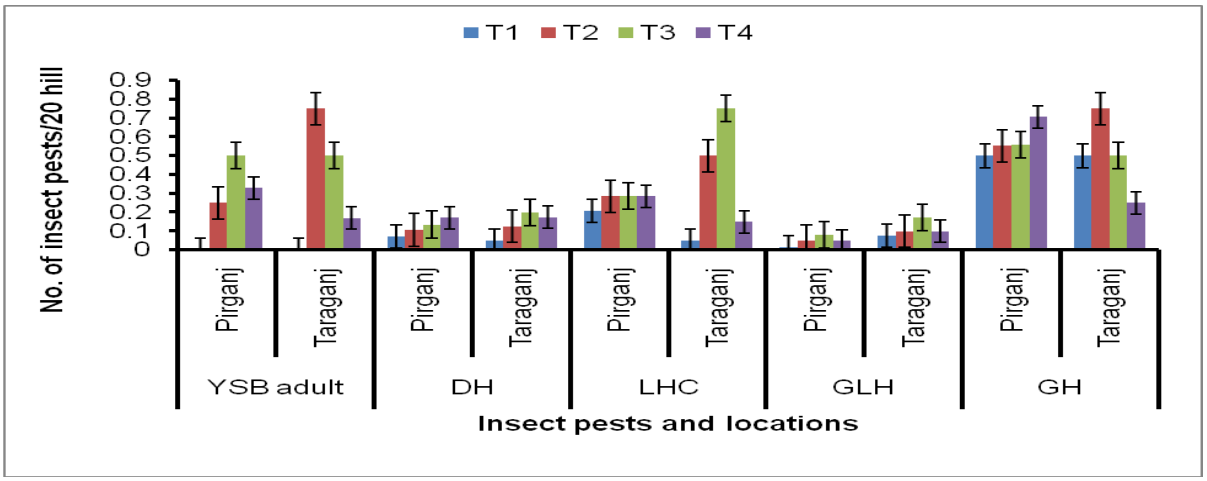

Fig. 9. Insect pests and their damages per 20 hill counts during Boro 2012-13 at Pirganj and Taraganj, Rangpur. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice.

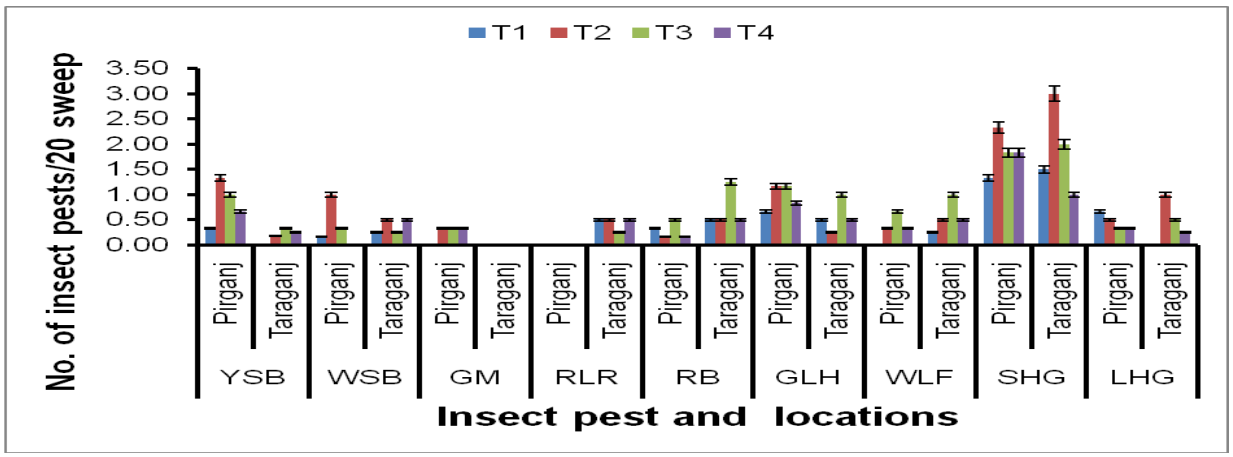

Fig. 10. Insect pests per 20 sweep during Boro 2012-13 at Pirganj and Taraganj, Rangpur. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice.

