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Effect of Cultivars and Botanicals on the Incidence of Major Insect Pests in Lowland Rice

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Abstract

A field experiment was conducted during the wet season of 2011 at the experimental farm of ICAR Complex for North East hill region, Jharnapani, Medziphema, Nagaland using Split Plot Design to study on the effect of cultivars and botanicals on the incidence of major insect pests in lowland rice. A rice variety, Ranjit and two rice cultivars, Miracle rice and Jalukie special were selected and three major pests were taken into account for the study. Peak incidence of rice stem borer and leaf folder in all the three varieties were observed at 105 days after transplanting of the crop. Jalukie special harboured the maximum number of borer population (26.67%) followed by ranjit (26.30%) and miracle rice (23.00%). Leaf folder incidence was maximum in ranjit (29.47%) followed by miracle rice (27.83%) and lowest incidence was in jalukie special (27.33%). The incidence of ear head bug was observed from 60 days after transplanting till harvest. Peak incidence was observed at 120 days after transplanting. Incidence was highest in ranjit (4.43 bugs 5 sweeps^{-1}) followed by Miracle ice (3.57 bugs 5 sweeps^{-1}) and Jalukie special (3.13 bugs 5 sweeps^{-1}). Among the botanical treatments, *Litsea citrata* seed extract was found to give effective control against the three pests almost at par with Monocrotophos. Crude stem extract of *Costus speciosus* and seed extract of *Chenopodium ambrosioides* were also found to be effective in reducing the pests.

1. Introduction

Rice stem borer, *Scirpophaga incertulas* (Walker) is one of the most serious pest of rice that occur in all the rice growing tracts of the Asian mainland and Japan (Narayana, 1953). Rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) was once reckoned as minor pest but has now became of a serious pest with the introduction of high yielding rice varieties with broad leaves and indiscriminate use of insecticides leading to decimation of its natural enemies. The rice ear head bug (*Leptocorisa* spp.) causes appreciable grain loss up to 53% during severe attack (Rai et al., 2000). The use of chemical insecticides to control these pests has created many problems such as environmental hazards, resistance in target species, pest resurgence etc. (Hollomon, 1993). Plant extracts have been found effective against the rice stored grain pests (Asangla Jamir, 2013). The pesticides of plant origin (botanicals) have many advantages over synthetic pesticides as they possess least or no health hazards, no environmental pollution and minimum risk of development of insect resistance, no risk of pest resurgence, surface persistence, no adverse effect on crop viability, less expensive and easily available. Keeping all these in mind, the present study was undertaken to explore the efficacy of three locally available plants viz., *Costus speciosus* (J. Konig), *Litsea citrata* (Bl.Bijdr) and *Chenopodium ambrosioides* L. against the insect pests of lowland rice.

2. Materials and Methods

Field experiment was carried out during the wet season of 2011 at the experimental farm of ICAR Complex for North East hill region, Jharnapani, Medziphema, Nagaland using Split Plot Design to study on the effect of cultivars and botanicals on the incidence of major insect pests in lowland rice. Three rice cultivars viz., Ranjit, Miracle Rice and Jalukie Special were taken in the main plots, while three botanicals viz., *Litsea citrata* (seed extract), *Chenopodium ambrosioides* (seed extract) and *Costus speciosus* (crude stem extract) @ 20 ml l^{-1} along with a synthetic chemical insecticide monocrotophos 36 SL @ 1.5 ml l^{-1} and untreated control were taken as sub plots (Plate 1). All the necessary recommended agronomic practices were carried out to raise the crop. The plant products were first extracted in the laboratory with the help of Soxhlet's apparatus. The dosage of the botanicals was determined by means of phyto-toxicity test in the net house i.e. 20 ml l^{-1}. The

insecticide and botanical treatments were applied as foliar spray and 2 sprayings were made throughout the experiment i.e., 45 and 90 days after of transplanting. Observations on stem borer infestation were recorded at 1, 7 and 15 days after application of the insecticide/plant products. Twenty hills were selected per plot excluding the border rows. The infested tillers were counted in all the twenty hills under observation. The tillers showing dead hearts were recorded as infested tillers. The percentage of infestation was calculated using the following formula:

$$\text{Percentage of infestation} = \frac{\text{Total number of infested tillers}}{\text{Total number of tillers in 20 hills}} \times 100$$

