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IMPACT OF CULTIVATION PRACTICES ON THE INCIDENCE OF INSECT-PESTS OF PADDY AND GREEN GRAM UNDER TERAI REGION OF WEST BENGAL

[a*]Ghosh, J., [b]Dahal D. and [c]Chaudhuri, N.
[a]Department of Agril. Entomology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India
[b]Assistant Director of Agriculture, Madarihat Block, Alipurduar, West Bengal, India
[c]Department of Agril. Entomology, Regional Research Station, Terai Zone, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India
*Corresponding author email: jaydebubkv@yahoo.com

ABSTRACT
The studies were conducted at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India during 2011-12 with a view to find out the impact of cultivation practices on the incidence of insect-pests of rice and green gram under Terai agro-ecology of West Bengal**.** Two types of cultivation processes like bio-accelerated and conventional farming system were adopted for the study. The maximum infestation of different insect-pests of rice (leaf folder, yellow stem borer, gundhi bug and grass hopper) and green gram (leaf folder, flea beetle, jassid and pod borer) was observed in the plots where conventional farming system was practiced while the minimum was recorded in the bio-accelerated one. The exception was observed in case of cutworm population where higher intensity was observed in bio-accelerated farming due to having suitable niche under mulching. In terms of grain yield, bio-accelerated farming was found to be better than conventional farming system.

KEY WORDS: paddy, green gram, bio-accelerated farming, conventional farming, pests.

INTRODUCTION
Chemical fertilizers play the major role to increase the productivity of the land as well as the insect-pests population of crops. The increased use of chemical fertilizers renders crops more vulnerable to diseases and insect attacks at present. Farmers are started to utilize more pesticides to overcome the increasing pest problems. Overuse and misuse of insecticides not only pose the problem by the development of new diseases and pests, development of insect resistance to insecticides had occurred but it also disturb the environment particularly soil, water and air. The problem of insect resistance to insecticides assumed serious proportion and as many as 124 species of insects were reported to have developed resistance to insecticides by the end of 1950s (Dhaliwal, 2001). Out of different production constraints that are being acted upon as yield barrier, insect-pests are the major one in the crop production all over the world. Due to application of high dose of fertilizers and pesticides and planting of high yielding or hybrid cultivars for higher productivity, pest problem have been aggravated many fold. The increase of productivity also appears to have accompanied by crop intensification which involves and increases in the number of crops grown per year that provide food and shelter to the insect-pests round the year. Besides, the improved cultivation technology has resulted in severe out breaks of some insect pests as documented. (Bramble, 1989; Dhaliwal and Arora, 1993 and 1994, Arora and Dhaliwal, 1996). According to Palekar (2001), use of organic mulch from crop residues continuously supply humus to improve soil quality through accelerating dynamics of biological processes like enhancing activities of microbials, earth worms, parasites, predators and induced resistance against pest and disease which ultimately lead into sustained supply of plant nutrients and keep the pest and disease incidence always at lower level.

Nowadays increasing awareness of pesticides residues in agricultural products among consumers, great emphasis has been given on organic or chemical free products both in international as well as domestic market. Keeping these facts, an attempt has been made to study the impact of bio-accelerated chemical free resilient cropping over conventional farming system regarding the incidence of insect-pests of rice and green gram.

MATERIALS & METHODS
The field experiments were conducted during 2010-11 and 2011-12 at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India.

The paddy variety Annada and green gramvariety Sonali were considered for the experiment and both the crops were sown on 30.03.2010 and 6.4.2011 in both the experimental year. The total experimental area was divided into two halves of $72m^2$ each, of which one half was utilized for bio-accelerated methods while the other half for conventional methods. For the bio accelerated farming one half was divided into three plots of 3 m × 8 m with irrigation channel (0.5 m) in between the plots. Each plot was considered as one replication. Another half utilized for the conventional one was divided into six plots of 3m x 4m having three replications each of paddy and green gram bean.

Bio-accelerated farming

An indigenous microbial culture was prepared with fresh cow dung (5 kg), cow urine (5 lt), lime (250g) and a handful of soil from the bund (uncultivated soil). The seeds were properly mixed with this culture @ 100gm/kg of seed and kept for shed drying for 24 hours before sowing.