Insect pest and natural enemy status during Boro 2012-13. During the experimental period YSB, white stemborer (WSB), GM, RB, GLH, white leafhopper (WLF), GH and LHC were found at Pirganj in fortnightly hill and sweep counting (Figs. 9 and 10). Rice leaf roller (RLR) was not found at Pirganj and also gall midge was absent at Taraganj. No significant differences were observed in rice insect infestation among the treatments at both the locations.

Among the natural enemies, SPD, damsel fly, dragon fly, LBB, CBB, STB and parasitic wasps (PW) were found at both the locations (Figs. 11 and 12). Damsel fly were not found in Pirganj and Taraganj where insecticides were used fortnightly. Parasitic wasps also was not found in 20 complete sweeping at Pirganj in the same treated fields. From 20 hill counting, LBB was the highest in number in treatment T_3 and T_2 than other treatments at Taraganj. Natural enemy populations were the lowest in number in treatment T_1 at both Pirganj and Taraganj where insecticide was applied as prophylactic or routinely.

Plant characteristics, yield component and yield during Boro 2012-13. There was no significant differences were observed among the treatments for tiller, leaf and panicle/hill and also plant height at the experimental field of Taraganj and Pirganj. Significantly lower yield was observed at T_4 in both the locations (Table 3). One farmers' plot of

Tukuria, Pirganj was highly infested with YSB (greater than ETL, 5% white head) and the farmer did not use perching as well as no sweeping rather use inappropriate insecticide ('Thiamethoxam 25WG' registered to control rice brown planthopper) to control the pest. So yield of this farmers' plot was drastically reduced, which ultimately reduced the average grain yield in farmers' treated plot. Similar yield reduction happened in the farmers' plot of Taraganj due to avoid perching, sweeping and use of lower doses of insecticide. Moreover, no significant difference in yield was observed in other three treatments in both the locations. In T_1 insecticides (Carbofuran 5G@ 10.0 kg/ha and Diazinon 10G @ 16.8 kg/ha in Pirganj and Taraganj respectively) were applied five times but no yield advantage was observed over the treatment T_2 and T_3 where perching and sweeping were done fortnightly without using any insecticide.

Table 3. Plant characteristics, yield component and yield of different treatments at Pirganj and Taraganj, Boro 2012-13.

Treatment	Plant height (cm) (Mean ± SE)	Leaf/hill (no.) (Mean ± SE)	Tiller/hill (no.) (Mean ± SE)	Panicle/hill (no.) (Mean ± SE)	Yield (t/ha) (Mean ± SE)
Taraganj					
T_1 = Prophylactic use of insecticide	99.06±0.68	95.20±2.86	24.35±0.65	25.65±0.55	7.41±0.25a
T_2 = Perching + sweeping + need based insecticide application	99.28±0.68	106.03±3.90	26.70±0.98	25.05±0.53	7.38±0.20a
T_3 = Perching	98.81±0.68	104.80±4.16	26.20±1.04	25.90±0.55	7.29±0.17a
T_4 = Farmers' practice	99.41±0.55	106.03±3.90	25.60±0.90	24.92±0.55	6.43±0.18b
F value	0.30	1.97	1.26	4.28	5.24
P≤	*NS*	*NS*	*NS*	*NS*	*0.05*
Pirganj					
T_1 = Prophylactic use of insecticide	105.10±0.38	86.00±1.59	17.79±0.22	16.85±0.68	7.46±0.23a
T_2 = Perching + sweeping + need based insecticide application	103.65±0.23	84.62±1.53	18.41±0.20	17.15±0.53	6.97±0.19a
T_3 = Perching	103.15±0.21	90.59±1.80	19.36±0.28	17.45±0.61	6.70±0.18a
T_4 = Farmers' practice	102.40±0.32	78.08±1.43	17.68±0.23	15.00±0.48	5.75±0.31b
F value	*7.22*	*0.20*	*0.94*	*7.51*	*14.48*
P≤	*NS*	*NS*	*NS*	*NS*	*0.01*

Value means within a column followed by the same letter (s) are not significantly different (P <0.05; Tukey's post hoc test).

Insect pest and natural enemy status during Boro 2013-14. During the experimental period GH, LHC, yellow YSB, WSB, GLH, RLR and RB were found in Pirganj in fortnightly sweeping and hill counting (Figs. 13 and 14). In addition BPH, GM and onion

shoots (OS) were observed in Pirganj. No significant differences were observed for insect infestation among the treatments for both the locations.

