seedlings was 18.83 cm and 1.59 cm respectively while in control it was 26.48 cm and 1.89 cm. Sulphur being a constituent of amino acids like methionine and cystein, its deficiency will definitely inhibit photosynthesis which in turn will affect the growth and development of plant. Due to deficiency there was a reduction in the content of S in plants (0.09%).

The initial symptoms of zinc deficiency was interveinal chlorosis of young leaves. Gradually chlorosis spread to young leaves also. Leaves produced were small in size. The internodal length was also shortend. Abscission of leaves was also noticed. Youngest leaves remained small and clustered resulting a rosetted condition. Tusi (1948) stressed the importance of Zn for the synthesis of tryptophan, a precursor for IAA, the important hormone responsible for cell elongation. When Zn is deficient with in the plant, RNA concentration gets reduced by the activation of oxidative enzyme resulting in decreased protein synthesis which may also contribute to reduction in vegetative growth. The foliar content of Zn was found to be 21 ppm while in control it was 63 ppm.

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(Received: July 1992 Revised: December 1995)

Madras Agric. J., 83(1): 20-24 January 1996
https://doi.org/10.29321/MAJ.10.A00957

Effect of different levels of white backed planthopper, (WBPH) *Sogatella furcifera* populations on different rice cultivars

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ABSTRACT

A field experiment was conducted during the *kharif* 1986-87 to study the effect of different population levels of white backed planthopper (WBPH) *Sogatella furcifera* (Horvath) on five rice varieties viz., ARC 10550 (resistant), Co 22, Co 13, Triveni (moderately resistant) and ACM 9 (locas check). The seedling screening bulk test indicated similar reaction to *S. furcifera* in the resistant and moderately resistant varieties. However, field screening showed that Triveni was more tolerant than other varieties, as evidenced from the low reduction in the mean plant height and plant weight. This clearly indicates the ability of Triveni to survive and produce more number of productive tillers even at higher population levels of WBPH. On the other hand, a minimum population of 25 WBPH/plant was sufficient to cause a significant reduction in the plant vigour, height and weight in all the varieties.

KEY WORDS : WBPH, Population Levels, Rice Varieties, Tolerance.

The white backed planthopper (WBPH), *Sogatella furcifera* (Horvath) has become one of the most serious pests of rice in the last decade in India (Vaidya and Kalode, 1981). Under favourable conditions, WBPH can multiply faster and cause hopper burn (Gunathilagaraj *et al.*, 1983). More emphasis is now placed on breeding or growing resistant varieties in the field to check the population growth of WBPH. However, these resistant varieties are also being subject to the attack by the different populations of WBPH on account of their narrow genetic make-up. Breeding a variety which is resistant to all the populations of WBPH is rather a very difficult and time

Table 1. Reaction of rice varieties to WBPH

Varieties	Mean grade
ARC 10550	1.0
CO 22	5.0
CO 13	5.0
Triveni	5.0
ACM 9	6.3

Mean of three replications

consuming one. Hence, varieties having field resistance, otherwise called moderate resistance governed by polygenes could prove useful in the pest management programme. When a moderately resistant or tolerant variety is grown, the natural enemies have more prey to feed on and can better sustain themselves in the field. So in terms of pest management, a high tolerance level results in a high economic threshold and less damage to the crop (Nalini and Gunathilagaraj, 1994). Thus the number of chemical sprays can be reduced in an integrated pest management system (Headley, 1972). This paper summarises the results of experiments conducted to locate the varieties tolerant to WBPH in the field.

MATERIALS AND METHODS

Modified seedling bulktest

Five varieties of rice *viz.*, ARC 10550, Triveni, Co 22, Co 13 and ACM 9 were sown in 5 cm rows each in wooden trays (60 x 40 x 10 cm) with 30 seedlings per row. Susceptible TN (1) was included for comparison. Ten days after sowing, seedlings were thinned and infested with five-second and third instar nymphs of WBPH per seedling. Damage rating was done when 90 per cent of TN (1) plants died.