The seeds were sown directly in inter-cropping system where legumes were intercropped with the main crop (one row of green gramin every two rows of paddy) so that they can fix the nitrogen in the soil.

The indigenous microbial culture made up of fresh cow dung (10 kg), cow urine (10 lt), molasses (2 kg), dust pulses (2 kg), a handful of soil from the bund (uncultivated soil) and water (200 lt) was applied at 15 days interval from germination to grain filling stage.

The different types of mulching (dhaincha, paddy straw, wheat straw, weeds and mustard straw etc) at approximately 3:1 ratio (Dicot: Monocot) were made continuously in between the rows of crops cultivated in the plots. No chemical fertilizer or synthetic pesticides were applied to the plots under bio-accelerated farming.

Conventional (chemical based) farming

Seeds were directly sown only after soaking in water for 24 hours. The normal agronomic practices were maintained with fertilizer @ 80:40:40 kg NPK/ha and spacing of 15 × 20 cm for rice and @ 25:50:50 kg NPK /ha and spacing of 25×10 cm for green gram bean.

Chemical pesticides were applied as and when needed.

Observations of the insect-pest as well as the damage caused by them in both the farming system were recorded at weekly interval starting from the day after transplanting (DAT) or initiation of insect-pests which one was earlier.

Rice

Observations on incidence of different insect-pest populations like leaf folder, yellow stem borer gundhi bug and grass hopper were recorded from 5 randomly selected hills at 3 different spots from each plot. Leaf folder and stem borer incidence was counted by damage symptom. The populations of the leaf folder were recorded as folded leaf where the stem borers were recorded in terms of number of "dead hearts" and "white ear head" produced during vegetative and reproductive stage respectively in each plot.

Green gram

The Flea beetle population was counted on ten plants at three different spots in each plot and the average of three spots was taken out for one replication. Jassid population was calculated for each plant by counting the pests from upper three leaves of each plant from five different spots in each replication. Ten plants were taken each time to count the damaged leaves (leaf roller) or pods (pod borer) in three spots and then taken average of it to calculate the pest for ten plants.

The cutworm population was taken in one square metre area at three different spots in each plot and the average of the three spots was taken out for one replication.

Results and discussion:

A good number of insect-pests namely yellow stem borer (*Scirpophaga incertulus* Walker), leaf folder (*Cnaphalocrocis medinalis* Guenee), grass hopper (*Hieroglyphus banian* Fabricius) and gundhi bug (*Leptocorisa acuta* Thunberg) were found on aus paddy. Among the different insect-pests attacked on mung bean, cut worm (*Agrotis ipsilon* Hufnagel), leaf folder (*Lamprosema indica* F.), flea beetle (*Phyllotreta sp*.), jassid (*Empoascca kerri* Pruthi) and pod borer (*Maruca testulalis* Geyer) were found to be most predominant and appeared persistently on green gram under present investigation.

Impact of cultivation practices on the incidence of different insect pest on paddy

Data from the table- 1 showed that the yellow stem borer, leaf folder and grass hopper were found throughout the crop growing period from 17^{th} to 26^{th} standard week excepting first one month after transplanting when the prevailing climatic conditions were 28.40^0 C to 28.77^0 C average temperatures; 8.57 to 4.72^0C temperature gradient; 76.49% to 84.96% average rh; 8.14% to 4.29% rh gradient and 0.21 to 24.59 mm total rainfall.

It was revealed from the data that the stem borer and leaf folder infestation initiated on 18^{th} SW in bio-accelerated and on 17^{th} SW in conventional farming. The grasshopper population appeared on 17^{th} SW in both the farming system. Maximum infestation of stem borer was found 2.00 nos./5hills during 23^{rd} SW in conventional farming and in the bio-accelerated one it was 0.67nos./5hills (24^{th} SW). Highest leaf folder population was recorded during 22^{nd} to 23^{rd} SW (4.90-5.47nos./5hills in the conventional and 1.87-2.10nos./5hills in bio-accelerated farming respectively).The higher population of grasshopper 1.67nos./5hills and 0.93nos./5hills were observed during 20^{th} standard week in conventional and bio-accelerated farming.