Among the natural enemies SPD, LBB adult (A), LBB grub (G), CBB, STB, damsel fly and dragon fly, were found in both the locations (Figs. 15 and 16). Staphylinid beetle and damsel fly were not found during hill counting in Pirganj and STB in Taraganj, where insecticide was used fortnightly. In Pirganj, STB and LBB grub were not found during sweeping where insecticide was used routinely. LBB was also absent in farmers' fields as the farmers used insecticides three times in his field. Although definite trend was not found but it was clear that lower number of different natural enemies found in insecticide treated plots both in Pirganj and Taraganj compared to the other treatments. Thus, it was found from both the locations that continuous use of insecticide has the detrimental effect on the population of natural enemies. Treatment T_2 was refrained from insecticide use at the early crop stages (30-40 days after transplanting, DAT) in all the locations. As a result, natural enemy populations increased in T_2, which might reduce pest population below the ETL level. So it should be avoided continuous/indiscriminate use of insecticide at early crop stage (30-40 DAT) to conserve natural enemies in the rice field.

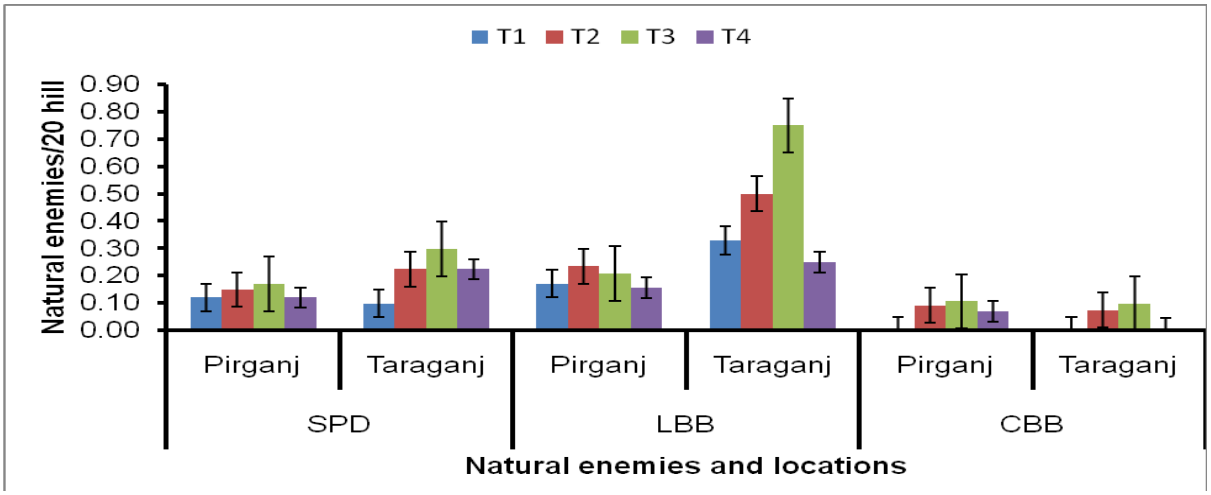

Fig. 11. Natural enemy per 20 hill count during Boro 2012-13 at Pirganj and Taraganj, Rangpur. Error bar indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice.

