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Impact of biophysical factors as influenced by organic sources of nutrients on major pests of rice

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ABSTRACT

Biophysical factors such as epicuticular wax,trichome density and leaf sheath thickness were analysed in the leaf sheath and laminae of plants treated with organic sources of nutrients. The results revealed that wax content and trichome density increased in plants as the age of the plant advanced. The difference in epicuticular wax content was significant among treatments. At 45 DAT, the treatments *viz*., FYM, biofertilizers, lignite fly ash and neem cake as basal and in splits and FYM plus neem cake as basal and in splits recorded maximum trichome density of 49.33, 49.67, 49.67 and 48.34 / cm^2 leaf respectively. The same trend was also noticed on 60 DAT. On 60 DAT, the combination of FYM, biofertilizers and neem cake as basal was significantly superior in having maximum wax content (23.67 mg/g) which was on par with the combination of FYM, biofertilizers, lignite fly ash and neem cake as basal (22.00 mg / g). Treatments showed significant difference in leaf sheath thickness on 60 DAT. But the difference was not significant on 30 DAT and it varied from 0.24 to 0.35 mg/mm^2 and the leaf sheath thickness was maximum in the combination of FYM, biofertilizers, lignite fly ash and neem cake in splits which recorded 0.58 mg/mm^2.

Keywords : Biophysical factors, organic sources of nutrents, pests of rice.

INTRODUCTION

Identification of resistance sources and their mechanism responsible for imparting induced resistance to major insect pests in rice is an effective and well accommodative strategy in the recent pest management programmes. The morphological, physical, physiological and chemical characteristics of the host plant interact with the pests and their parasitoids by influencing their host seeking ability (Price, 1986 and Hassel and Waage, 1984) and affecting the efficacy with which they locate and utilise the host (Muller, 1983 and Prokopy, 1983).

In rice, leaf hairiness, length and density of trichomes, leaf surface and leaf sheath compactness were associated with resistance (Israel, 1969; Roy *et al*., 1969). Lin (1993) suggested that the external diameter of the culm and the length of third internode had a role in rice varieties showing induced resistance to *Scirpophaga*. Tall, long and broad leaved cultivars were more preferred for oviposition by *Cnaphalocrocis medinalis* (Guenee) adults (Barrion *et al*., 1991).

The insects examine the plant surface and receive cues often chemical as to whether the plant is suitable for oviposition, settling or feeding (Woodhead and Chapman, 1986). Observation by Cook *et al*. (1987) suggested that the surface of the rice plant plays a part in food plant selection by BPH, *Nilaparvata lugens* (Stal).

Materials and Methods

Field experiments were conducted in RBD with three replications with plot size of 5x4 m^2 with the following treatments at Agricultural College and Research Institute, Madurai using the variety MDU 5. Leaf sheath and leaf laminae were collected from randomly selected 10 plants for each treatment and utilized to analyse the biophysical characters. Samples were taken at 30,45 and 60 DAT. The incidence of major pests *viz.*, BPH, WBPH, GLH, gall midge, stem borer and leaffolder was recorded in 10 hills selected at random in each subplots at 15 day interval.

Treatment details are as follows: T_1 – NPK alone (100: 50: 50 kg NPK / ha); T_2 – FYM alone (12.5 t / ha); T_3 – FYM + neem cake (NC) (250 Kg/ha); T_4 – FYM + NC in splits (125 Kg/ha as basal, 125 Kg/ha in 3 equal splits); T_5 – FYM + *Azospirillum* + phosphobacterium + silicate solubilizing bacteria (SSB) + NC; T_6 – FYM + *Azospirillum* + phosphobacterium + SSB + NC in splits; T_7 – FYM + *Azospirillum* + phosphobacterium + SSB + lignite fly ash + NC; T_8 - FYM + *Azospirillum* + phosphobacterium + SSB + lignite fly ash +NC in splits and T_9- Untreated check.