Another important pest gundhi bug was first noticed on 20th SW *i.e.* seven weeks after sowing at the panicle emergence stage and continued till the grain maturing stage (20^{th} SW to 26^{th} SW). The average temperature ranges 28.77^0C to 30.52^0C; the temperature gradient from 7.71^0C to 4.72^0C; average rh from 79.94% to 84.96% and rh gradient from 5.00% to 4.29% during the period of incidence. The rainfall was moderate (9.08mm) when the gundhi bug population reached the peak during 23^{rd} SW (1.63nos./5hills in bio-accelerated and 4.40nos/5hills in conventional farming respectively). The population was significantly higher in the conventional farming and varied significantly in all the days of observations.

TABLE 1: Effect of cultivation practices of paddy on the incidence of different pests

Pests	Year	Cultivation process	Standard week 14	15	16	17	18	19	20	21	22	23	24	25	26
Yellow stem borer/5hill	1st year	B F	0.00	0.00	0.00	0.00	0.27	0.27	0.53	0.40	0.67	0.60	0.27	0.27	0.20
			(0.71)	(0.71)	(0.71)	(0.71)	(0.88)	(0.88)	(1.01)	(0.95)	(1.08)	(1.05)	(0.88)	(0.88)	(0.84)
		C F	0.00	0.00	0.00	0.00	0.53	0.80	0.80	1.27	1.40	1.80	0.80	0.73	0.73
			(0.71)	(0.71)	(0.71)	(0.71)	(1.01)	(1.14)	(1.14)	(1.33)	(1.38)	(1.52)	(1.14)	(1.11)	(1.11)
	2nd year	B F	0.00	0.00	0.00	0.00	0.13	0.20	0.33	0.40	0.27	0.47	1.07	0.80	0.00
			(0.71)	(0.71)	(0.71)	(0.71)	(0.79)	(0.84)	(0.91)	(0.95)	(0.88)	(0.98)	(1.25)	(1.14)	(0.71)
		C F	0.00	0.00	0.00	0.27	0.80	2.13	1.80	1.80	1.67	2.20	2.33	2.33	0.00
			(0.71)	(0.71)	(0.71)	(0.88)	(1.14)	(1.62)	(1.52)	(1.52)	(1.47)	(1.64)	(1.68)	(1.68)	(0.71)
	Pooled	BF	0.00	0.00	0.00	0.00	0.20	0.23	0.43	0.40	0.47	0.53	0.67	0.53	0.10
			(0.71)	(0.71)	(0.71)	(0.71)	(0.84)	(0.85)	(0.96)	(0.95)	(0.98)	(1.01)	(1.08)	(1.01)	(0.77)
		CF	0.00	0.00	0.00	0.13	0.67	1.47	1.30	1.53	1.53	2.00	1.57	1.53	0.37
			(0.71)	(0.71)	(0.71)	(0.79)	(1.08)	(1.4)	(1.34)	(1.42)	(1.42)	(1.58)	(1.44)	(1.42)	(0.93)
Leaf Folder/5hill	1st year	B F	0.00	0.00	0.00	0.00	0.00	0.33	0.40	0.13	2.2	2.73	0.53	1.07	1.73
			(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.91)	(0.95)	(0.79)	(1.64)	(1.80)	(1.01)	(1.25)	(1.49)
		C F	0.00	0.00	0.00	0.00	0.00	1.00	1.80	1.60	7.13	7.47	2.73	2.67	4.53
			(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(1.22)	(1.52)	(1.45)	(2.76)	(2.82)	(1.80)	(1.78)	(2.24)
	2nd year	B F	0.00	0.00	0.00	0.00	0.20	0.53	2.00	1.67	2.00	1.00	2.00	0.07	0.00
			(0.71)	(0.71)	(0.71)	(0.71)	(0.84)	(1.01)	(1.58)	(1.47)	(1.58)	(1.22)	(1.58)	(0.75)	(0.71)
		C F	0.00	0.00	0.00	0.73	1.60	1.93	3.60	3.00	2.67	3.47	3.27	0.53	0.00
			0.71)	(0.71)	(0.71)	(1.11)	(1.45)	(1.56)	(2.02)	(1.87)	(1.78)	(1.99)	(1.94)	(1.01)	(0.71)
	Pooled	BF	0.00	0.00	0.00	0.00	0.10	0.43	1.20	0.90	2.10	1.87	1.27	0.57	0.87
			(0.71)	(0.71)	(0.71)	(0.71)	(0.77)	(0.96)	(1.3)	(1.18)	(1.61)	(1.54)	(1.33)	(1.03)	(1.17)