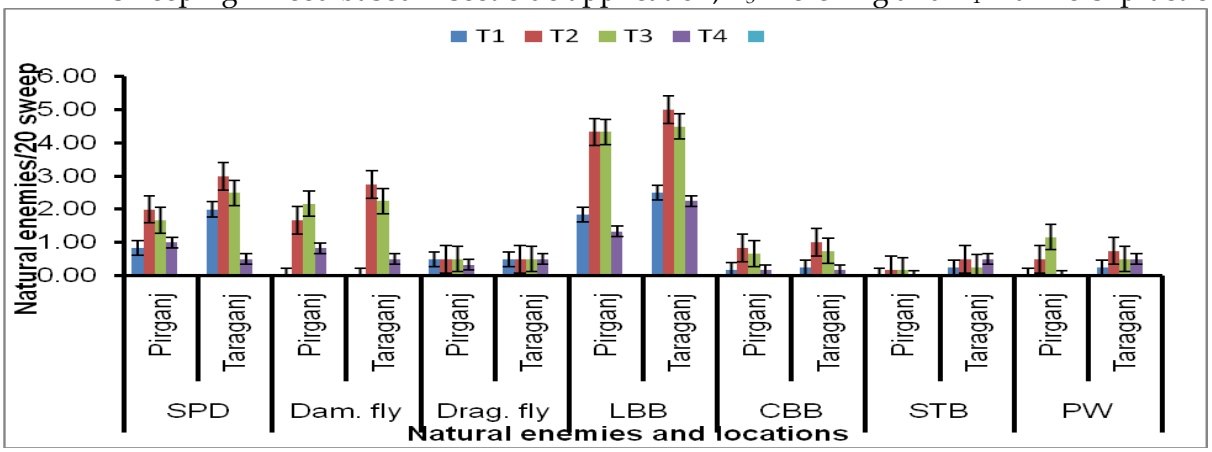

Fig. 12. Natural enemy per 20 complete sweeps during Boro 2012-13 at Pirganj and Taraganj, Rangpur. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice.

Plant characteristics, yield component and yield during Boro 2013-14. There was no significant differences among the treatments T_2, T_3 and T_4 for tiller, leaf and plant height at the experimental field of Taraganj. Though significantly the highest tiller, leaf and plant height were observed in T_1 compared to T_2 and T_3 but no difference was observed in case of panicle/hill. Significantly, lower panicle and yield was observed at treatment T_4 in both the locations (Table 4). In Pirganj, no significant differences were observed among the treatments T_1, T_2, and T_3 for different plant and yield components except leaf/hill. Though significantly the highest leaf/hill was observed in T_1 than other treatments but it had no significant contribution in panicle number and yield per hill (Table 4). In T_4 significantly lower plant and yield components were observed except leaf/hill. As a result yield reduction was observed. Most of the farmers in both the locations avoided line sowing, perching, sweeping but applied insecticides at least two times. They used imbalanced fertilizer doses and lower doses of insecticides. As a result, yield reduction might be happened in the farmers treated plots in both the locations. Moreover, no significant difference in yield was observed in other three treatments (T_1, T_2 and T_3) in both the locations. In T_1 insecticides (Carbofuran 5G @ 10.0 kg/ha) were applied five times but no yield advantage was observed over the treatment T_2 and T_3, where perching and sweeping were done fortnightly without using any insecticide.

Table 4. Plant characteristics, yield component and yield of different treatments at Taraganj and Pirganj, Boro 2013-14.

Treatment	Plant height (cm) (Mean ± SE)	Leaf/hill (no.) (Mean ± SE)	Tiller/hill (no.) (Mean ± SE)	Panicle/hill (no.) (Mean ± SE)	Yield (t/ha) (Mean ± SE)
Taraganj					
T_1 = Prophylactic use of insecticide	97.67 ±0.60a	69.83 ±1.53 a	17.41 ± 0.36a	12.43 ± 0.29a	7.01 ± 0.22a
T_2 = Perching + sweeping + need based insecticide application	94.91 ± 0.48ab	63.85 ±1.31b	16.01 ± 0.29b	12.73 ±0.24a	7.04 ± 0.29a
T_3 = Perching	93.36 ± 1.14b	62.17 ± 1.21b	15.56 ± 0.27b	12.62 ±0.27a	6.96 ± 0.24a
T_4 = Farmers' practice	93.60 ± 0.51b	61.38 ± 1.29b	15.32 ± 0.29b	11.45 ±0.25b	6.45 ±0.31b
F value	*7.31*	*8.14*	*9.48*	*10.51*	*72.08*
P≤	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
Pirganj					
T_1 = Prophylactic use of insecticide	100.75 ±0.24a	79.19 ±1.56a	15.40 ±0.27a	13.89 ±0.22a	8.45 ± 0.21a
T_2 = Perching + sweeping + need based insecticide application	100.54 ±0.25a	72.30 ±1.58b	14.61 ± 0.27a	13.61±0.27a	8.49 ±0.23a
T_3 = Perching	100.21 ±0.27a	71.56 ± 1.60b	14.02 ± 0.28a	13.15±0.23a	8.30 ±0.24a
T_4 = Farmers' practice	99.59 ±0.23b	71.36 ± 1.64b	13.57 ± 0.28b	12.09 ±0.27b	7.40 ±0.30b
F value	*2.00*	*13.97*	*12.55*	*77.08*	*4.3*
P≤	*0.05*	*0.01*	*0.01*	*0.01*	*0.05*

Value means within a column followed by the same letter (s) are not significantly different (P <0.05; Tukey's post hoc test).