Neem cake was applied in four splits, first as basal and subsequent splits at 20 days interval. Lignite fly ash was applied in three splits, first as basal and subsequent splits

Table 1. Influence of organic sources of nutritions on Trichomes, wax content and leaf sheath thickness in rice

Treatments	Trichomes (No. / cm^2 leaf*)			Wax content (mg/g plant*)			Leaf sheath thickness(mg/mm^2)			Yield t/ha
	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45DAT	60 DAT	
NPK alone	12.33(3.50)^{d}	23.33(4.81)^{c}	28.35(5.37)^{c}	6.00(2.43)^{d}	8.00(2.81)^{c}	10.00(3.16)^{e}	0.26	0.29	0.31(0.56)^{d}	5.38^{ab}
FYM alone	28.00(5.29)^{b}	46.00(6.79)^{ab}	47.62(6.87)^{b}	11.67(3.40)^{c}	11.67(3.39)^{b}	12.33(3.50)^{de}	0.29	0.30	0.40(0.64)^{c}	4.80^{f}
FYM + NC	32.33(5.68)^{ab}	49.67(7.04)^{a}	49.15(7.14)^{a}	10.00(3.16)^{c}	12.33(3.50)^{b}	14.53(3.73)^{cd}	0.28	0.31	0.42(0.65)^{c}	4.91^{e}
FYM + NC in splits	32.67(5.70)^{ab}	48.34(6.96)^{a}	49.00(7.11)^{a}	13.33(3.64)^{bc}	12.33(3.50)^{c}	14.67(3.82)^{cd}	0.25	0.34	0.47(0.68)^{bc}	5.10^{d}
FYM + Azos + phos + SSB + NC	34.00(5.83)^{a}	41.34(6.42)^{b}	48.35(6.91)^{ab}	21.67(4.65)^{a}	20.00(4.47)^{a}	23.67(4.86)^{a}	0.24	0.34	0.47(0.68)^{bc}	5.22^{c}
FYM + Azos + phos + SSB + NC in splits	31.33(5.59)^{ab}	46.00(6.77)^{ab}	47.12(6.45)^{b}	16.67(4.07)^{ab}	12.33(3.50)^{b}	14.67(3.79)^{cd}	0.25	0.31	0.33(0.72)^{d}	5.34^{b}
FYM + Azos + phos + SSB LFA + NC	34.67(5.88)^{a}	49.33(7.03)^{a}	50.65(7.21)^{a}	13.33(3.64)^{bc}	18.33(4.27)^{a}	22.00(4.69)^{ab}	0.35	0.36	0.50(0.71)^{b}	5.29^{bc}
FYM + Azos phos + SSB + LFA + NC in splits	35.33(5.94)^{a}	49.67(7.04)^{a}	51.12(7.28)^{a}	16.67(4.07)^{ab}	16.33(4.04)^{a}	18.00(4.24)^{bc}	0.33	0.42	0.58(0.76)^{a}	5.49^{a}
Untreated check	16.00(3.99)^{c}	24.00(4.88)^{c}	30.14(5.42)^{c}	5.33(2.28)^{d}	6.00(2.45)^{c}	9.33(3.05)^{e}	0.25	0.26	0.25(0.50)^{d}	3.75^{g}

Values in parentheses are square root transformations; In a column mean followed by same letter are not significantly different at $P = 0.05$ as per DMRT.

at monthly interval. At harvest, the grain yield was recorded in all the treatments.

Extraction of plant surface waxes

Surface waxes of rice plant in various treatments were extracted following the method described by Woodhead and Padgham (1988). Rice tillers taken from various treatments were weighed and immersed in chloroform approximately 25-30 ml for 10 minutes. The extracts were allowed to concentrate with out heat or vacuum to negate the losses of allelochemicals of higher volatility. The weight of crude wax per gram of tiller was calculated. This experiment was carried out in three replications.

Estimation of trichome density

The trichome density of rice leaf in different treatments was estimated as per the procedure described by Maite *et al*. (1980). Leaf samples collected at random in the rice plant were cut into one square centimeter size and boiled in 20 ml of water in small glass vials for 15 minutes in hot water bath at 85^0C. The water was then poured out retaining the leaves and boiled after adding 20 ml of 96 per cent ethanol for 20 minutes at 80^0C. Then alcohol was poured off and boiling process with alcohol was repeated to remove the chlorophyll completely from the leaves. Alcohol was again removed and 90 per cent lactic acid was added and heated at 85^0C until the leaf segments cleared (approximately 30 – 45 minutes).