Observations on leaf folder infestation were recorded at 1, 7 and 15 days after application of the insecticide/plant products. Twenty hills were selected per plot excluding the border rows. Leaves and infested tillers were counted in all 20 hills under observation and were recorded. The percentage of infestation of rice leaf folder was calculated by using the following formula:

$$\text{Percentage of infestation} = \frac{\text{Number of infested leaves}}{\text{Total number of leaves in 20 hills}} \times 100$$

The ear head bug or gundhi bug population (both adults and nymphs) were accounted with the help of sweep net @ 5 sweeps per plot. The mean catch of the five sweeps in each plots were recorded. The cost benefit ratio of each treatment was calculated taking into account the prevailing market price of inputs, produce and labour charges. The percentage of infestation in case of stem borer and leaf folder were transformed into angular values where as for ear head bug it was transformed into square root ($\sqrt{X+0.5}$) values and the data thus transformed were subjected to analysis of variance.

3. Result and Discussion

3.1. Effect of cultivar on the incidence of rice stem borer

The rice stem borers were the first pests of concern to be observed in the study at 15 DAT (days after transplanting), the pest was observed in Ranjit variety (Table 1). As reported by Ayyanna and Hamid Ali (1970), the peak population of stem borer was observed during the first week of October i.e. 105 DAT after which the infestation are gradually decreased. Kumar (2003) also found similar findings who reported that the quantum of dead hearts or white ears peaked on 135 DAT starting from 110 DAT during 1990, which is in conformity with the present study where quanta of white ears in all the three varieties were maximum during 105 DAT, coinciding with flowering and ear head formation stage of crop when the maximum temperature was 32.7°C and RH of 88%. The correlation studies revealed no significant relationship between the incidence of borers and the abiotic weather parameters (Table 2).

3.2. Effect of cultivars on the incidence of rice leaf folder

Incidence of rice leaf folder, *Cnaphalocrocis medinalis* was observed uniformly in all the three rice variety and cultivars i.e. from 30 DAT (Table 1). The peak infestation percentage was recorded during October, after which the percentage gradually subsided. This is similar to the findings of Khan et al. (1999) who reported that leaf folder infestation started from July and reached its peak in the month of October (95 DAT), when the larval population and the per cent damage reached 2.0-4.5 and 12.9-26.2 levels, respectively. The correlation studies revealed no significant relationship between the incidence of leaf folders

Table 1: Incidence of rce stem borer, leaf folder and gundhi bug with abiotic factors on three variety/cultivars

DAT	Percent infestation 20 hills^{-1}						Population 5 sweeps^{-1}			Temperature (°C)		Average relative humidity (%)	Average rainfall (mm)
	Rice stem borer			Rice leaf folder			Rice gundhi bug						
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	Maximum	Minimum		
15	-	1.53	-	-	-	-	-	-	-	32.50	25.30	88	6.45
30	1.50	1.77	-	-	-	-	-	-	-	32.30	25.50	88	3.63
45	3.00	4.44	3.64	2.30	2.30	1.00	-	-	-	34.30	26.10	92	7.21
60	3.74	5.16	4.23	5.07	4.93	5.03	-	-	-	32.70	23.30	88	19.70
75	9.30	15.67	13.43	5.63	5.61	5.54	0.43	0.60	0.30	33.30	23.50	88	10.40
90	18.37	25.10	24.67	16.27	16.47	16.00	0.58	0.53	0.43	31.70	24.30	88	2.23
105	23.00	26.30	26.67	26.43	27.80	25.67	2.03	2.20	1.53	32.70	22.30	88	11.88
120	16.27	16.10	16.67	27.83	29.47	27.33	2.57	2.77	2.33	31.50	22.10	87	0
135	6.73	9.12	8.67	21.30	18.03	17.67	3.57	4.43	3.13	28.70	15.10	86	0
150	2.53	4.80	4.00	14.43	10.00	10.67	2.73	3.30	2.27	27.30	15.10	89	0
165	-	-	-	7.40	4.33	5.00	1.97	3.10	1.80	27.30	15.10	89	0
Mean	9.38	12.05	12.75	14.07	13.22	12.66	1.98	2.42	1.68	-	-	-	-

DAT: Days after transplanting, V_1: Miracle rice, V_2: Ranjit, V_3: Jalukie special

and the abiotic weather parameters (Table 2).