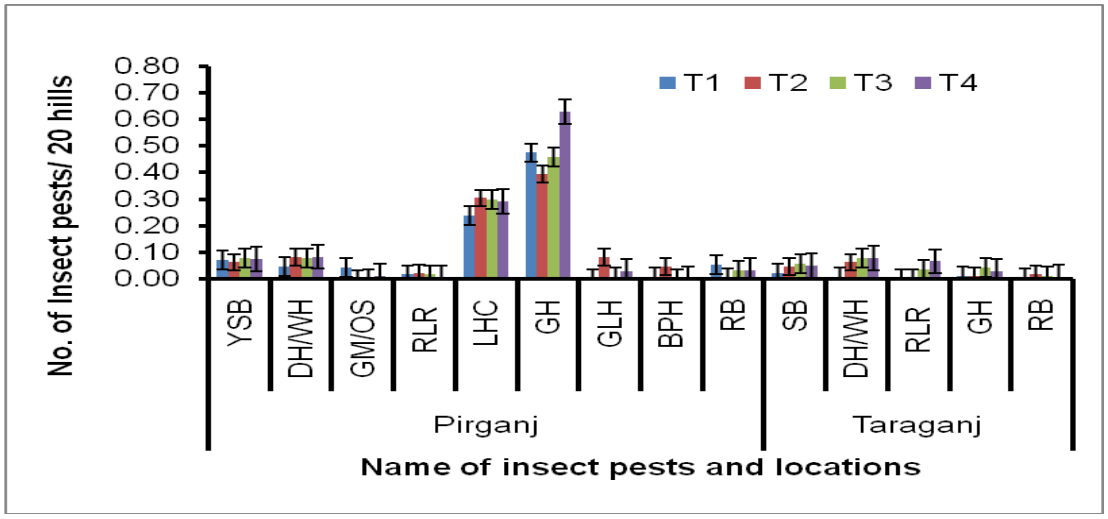

Fig. 13. Insect pests per 20 hill counts during Boro 2013-14 at Pirganj and Taraganj, Rangpur. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice.

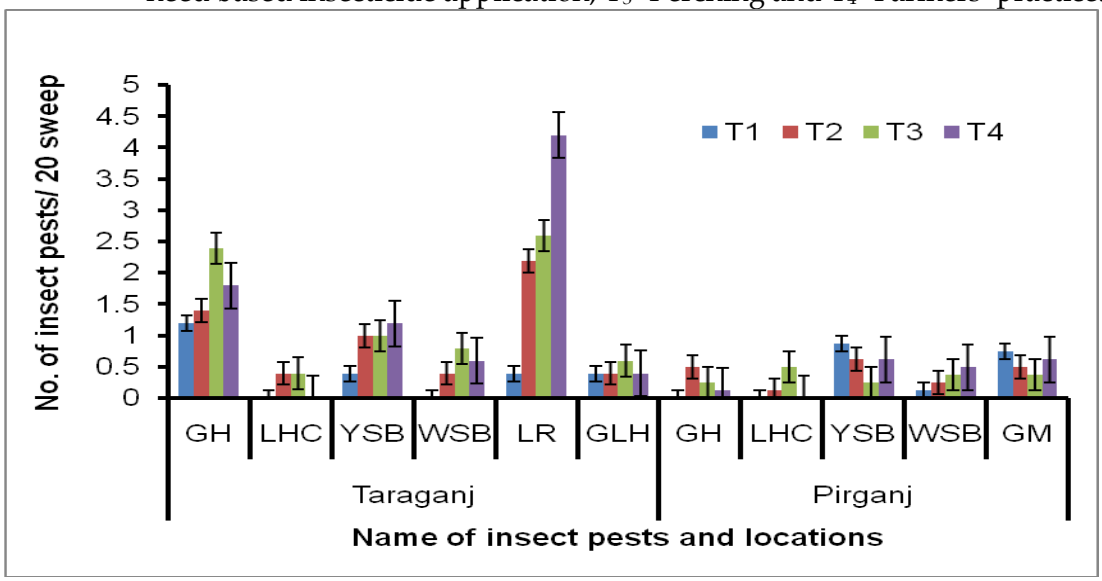

Fig. 14. Insect pests per 20 sweep during Boro 2013-14 at Pirganj and Taraganj, Rangpur. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need base insecticide application, T_3=Perching and T_4=Farmers'practice.