Then the vials were cooled and leaf bits were taken and mounted on clean slides using a drop of lactic acid to observe the trichome density. The number of trichomes per square centimeter was counted under compound microscope (45 x magnification) for each sample. The trichome density was correlated with the incidence of rice leaffolder.

Leaf sheath thickness

It was estimated by calculating specific leaf weight

$$\text{Specific leaf weight (SLW)} = \frac{\text{Leaf weight}}{\text{Leaf area}}$$

SLW was expressed as mg / mm^2

Statistical analysis

Data collected in field experiments were statistically analysed using randomized block design. Square root transformation was followed for converting the population numbers. The treatment means were compared by Duncan's Multiple Range Test (DMRT) for their significance (Gomez and Gomez, 1985).

RESULT AND DISCUSSION

Epicuticular wax

The wax content of the plant gradually increased as the age of the plant advanced. The difference in epicuticular wax content was significant among treatments. On 30 DAT, the wax content ranged from 5.33 to 21.67 mg/g. It was significantly higher in the treatment with FYM, biofertilizers and neem cake as basal which was on par with the combination of FYM, biofertilizers and neem cake in splits and FYM, biofertilizers, lignite fly ash and neem cake in splits. At 45 DAT, the combination of FYM, biofertilizers and neem cake as basal; FYM, biofertilizers, lignite fly ash and neem cake as basal and in splits were on par with each other and they recorded maximum wax content of 20.00, 18.33 and 16.33 mg / g respectively. On 60 DAT, the combination of FYM, biofertilizers and neem cake as basal was significantly superior in having maximum wax content which was on par with the combination of FYM, biofertilizers, lignite fly ash and neem cake as basal. In all the three periods of observation, the wax content was minimum in NPK applied plants and in untreated check. It was 6.00, 8.00 and 10.00 mg/g in NPK applied plants and 5.33, 6.00 and 9.33 mg/ g in untreated check on 30, 45 and 60 DAT respectively (Table 1).

Trichome density

In general trichome density increased in plants as the plant age advanced. Application of organic sources of nutrition significantly influenced the trichome density on 30, 45 and 60 DAT. On 30 DAT, the number of trichomes varied from 12.33 to 35.33 per cm^2 leaf. The trichome density varied from 23.33 to 49.67 per cm^2 leaf on 45 DAT and at 60 DAT it ranged from 28.35 to 51.12 per cm^2 leaf. The treatments *viz*., FYM, biofertilizers and neem cake as basal and FYM, biofertilizers, lignite fly ash and neem cake as basal and in splits were significantly superior in registering more number of trichomes (Table 1). At 45 DAT, the treatments *viz*., FYM, biofertilizers, lignite fly ash and neem cake as basal and in splits and FYM plus neem cake as basal and in splits recorded maximum trichome density of 49.33, 49.67, 49.67 and 48.34 / cm^2 leaf respectively. The same trend was also noticed on 60 DAT.

Table 2. Correlation between insects and biophysical factors in rice (45 DAT)

Insects	Epicuticular wax	Trichome density	Leaf sheath thickness
GLH	-0.829**	-0.872**	-0.446 NS
WBPH	-0.768**	-0.745*	-0.285 NS
BPH	-0.821**	-0.881**	-0.449 NS
Leaf folder	-0.778*	-0.820**	-0.384 NS
Stem borer	-0.866**	-0.731*	-0.387 NS
Gall midge	-0.769*	-0.424 NS	-0.469 NS

²% - Correlations worked out at 60 DAT; *- significant at 5 per cent level ; ** - significant at 1 per cent level; NS – non significant

Table 3. Influence of organic sources of nutritions on major insect pests of rice