		CF	0.00	0.00	0.00	0.37	0.80	1.47	2.70	2.30	4.90	5.47	3.00	1.06	2.27
			(0.71)	(0.71)	(0.71)	(0.93)	(1.14)	(1.4)	(1.79)	(1.67)	(2.32)	(2.44)	(1.87)	(1.45)	(1.66)
Gundibug/5hill	1st year	B F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	1.33	0.33	0.67	1.33
			(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.98)	(1.35)	(0.91)	(1.08)	(1.35)
		C F	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.67	2.4	3.87	1.73	3.53	3.20
			(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(1.01)	(1.08)	(1.7)	(2.09)	(1.49)	(2.01)	(1.92)
	2nd year	B F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.13	1.8	1.93	0.13	0.33	0.00
			(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(1.28)	(1.52)	(1.56)	(0.79)	(0.91)	(0.71)
		C F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.67	4.07	4.93	2.27	0.73	0.00
			(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(1.78)	(2.14)	(2.33)	(1.66)	(1.11)	(0.71)
	Pooled	BF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	1.13	1.63	0.23	0.50	0.67
			(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(1.03)	(1.28)	(1.46)	(0.85)	(1.00)	(1.08)
		CF	0.00	0.00	0.00	0.00	0.00	0.00	0.27	1.67	3.23	4.40	2.00	2.13	1.60
			(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.88)	(1.47)	(1.93)	(2.21)	(1.58)	(1.62)	(1.45)
Grasshopper/5hill	1st year	B F	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.07	0.13	0.00	0.00	0.00	0.00
			(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.75)	(0.71)	(0.75)	(0.79)	(0.71)	(0.71)	(0.71)	(0.71)
		C F	0.00	0.00	0.00	0.00	0.00	0.27	0.33	0.20	0.6	0.13	0.20	0.00	0.00
			(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.88)	(0.91)	(0.84)	(1.05)	(0.79)	(0.84)	(0.71)	(0.71)
	2nd year	B F	0.00	0.00	0.00	0.20	0.00	0.53	1.87	1.20	1.47	1.07	0.67	0.27	0.00
			(0.71)	(0.71)	(0.71)	(0.84)	(0.71)	(1.01)	(1.54)	(1.3)	(1.4)	(1.25)	(1.08)	(0.88)	(0.71)
		C F	0.00	0.00	0.00	0.20	0.00	0.86	3.00	1.93	1.60	1.87	0.67	0.47	0.00
			(0.71)	(0.71)	(0.71)	(0.84)	(0.71)	(1.17)	(1.87)	(1.56)	(1.45)	(1.54)	(1.08)	(0.98)	(0.71)
	Pooled	BF	0.00	0.00	0.00	0.10	0.00	0.30	0.93	0.63	0.8	0.53	0.33	0.13	0.00
			(0.71)	(0.71)	(0.71)	(0.77)	(0.71)	(0.89)	(1.2)	(1.06)	(1.14)	(1.01)	(0.91)	(0.79)	(0.71)
		CF	0.00	0.00	0.00	0.10	0.00	0.57	1.67	1.07	1.10	1.00	0.43	0.23	0.00
			(0.71)	(0.71)	(0.71)	(0.77)	(0.71)	(1.03)	(1.47)	(1.25)	(1.26)	(1.22)	(0.96)	(0.85)	(0.71)

BF=Bio-accelerated farming, CF=Conventional farming, DAS=Days after sowing;
Figures in parenthesis are square root transformed values

t- test result showed that the incidence of different insect-pests attacking aus paddy (Table 2) varied significantly among two cultivation practices as well as with different date of observations. The conventional farming showed significantly higher insect-pest population over the bio-accelerated farming practices.