3.3. Effect of cultivars on the incidence of rice gundhi bug

The incidence of rice gundhi bug was observed when the other pests were almost at their peak. Incidence was recorded from 75 DAT where the population was quite low. The population reached its peak in between 120-135 DAT i.e. at milking and grain filling stage of the crop (Table 1). It was in confirmation with Rai et al. (2000) who observed the peak population of *Leptocorisa acuta* from 37-40th (110-140 DAT) standard weeks when the crop at milky grain stage. The correlation studies revealed no significant relationship between the incidence of rice gundhi bugs and the abiotic weather parameters like temperature and relative humidity. However, negative but significant correlation was recorded with rainfall in all the 3 variety/cultivars in the order of Ranjit (-0.77), Miracle rice (-0.72) and Jalukie special (-0.69) (Table 2).

3.4. Efficacy of botanicals against rice stem borer

In this context, it is interesting to record that the chemical insecticide under the present study, Monocrotophos 36 SL, proved to be significantly superior over the three botanicals (Table 3). However *Litsea citrata* seed extract @ 20 ml l^{-1} performed against rice stem borer at 7 days after application in the first application in reducing the dead heart percentage. Similarly, *Costus speciosus* crude stem extract and *Chenopodium ambrosioides* seed extract also reduced the borer infestation to some extent in comparison to the control plots. Similar results were reported by Panda et al. (1988) regarding granular Carbofuran and Monocrotophos @ 0.05% concentration. *Litsea citrata* seed extract effectively reduced the borer infestation up to 7 days after application. All the botanicals gave significant reduction in the borer infestation over the control in the order of *Litsea citrata* seed extract followed by *Costus speciosus* crude stem extract and *Chenopodium ambrosioides* seed extract.

3.5. Efficacy of botanicals against rice leaf folder

The chemical insecticide Monocrotophos 36 SL proved to be the most effective over the three botanicals in reducing the pest (Table 3). The present study also revealed that all the botanicals were effective; the highest efficacy was indicated by *Litsea*

Table 2: Correlation coefficient of rice stem borer, leaf folder and gundhi bug incidence with abiotic factors on three cultivars

Abiotic factors	Stem Borer			Leaf folder			Gundhi bug		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
Temperature (°C) Maximum	0.164	0.105	0.213	0.030	0.182	0.145	-0.369	-0.542	-0.379
Minimum	0.115	0.007	0.273	0.029	0.135	0.080	-0.322	-0.473	-0.347
Relative Humidity (%)	-0.326	-0.261	-0.360	-0.402	-0.299	-0.313	-0.475	-0.378	-0.425
Rainfall (mm)	-0.011	0.009	-0.074	-0.115	-0.018	0.001	-0.716*	-0.774*	-0.686

*Significant at p=0.05, V_1: Miracle rice, V_2: Ranjit, V_3: Jalukie special

Table 3: Field efficacy of different treatments against rice stem borer and leaf folder during the wet season of 2011