Treatments	45 Day after transplanting					
	GLH No./ tiller	WBPH No./ tiller	BPH No./ tiller	Leaffolder-leaf damage (in %)	Stem borer- dead heart (in %)	Gall midge - silver shoot (in %)
NPK alone	3.23(1.78)[e]	3.01(1.71)[f]	3.81(1.94)[d]	11.23(19.53)[f]	12.31(20.93)[c]	11.11(19.81)[b]
FYM alone	2.51(1.57)[d]	2.51(1.59)[e]	2.50(1.56)[c]	7.51(16.54)[e]	8.53(17.10)[b]	11.23(20.01)[b]
FYM + NC	1.87(1.35)[c]	2.23(1.47)[d]	1.87(1.35)[b]	5.62(13.61)[d]	7.91(16.85)[b]	10.89(19.51)[b]
FYM + NC in splits	1.65(1.25)[bc]	2.15(1.45)[d]	1.51(1.22)[b]	4.50(12.63)[c]	7.25(16.23)[b]	10.92(19.64)[b]
FYM + Azos + phos + SSB + NC	1.58(1.22)[b]	1.85(1.34)[c]	1.31(1.13)[ab]	4.17(12.31)[bc]	3.11(9.82)[a]	8.21(16.93)[a]
FYM + Azos + phos + SSB + NC in splits	1.47(1.20)[b]	1.33(1.13)[b]	1.10(1.03)[a]	3.82(11.91)[b]	2.98(10.91)[a]	8.18(16.67)[a]
FYM + Azos + phos + SSB + LFA + NC	1.35(1.13)[a]	1.29(1.11)[b]	1.23(1.10)[a]	3.23(11.45)[b]	2.81(9.84)[a]	7.82(17.21)[a]
FYM + Azos + phos+ SSB + LFA + NC in splits	1.32(1.11)[a]	1.11(1.03)[a]	0.97(0.98)[a]	2.04(9.41)[a]	2.23(8.87)[a]	7.76(17.13)[a]
Untreated check	3.11(1.77)[e]	2.87(1.68)[f]	3.56(1.87)[d]	8.31(16.84)[e]	11.15(11.84)[c]	10.86(19.47)[b]

Values in parentheses are square root transformations; In a column mean followed by same letter are not significantly different at P = 0.05 as per DMRT.

Leaf sheath thickness

It varied from 0.24 to 0.35 mg/mm^2 on 30 DAT ,but the difference was not significant.Various treatments showed significant difference in leaf sheath thickness on 60 DAT. The leaf sheath thickness was maximum in the combination of FYM, biofertilizers, lignite fly ash and neem cake in splits which recorded 0.58 mg/mm^2 as against the minimum of 0.25 mg / mm^2 in the untreated check and 0.31 mg/mm^2 in NPK as inorganic form alone at 60 DAT.

Correlation between major insects and biophysical factors

Correlation studies carried out in between the incidence of major insect pests and the biophysical factors of rice treated with various organic sources of nutrition revealed the following. The plant biophysical factors *viz*., trichome density, epicuticular wax content and leaf sheath thickness were higher in the treatment with the combination of FYM, biofertilizers, lignite fly ash and neem cake applied in splits followed by the combination of FYM, biofertilizers and neem cake applied in splits. Regarding the insect population, the results revealed that BPH, WBPH and GLH population were significantly less in the treatment with FYM, neem cake, SSB and lignite fly ash. Similarly the application of FYM, biofertilizers either with or without lignite fly ash and neem cake applied in splits were highly effective in reducing the stem borer damage in all the growth stages and had less silver shoot damage.

Correlation values between epicuticular wax and insects were highly negatively significant:0.821 for BPH,0.829 for GLH,0.866 for stem borer. Similarly correlation between trichome density insectsindicated that all the insects showed significantly negative correlation.Regarding leaf sheath thickness, eventhough all insects exhibited negative correlation the values are not significant. Correlation studies also indicated a negative relationship between these biophysical factors and the occurrence of hoppers, leaf folder, stem borer and gall midge (Table 2) which in turn reflected in yield .This is in consonance with the findings of Rajeswari (2000) who reported that the application of lignite fly ash @ 25 kg/ha increased number of leaf trichomes. Khan and Saxena (1985) evidently proved that the density of trichomes of the abaxial surface of TKM 6 showed resistance to *Cnaphalocrocis medinalis* (Guenee). In the present study leaf sheath thickness increased due to the application of organic nutrients which inturn reduced the feeding of BPH.This is in consonance with the findings of Cook *et al*. (1987) who suggested that the surface of the rice plant plays a part in food plant selection by BPH , *Nilaparvata lugens* (Stal).

As a result of chemical cues from the surface wax, settling of hoppers was inhibited with increased probing frequency. The maximum epicuticular wax content in rice genotypes provides resistant mechanism (Nalini, 2000). These observations are in agreement with the present investigation.

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