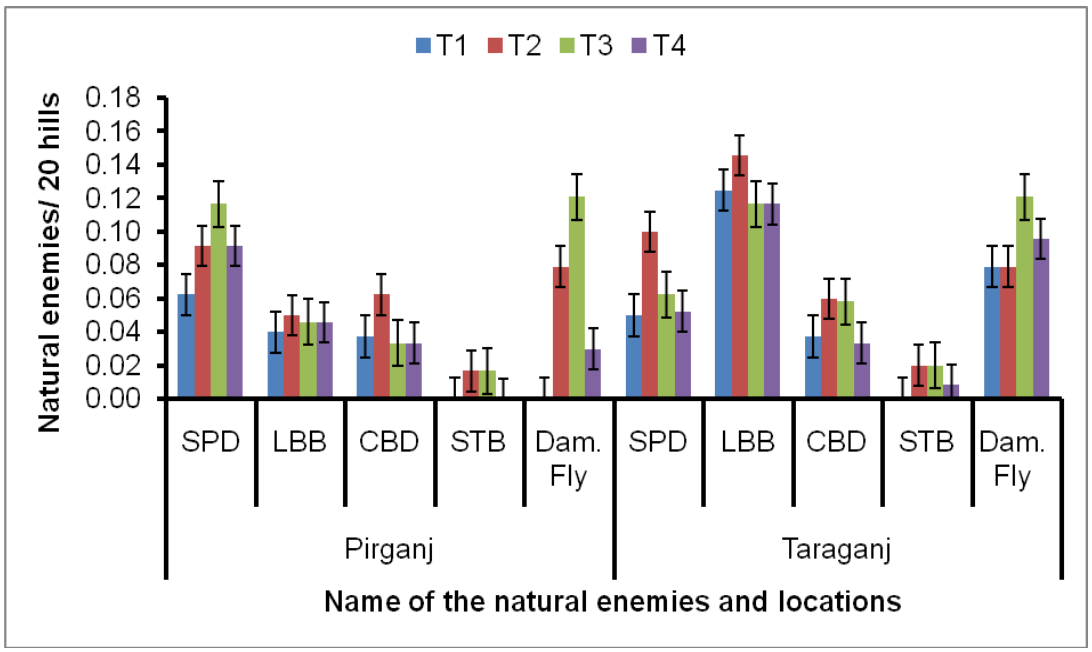

Fig. 15. Natural enemy per 20 hill counts during Boro 2013-14 at Pirganj and Taraganj, Rangpur. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice.