Multiple regression equation (Table 3) showed that individual weather parameters had no significant impact on insect pest population of pre-kharif paddy in most of the cases. Average temperature showed significant impacts in conventional practices against stem borer population which depicted that a unit change in average temperature could influence pest population at an extent of 0.709 units in the positive direction. In case of leaf folder, average temperature in both the cultivation practices had significant variation which showed that a unit change of average temperature could influence leaf folder population at an extent of 0.663 units and 1.674 units in bio-accelerated and conventional methods respectively. Population of gundhi bug and grasshopper showed no significant relation with weather factors. R-value for regression between stemborer and weather factors was found 62.7% and 60.4% in bio-accelerated and conventional farming respectively. Similarly, leaf folder had 51.1% and 53.6%; gundhi bug had 44.9% and 50.5% and grass hopper had 40% and 35.9% in bio-accelerated and conventional farming respectively.

TABLE 2: 't'-test on the effect of cultivation practices of pre-kharif paddy on the incidence of different pests

Pests	Standard Week	17	18	19	20	21	22	23	24	25	26
Yellow stem borer	t-value	-2.51	-3.74	-6.07	-4.96	-8.86	-4.85	-10.77	-2.95	-3.79	-2.06
	Pr>t	0.0175	0.0008	<.0001	<.0001	<.0001	<.0001	<.0001	0.0062	0.0007	0.0482
Leaf folder	t-value	-2.66	-3.03	-5.42	-4.29	-3.72	-4.41	-5.44	-5.24	-2.59	-1.57
	Pr>t	0.0124	0.0051	<.0001	0.0002	0.0008	0.0001	<.0001	<.0001	0.0148	0.1272
Gundhibug	t-value	-	-	-	-2.80	-2.91	-6.33	-6.57	-6.71	-3.78	-1.57
	Pr>t	-	-	-	0.0088	0.0067	<.0001	<.0001	<.0001	0.0007	0.1269
Grasshopper	t-value	0.02	-	-1.68	-1.49	-1.13	-1.47	-1.45	-0.77	-0.37	-
	Pr>t	0.9873	-	0.104	0.1463	0.2672	0.1520	0.1566	0.4461	0.7162	-

TABLE 3: Regression analysis of different weather parameters with pest

Pests	Treatments	Equation	R^2
Yellow stem borer	BF	$Y= -3.624 + 0.169 x_1 + 0.001x_2 - 0.016 x_3 - 0.002 x_4 + 0.019 x_5$	0.627
	CF	$Y= -14.621 + 0.709x_1^* - 0.132x_2 - 0.052x_3 - 0.003x_4 + 0.003x_5$	0.604
Leaf folder	BF	$Y= -16.019 + 0.663x_1^* - 0.084x_2 - 0.027x_3 + 0.017x_4 - 0.001x_5$	0.511
	CF	$Y= -35.007 + 1.674x_1^* - 0.438x_2 - 0.112x_3 + 0.108x_4 - 0.046x_5$	0.536
Gundhibug	BF	$Y= -12.037 + 0.460x_1 - 0.151x_2 + 0.002x_3 + 0.051x_4 - 0.042x_5$	0.449
	CF	$Y= -32.385 + 1.237x_1 - 0.244x_2 - 0.016x_3 + 0.111x_4 - 0.027x_5$	0.505
Grasshopper	BF	$Y= -5.609 + 0.253x_1 + 0.007x_2 - 0.019x_3 - 0.023x_4 + 0.006x_5$	0.407
	CF	$Y= -7.344 + 0.387x_1 - 0.026x_2 - 0.039x_3 - 0.034x_4 + 0.004x_5$	0.359

Where, x_1=average temperature, x_2=temperature gradient, x_3=average relative humidity, x_4=relative humidity gradient, x_5=rainfall, * means significant at 5% level.

TABLE 4: Effect of cultivation practices of green gram on the incidence of different pests