Treatments	Mean infestation (%)											
	1st Application						2nd Application					
	Rice stem borer			Rice leaf folder			Rice stem borer			Rice leaf folder		
	1 DAA	7 DAA	15 DAA	1 DAA	7 DAA	15 DAA	1 DAA	7 DAA	15 DAA	1 DAA	7 DAA	15 DAA
Monocrotophos 36 SL @ 1.5 ml l^{-1}	2.55 (1.74)	1.84 (1.53)	1.75 (1.50)	4.24 (2.18)	3.03 (1.88)	3.23 (1.93)	11.76 (3.50)	7.26 (2.79)	7.01 (2.74)	19.18 (4.43)	15.69 (4.02)	14.53 (3.87)
Litsea citrata seed extract @ 20 ml l^{-1}	2.83 (1.82)	2.15 (1.62)	2.41 (1.70)	4.46 (2.23)	3.34 (1.96)	3.71 (2.05)	12.92 (3.66)	9.77 (3.21)	10.52 (3.32)	20.94 (4.63)	17.51 (4.24)	18.04 (4.31)
Costus specious stem extract @ 20 ml l^{-1}	3.18 (1.92)	2.58 (1.75)	2.88 (1.84)	4.66 (2.27)	3.62 (2.03)	4.02 (2.13)	13.38 (3.73)	10.77 (3.36)	12.27 (3.57)	22.44 (4.79)	19.69 (4.49)	20.46 (4.58)
Chenopodium ambrosioides seed extract @ 20 ml l^{-1}	2.96 (1.86)	2.43 (1.71)	2.82 (1.82)	4.96 (2.34)	3.94 (2.11)	4.41 (2.22)	14.07 (3.82)	10.85 (3.37)	14.04 (3.81)	23.51 (4.90)	21.48 (4.68)	23.19 (4.86)
Control	3.15 (1.91)	3.44 (1.99)	3.87 (2.09)	4.94 (2.33)	5.02 (2.35)	5.59 (2.47)	17.68 (4.26)	19.49 (4.47)	21.94 (4.74)	26.72 (5.21)	27.28 (5.27)	28.11 (5.35)
SEm±	0.022	0.025	0.025	0.024	0.307	0.028	0.039	0.048	0.052	0.046	0.047	0.049
CD (p=0.05)	0.073	0.085	0.085	0.081	1.038	0.095	0.131	0.162	0.175	0.157	0.159	0.166

DAA: Days after application; Figure in the parenthesis are angular transformed values

citrata seed extract @ 20 ml l^{-1} at both the applications and was found to be almost at par with Monocrotophos 36 SL @ 0.05%. Deka (2003) conducted an experiment on the use of Indigenous Technological Knowledge (ITK) for rice pests in Assam. Extracts of locally available plants viz., *Litsea citrata*, *Costus speciosus* and neem were used and reported significant reduction in insect pest infestation which is in conformity with the present findings. Similar results were reported by Moanaro (2007) who evaluated some indigenous plants for their insecticidal property and reported that the effectiveness of acetone extract of *L. citrata* was at par with 2% neem oil which is significantly effective in reducing *Cnaphalocrocis medinalis.*

3.6. Efficacy of botanicals against rice gundhi bug

The effectiveness of Monocrotophos against rice gundhi bug population has been reported by many workers. In the present investigation also, it was found that Monocrotophos 36 SL @ 0.05% was significantly effective in reducing the population at 1 day after application (Table 4). Similar observations were reported by Heinrichs et al. (1982) who tested numerous insecticides for the control of *Leptocorisa oratorius* on rice including 0.05% Monocrotophos and reported cent percent reduction of the pest population. In the present findings, it was observed that there was a reduction of about 70% population in the 1st day after application and the population was kept in check till 15th day. The efficacy of the botanicals against the pest was quite remarkable during the 1st day after application. All the three botanicals gave much reduction in the pest population. However the effect of the botanicals wears off as indicated by the gradual build up of the population from the 7th day after application. But the control of the pest was evident and this can be compared to the findings and researches by many scholars.