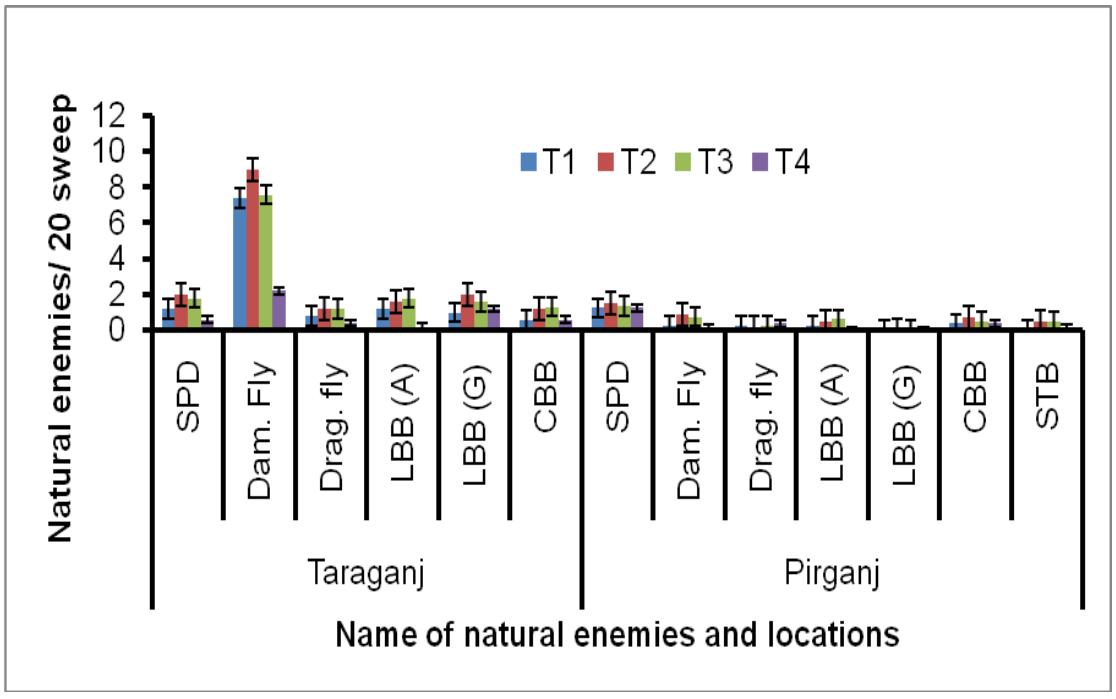

Fig. 16. Natural enemy per 20 sweep during Boro 2013-14 at Pirganj and Taraganj, Rangpur. Error bars indicate standard errors. T_1=Prophylactic use of insecticide, T_2=Perching + sweeping + need based insecticide application, T_3=Perching and T_4=Farmers' practice, A=adult, G=grub.

DISCUSSION

The present results show that prophylactic use of insecticide for rice insect pests management did not give any yield advantage or those were at par compared to only perching or perching along with sweeping techniques. Farmers managed field yielded lower compared to all other managements. Although farmers has applied 3-5 times insecticide in their fields. That means use of insecticide to control insect pests in rice did not give any yield advantages, rather increased production cost as well as environmental pollution. Also, insecticide application reduced natural enemies number in each cases and sometimes found a few species of those natural defenders. However, in the present study any of the rice insect pests did not exceed economic threshold level (ETL). Islam et al. (2010) found twice out of six rice seasons green leafhopper and rice hispa exceed ETL, both in T. Aman season in central parts of Bangladesh. They also found double number of insects compared to Boro season, which also found in our study. Also, they did not find any differences for insecticide application as preventive or curative. Insecticide application in rice reduced natural enemies for example, Dimecron 100EC, Diazinon 60EC or Carbofuran 5G applied to control rice yellow stem borer (YSB) reduce egg parasitoids (Ahmed *et al.* 2002). Most of the farmers of Pirganj and Taraganj did not use perching or no sweeping and did not follow line sowing. Lack of proper water and weed management, inappropriate insecticide use at early stage might also have negative effect on yield in farmers practiced plots in both the locations of Pirganj and Taraganj. For example, one farmers' field of Tukuria at Pirganj highly infested with Stem borers (SB), which was greater than ETL at reproductive phage (> 5% whitehead) and for controlling the SB, 'Thiamethoxam 25WG' (registered to control rice brown planthopper) was applied. Furthermore, the farmer did not use any perching or sweeping rather he used inappropriate insecticide. Regular observation or field visit is one of the key factors for implementation of IPM. Farmers usually apply insecticide to avoid regular field visit and drudgery but IPM system is highly complex, need in depth understanding and particularly one or several techniques need to control a pest. In the present study, in treatment T_2 (perching, sweeping and need based insecticide application) as there was no pests, which exceed ETL, also we did not apply any insecticide particularly at the early crop stages (30-40 DAT) in all the locations. As a result, natural enemy populations increased, which might reduce insect pest population below the ETL level. Thus, use of insecticide should be avoided at early crop stage, which could conserve natural enemies in the rice field.

CONCLUSIONS

Prophylactic use of insecticide had no effect on yield and other yield contributing characters of rice, when insect pest infestation below the ETL. So, farmers could avoid indiscriminate use of insecticide, which would finally save production cost and the environment from insecticidal pollution. Also, farmers need to visit their fields on regular basis and need to use different IPM techniques eg perching, sweeping etc.

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