Pests	Year	cultivation process	Standard week								
			14	15	16	17	18	19	20	21	22
Cutworm /m^2	1st	BF	0.00 (0.71)	0.20 (0.84)	2.07 (1.61)	0.67 (1.09)	0.47 (0.99)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
		CF	0.00 (0.71)	0.00 (0.71)	0.93 (1.20)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
	2nd	BF	0.00 (0.71)	1.00 (1.23)	0.33 (0.92)	0.27 (0.88)	0.07 (0.76)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
		CF	0.00 (0.71)	0.00 (0.71)	0.27 (0.88)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
	Pooled	BF	0.00 (0.71)	0.60 (1.05)	1.20 (1.31)	0.47 (0.99)	0.27 (0.88)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
		CF	0.00 (0.71)	0.00 (0.71)	0.60 (1.05)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
Leaf Folder /10pl	1st	BF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.00 (1.23)	0.00 (0.71)	0.73 (1.11)	1.33 (1.36)	0.20 (0.84)	0.00 (0.71)
		CF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.93 (1.56)	0.73 (1.11)	1.27 (1.33)	2.07 (1.61)	0.60 (1.05)	0.27 (0.88)
	2nd	BF	0.00 (0.71)	0.00 (0.71)	0.73 (1.11)	1.53 (1.53)	1.73 (1.49)	0.53 (1.02)	0.80 (1.14)	0.47 (0.99)	0.00 (0.71)
		CF	0.00 (0.71)	0.00 (0.71)	1.87 (1.54)	2.00 (1.58)	3.33 (1.96)	0.93 (1.2)	1.40 (1.38)	0.67 (1.09)	0.67 (1.09)
	Pooled	BF	0.00 (0.71)	0.00 (0.71)	0.37 (0.94)	1.27 (1.33)	0.87 (1.17)	0.63 (1.07)	1.07 (1.26)	0.33 (0.92)	0.00 (0.71)
		CF	0.00 (0.71)	0.00 (0.71)	0.93 (1.20)	1.97 (1.57)	2.03 (1.59)	1.1 (1.27)	1.73 (1.50)	0.63 (1.07)	0.47 (0.99)
Flea Beetle /10pl	1st	BF	0.00 (0.71)	0.00 (0.71)	1.73 (1.49)	1.33 (1.36)	1.27 (1.33)	1.47 (1.41)	0.33 (0.92)	0.27 (0.88)	0.27 (0.88)
		CF	0.00 (0.71)	0.00 (0.71)	1.80 (1.52)	1.87 (1.54)	1.80 (1.52)	1.93 (1.56)	0.6 (1.05)	0.67 (1.09)	1.27 (1.33)
	2nd	BF	0.00 (0.71)	0.00 (0.71)	1.33 (1.36)	2.00 (1.58)	2.00 (1.58)	1.07 (1.26)	3.87 (2.09)	0.67 (1.09)	0.67 (1.09)
		CF	0.00 (0.71)	0.27 (0.88)	2.47 (1.73)	4.47 (2.23)	2.87 (1.84)	3.13 (1.91)	6.54 (2.66)	1.73 (1.49)	2.07 (1.61)
	Pooled	BF	0.00 (0.71)	0.00 (0.71)	1.53 (1.43)	1.67 (1.48)	1.63 (1.46)	1.27 (1.33)	2.10 (1.62)	0.47 (0.99)	0.47 (0.99)

		CF	0.00 (0.71)	0.13 (0.80)	2.13 (1.62)	3.17 (1.92)	2.33 (1.69)	2.53 (1.74)	3.57 (2.02)	1.20 (1.31)	1.67 (1.48)
Pod Borer /10pl	1st	BF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.53 (1.02)	1.67 (1.48)	7.27 (2.79)	8.60 (3.02)	5.33 (2.42)	0.00 (0.71)
		CF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	2.13 (1.62)	4.93 (2.33)	12.27 (3.57)	11.93 (3.53)	7.73 (2.87)	0.00 (0.71)
	2nd	BF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.53 (1.43)	2.13 (1.62)	10.40 (3.3)	4.80 (2.30)	0.00 (0.71)
		CF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	3.67 (2.04)	4.40 (2.22)	16.00 (4.06)	7.00 (2.74)	0.00 (0.71)
	Pooled	BF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.27 (0.88)	1.60 (1.45)	4.70 (2.28)	9.50 (3.16)	5.07 (2.36)	0.00 (0.71)
		CF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.07 (1.26)	4.30 (2.19)	8.33 (2.97)	13.97 (3.81)	7.37 (2.81)	0.00 (0.71)
Jassid /Pl	1st	BF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.60 (1.05)	2.07 (1.61)	0.47 (0.99)	0.00 (0.71)	0.00 (0.71)
		CF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.53 (1.43)	3.73 (2.06)	2.2 (1.65)	0.00 (0.71)	0.00 (0.71)
	2nd	BF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.47 (0.99)	1.13 (1.28)	0.07 (0.76)	0.00 (0.71)	0.00 (0.71)
		CF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.07 (0.76)	2.07 (1.61)	2.80 (1.82)	2.00 (1.58)	0.13 (0.80)	0.00 (0.71)
	Pooled	BF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.53 (1.02)	1.6 (1.45)	0.27 (0.88)	0.00 (0.71)	0.00 (0.71)
		CF	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.03 (0.73)	1.80 (1.52)	3.27 (1.94)	2.10 (1.62)	0.07 (0.76)	0.00 (0.71)