3.7. Effect of botanicals on percent increase of yield

It is evident from the data (Table 5) that there is increase in yield over the control plots in all the treatments. Among the botanicals, rice treated with *L. citrata* seed extract showed maximum increase in yield in the two cultivars i.e. 28.39% in Miracle rice and 19.13% in Jalukie special. *Costus speciosus* crude stem extract also showed an increase of 14.54% in Miracle rice and 12.30% increase in Jalukie special. *Chenopodium ambrosioides* seed extract also showed increase in yield over control in all the rice cultivars/variety. Many works have been done on the effect of grain yield due to the use of botanicals and plant bio-rationales for managing the serious

Table 4: Field efficacy of different treatments against rice gundhi bug during the wet season of 2011

Treatments	Gundhi bug population 5 sweeps^{-1}			
	Pre count	1 DAA	7 DAA	15 DAA
Monocrotophos 36 SL@ 1.5 ml l^{-1}	1.40 (1.38)	0.44 (0.97)	0.63 (1.06)	0.87 (1.17)
Litsea citrata seed extract @ 20 ml l^{-1}	1.53 (1.43)	0.64 (1.07)	0.93 (1.19)	1.35 (1.36)
Costus specious stem extract @ 20 ml l^{-1}	1.92 (1.56)	0.91 (1.19)	1.19 (1.30)	1.87 (1.54)
Chenopodium ambrosioides seed extract @ 20 ml l^{-1}	1.67 (1.47)	0.94 (1.19)	1.23 (1.32)	1.72 (1.49)
Control	1.88 (1.54)	2.00 (1.58)	2.21 (1.65)	2.51 (1.73)
SEm±	0.022	0.025	0.021	0.027
CD (p=0.05)	0.110	0.124	0.105	0.133

DAA: Days after application; Figure in the parenthesis are angular transformed values

Table 5: Efficacy of different treatments on increase in yield over control on three cultivars

Treatments	Miracle rice			Ranjit			Jalukie special		
	Mean yield (kg ha^{-1})	Mean increase over control (kg ha^{-1})	Increase over control (%)	Mean yield (kg ha^{-1})	Mean increase over control (kg ha^{-1})	Increase over control (%)	Mean yield (kg ha^{-1})	Mean increase over control (kg ha^{-1})	Increase over control (%)
Monocrotophos 36 SL @ 1.5 ml l^{-1}	3909.05	945.56	31.91	3292.69	852.60	27.71	3997.40	941.29	30.80
Litsea citrata seed extract @ 20 ml l^{-1}	3840.79	841.25	28.39	3272.17	195.08	6.34	3640.63	584.52	19.13
Costus specious stem extract @ 20 ml l^{-1}	3394.53	430.99	14.54	3289.06	211.97	6.89	3432.00	375.89	12.30
Chenopodium ambrosioides seed extract @ 20 ml l^{-1}	3515.91	551.65	18.61	3175.78	98.69	3.21	3100.26	44.15	1.44
Control	2963.54	-	-	3077.09	-	-	3056.11	-	-