BF=Bio-accelerated farming, CF=Conventional farming, DAS=Days after sowing;
Figures in parenthesis are square root transformed values

Impact of cultivation practices on the incidence of different insect pest on green gram

The conventional farming showed significantly higher insect-pest population over the bio-accelerated farming practices except cutworms which showed higher population in bio-accelerated farming due to having suitable niche under mulching (Table 4). Cutworm is gaining importance as an important pest in this region mainly on green gram, black gram, cowpea, potato and maize. Cutworm population was interestingly found more in bio-accelerated methods over conventional methods; probably they got ease shelter inside the mulching. In the present investigation, the pest appeared on 15th SW and damaging symptom persisted for one month in bio-accelerated farming while it present for only one week 16th SW in conventional farming. The highest infestation was recorded on 16th SW on bio-accelerated (1.20/5 plants) than on conventional farming (0.60 /5 plants) at 28.37^{0}C to 28.95^{0}C average temperature; 8.57 to 11.57^{0}C temperature gradient; 76.50% to 77.96% average RH; 5.00% to 13.57% RH gradient and 4.49mm rainfall.

The leaf folder, flea beetle and pod borer incidence were initiated on 16th SW, 15th SW and 17th SW and continued upto 22nd SW. The population increased gradually and reached its maximum on 20th SW at 28.37–30.52^{0}C average temperature; 7.71-10.15^{0}C temperature gradient; 76.50–81.60% average RH; 3.75–11.24% RH gradient and 3.75mm rainfall. The respective population was significantly higher in conventional farming than the bio-accelerated one. The peak populations were, leaf folder (1.97/10plants and 1.27/10plants in conventional and bio-accelerated farming respectively), flea beetle (3.57/5 plants and2.10/5 plants in conventional and bio-accelerated farming respectively) and pod borer (13.97/5 plants and9.50/5 plants in conventional and bio-accelerated farming respectively).

Jassid is also gaining importance in pest status of green gram in this terai region of West Bengal. The maximum population was recorded in conventional farming (3.27/plant) against bio-accelerated farming (1.60/plant) in 19th SW. The pest was present till 21SW. The climatic conditions during the period of peak infestation were 28.40^0 C to 30.19^{0}C average temperature; 7.71 to 9.57^{0}C temperature gradient; 76.50% to 79.94% average RH; 5.00% to 12.14% RH gradient and 3.75mm rainfall.

t- test result showed that the incidence of different insect-pests attacking green gram (Table 5) varied significantly among two cultivation practices as well as with different date of observations.

The multiple regression equation (Table- 6) showed that weather parameters, in most of the cases had no significant impact on the population of these pests. Only temperature average and temperature gradient revealed significant negative impact against leaf roller and flea beetle in both bio-accelerated and conventional farming system. Impact of weather parameters in together was found 86.7% and 75.5% against leaf roller in bio-accelerated and conventional farming respectively whereas 89.9% and 88.6% contribution of weather factors in total were noticed against flea beetle in both the farming system. In other insect pests, weather parameters had no significant impact on their population development.

The average of the two year study revealed that the yield was significantly more in the bio-accelerated farming (3682.50 kg ha^{-1} of aus paddy and 1500.5 kg ha^{-1} of mung bean) than conventional farming (3498.70 kg ha^{-1}of aus paddy and1375.0 kg ha^{-1} of green gram bean).