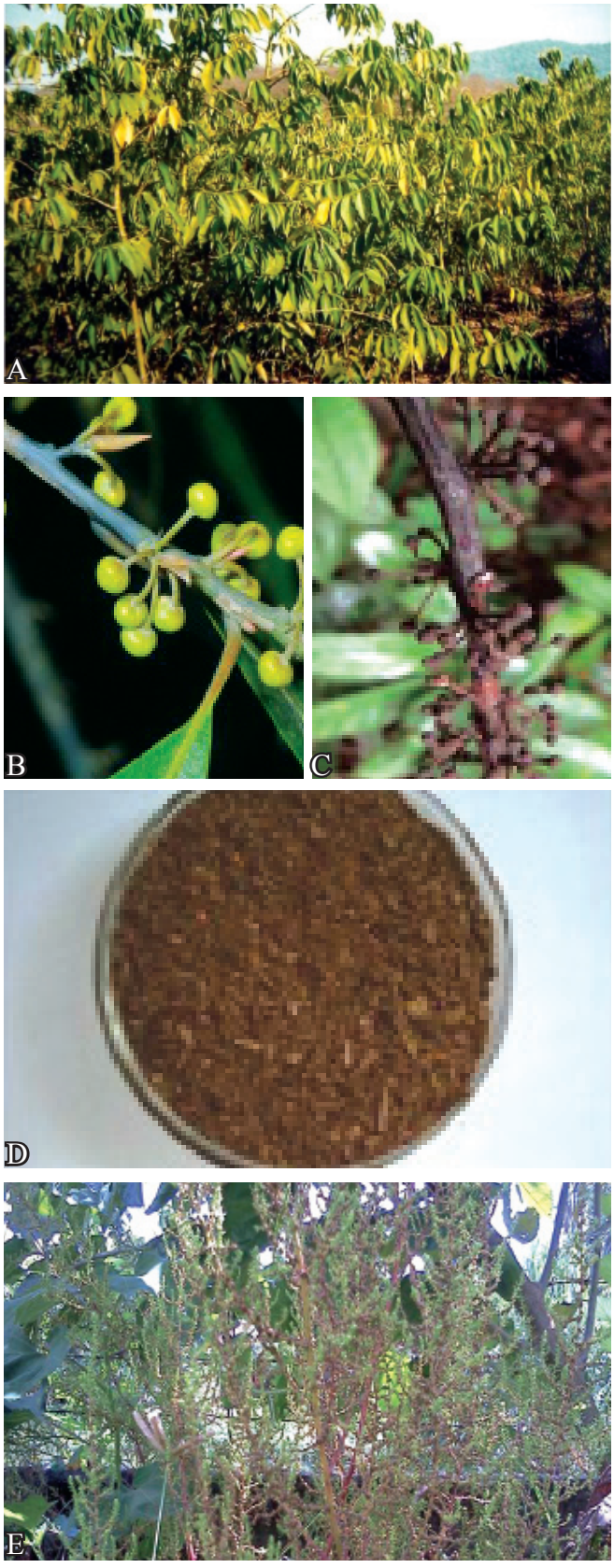

Plate 1: A-D: *Litsea citrata*; A: Tree growing wild in the forest of Nagaland; B: Fruits; C: Dried fruits; D: Powdered seeds

for extraction; E-F: *Chenopodium ambrosioides* L.; E: Matured plant; F: Seeds; G-I: *Costus speciosus* (J. Koenig); G: *Costus* plant growing in wild, H: Flower; I: Fresh stems used for extraction

pest in rice crop. Rath (1999) evaluated several neem products and reported that neemgold 2% recorded the lowest dead heart, white ears and the highest grain yield. Moanaro (2007) also evaluated plant extracts against rice leaf folder and reported significant increase in yield over control, the highest being by neem oil followed by *L. citrata* acetone extract.

3.8. Benefit cost ratio

The analysis of benefit cost ratio shows the highest ratio in Monocrotophos 36 SL (2.40) indicating that the use of this chemical is cost effective in reducing the pest and increasing the

Table 6: Benefit-cost ratio

Treatments	Total cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	Benefit Cost ratio
Monocrotophos 36 SL@ 1.5 ml l^{-1}	5404.00	18392.00	12988.00	2.40:1
Litsea citrata seed extract @ 20 ml l^{-1}	5980.00	16825.44	10845.44	1.81:1
Costus speciosus stem extract @ 20 ml l^{-1}	5880.00	15932.52	10052.52	1.71:1
Chenopodium ambrosioides seed extract @ 20 ml l^{-1}	5730.00	14325.36	8955.36	1.57:1
Control	4980.00	7240.60	2260.60	0.45:1

1 US$: Approx. Indian rupees (₹) 60 as on 07.03.2014

yield and thus high profit (Table 6). Among the three botanicals, benefit cost ratio was the highest in *L. citrata* (1.81) followed by *C. speciosus* (1.71) and *C. ambrosioides* (1.57). It is evident from the work of Prasad et al. (1995) who reported on the efficacy of Monocrotophos giving high benefit cost ratio.

4. Conclusion

In this experiment, the most promising cultivar was found Jalukie special and the most effective botanical was *Litsea citrata* seed extract @ 20 ml l^{-1}. However, further investigations can be done on the most promising indigenous plant products such as *Litsea citrata* seed extract, *Chenopodium ambrosioides* seed extract or *Costus speciosus* stem extract to determine the inherent properties and active ingredients which would elucidate their efficacy besides improving the delivery systems so that concrete results on the efficacy of these plant products can be found which further act as an alternative to synthetic pesticides.

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