TABLE 5:'t'-test analysis on effect of cultivation practices of green gram on the incidence of different pests

Pests	Std. Wk.	15	16	17	18	19	20	21	22
Cutworm	t-value	4.65	2.01	3.39	3.05	-	-	-	-
	Pr>t	<.0001	0.0536	0.0004	0.0048	-	-	-	-
Leaf folder	t-value	-	-1.61	-2.79	-2.59	-2.85	-3.35	-1.74	-4.17
	Pr>t	-	0.1180	0.009	0.0145	0.0079	0.0022	0.0925	0.0002
Flea beetle	t-value	-1.97	-2.41	-3.46	-2.31	-5.35	-1.31	-3.35	-5.45
	Pr>t	0.058	0.0221	0.0016	0.0282	<.0001	0.2013	0.0022	<.0001
Pod borer	t-value	-	-	-2.40	-8.52	-2.69	-4.51	-4.92	-
	Pr>t	-	-	0.0230	<.0001	0.0115	<.0001	<.0001	-
Jassid	t-value	-	-	-1.56	-5.49	-5.75	-10.52	-2.15	-
	Pr>t	-	-	0.1295	<.0001	<.0001	<.0001	0.0401	-

TABLE 6: Regression analysis of different weather parameters with pest

Sl.No.	Pest	Treatments	Equation	R^2
1	Cut worm	BF	$Y= 4.198 -0.312x_1 + 0.075x_2 + 0.058x_3 -0.005x_4 + 0.004x_5$	0.470
		CF	$Y= 0.388 -0.103x_1 + 0.067x_2 + 0.028x_3 -0.022x_4 + 0.010x_5$	0.347
2	Leaf roller	BF	$Y= 14.428 -0.500x_1^{**} -0.389x_2^{**} + 0.056x_3 + 0.023x_4 -0.041x_5$	0.867
		CF	$Y= 16.514 -0.765x_1^{*} -0.614x_2^{*} + 0.162x_3 + 0.042x_4 -0.085x_5$	0.755
3	Flea beetle	BF	$Y= 13.680 -0.907x_1^{**} -0.505x_2^{*} + 0.243x_3^{*} -0.009x_4 -0.068x_5$	0.899
		CF	$Y= 11.520 -1.229x_1^{*} -0.848x_2^{*} + 0.450x_3^{*} -0.034x_4 -0.135x_5$	0.886
4	Pod borer	BF	$Y= 12.132 -1.141x_1 -1.651x_2 + 0.534x_3 -0.226x_4 -0.206x_5$	0.629
		CF	$Y= 23.955 -1.808x_1 -2.902x_2 + 0.817x_3 -0.247x_4 -0.405x_5$	0.671
5	Jassid	BF	$Y= -2.386 + 0.024x_1 -0.266x_2 + 0.063x_3 -0.004x_4 -0.067x_5$	0.470
		CF	$Y= -0.688 -0.367x_1 -0.757x_2 + 0.259x_3 + 0.005x_4 -0.156x_5$	0.572

Where, x_1=average temperature, x_2=temperature gradient, x_3=average relative humidity, x_4=relative humidity gradient, x_5=rainfall * means significant at 5% level.

TABLE 7: 't'-test analysis on effect of cultivation practices on the yield of paddy and green gram

Yield (kg ha^{-1})	1^ST Year		2^ND Year		Pooled		t-value	Pr>t
	BF	CF	BF	CF	BF	CF		
Paddy	3613.00	3440.30	3752.00	3557.10	3682.50	3498.70	4.84	<.0001
Green gram	1521.30	1367.40	1479.80	1382.60	1500.50	1375.00	7.76	<.0001

The result of present findings regarding insect-pests of rice and green gram and also their yield showed better performance by bio-accelerated farming over conventional farming which are in conformity with the findings of many workers (Li, Xue-Y.; Wang, Q.; Xu, F.L., 2000.; Fang, S. Xie, B.; Zhang, H. 2007; Xu-Guo and Chang, 2007; Mulamba and Lal, 2008; S.B. Goswami and S.K. Das, 2009.).

From overall performance of these two systems, it can, therefore, be concluded that bio-accelerated farming in all respect showed better performance over conventional farming and also associated with low inputs, high quality product, eco-friendly environment system, multiple cropping. Hence, this system can certainly minimize the environmental hazard without compromising on return from the crop.

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Kg= Kilogram, Ha=Hectare