Effect of different insect levels on test varieties

A field experiment was conducted during *kharif* 1986-87 to study the effect of different levels of WBPH populations on test varieties *viz.*, ARC 10550 (resistant check), Triveni, Co 22, Co 13 (moderately resistant) and ACM 9 (check) were

Table 2. Field tolerance in rice to WBPH

	WBPH population (No./hill)				
Varieties	0	25	50	100	Mean
ARC 10550	1.0 (1.0) a	4.5 (2.20) b	5.0 (2.22) bc	6.0 (2.45) d	4.13 (1.94) a
CO 22	1.0 (1.0) a	5.5 (2.34) cd	5.0 (2.22) bc	7.5 (2.74) efg	4.75 (2.07) b
CO 13	1.0 (1.0) a	5.5 (2.24) cd	5.5 (2.32) cd	8.5 (2.91) g	5.13 (2.14) c
ACM 9	1.0 (1.0) a	7.5 (2.89) fg	7.5 (2.72) ef	8.5 (2.91) g	6.13 (2.37) d
Triveni	1.0 (1.0) a	5.5 (2.34) cd	7.0 (2.64) e	7.5 (2.72) ef	5.25 (2.18) c
Mean	1.0 (1.0) A	5.70 (2.39) B	6.00 (2.42) B	7.6 (2.75) C	

CD (P = 0.05) : Varieties = 0.045
Population = 0.037
Interaction = 0.18

Mean of three replications. Figures in parentheses are transformed values; Means followed by a common (small and capital) letter(s) are not significantly different at 5% level.

Table 3. Population of WBPH on test varieties at harvest (1986-87)

	WBPH population (No./hill)				
Varieties	0	25	50	100	Mean
ARC 10550	0.5 (0.71)	23.25 (4.78)	49.75 (6.93)	77.00 (8.73)	37.63 (5.28) a
CO 22	0.5 (0.71)	29.00 (5.37)	47.25 (6.86)	81.50 (9.02)	39.94 (5.49) b
CO 13	0.5 (0.71)	22.00 (4.68)	35.50 (5.92)	87.75 (9.34)	36.44 (5.16) a
ACM 9	0.5 (0.71)	26.25 (5.08)	56.25 (7.49)	93.75 (9.65)	44.19 (5.74) b
Triveni	0.5 (0.71)	25.00 (4.95)	46.75 (6.24)	75.75 (8.64)	37.13 (5.28) a
Mean	0.5 (0.71) A	25.20 (4.97) B	47.30 (6.81) C	83.25 (9.08) D	

CD (P = 0.05) : Varieties = 0.14
Population = 0.10
Interaction = 0.51

Mean of three replications. Figures in parentheses are transformed values; Means followed by a common (small and capital) letter(s)

Table 4. Effect of different levels of WBPH population on height of rice varieties

	Plant height (cm)				
	WBPH population (No./hill)				
Varieties	0	25	50	100	Mean
ARC 10550	133.00 b (11.53)	100.38 cd (9.99)	101.00 cd (10.04)	95.26 def (9.76)	107.44 b (10.33)
CO 22	146.38 a (12.10)	96.88 cde (9.83)	103.13 c (10.13)	92.88 efg (9.64)	109.81 a (10.43)
CO 13	145.80 a (12.07)	95.62 def (9.76)	95.63 def (7.76)	89.00 g (9.43)	106.51 b (10.20)
ACM 9	76.70 h (8.76)	64.25 i (8.01)	58.83 j (7.67)	52.48 k (7.24)	63.06 d (7.92)
Triveni	90.53 fg (9.51)	73.90 h (8.60)	68.90 i (8.20)	67.15 i (8.19)	75.12 c (8.65)
Mean	118.43 B (10.79)	86.21 C (9.24)	85.50 B (9.18)	79.28 A (8.85)	

CD (P = 0.05) : Varieties = 0.076
Population = 0.06
Interaction = 0.30

Mean of three replications. Figures in parentheses are transformed values; Means followed by a common (small and capital) letter(s) are not significantly different at 5% level.

selected from the seedling bulk test. Forty days after transplanting, three randomly selected plants of test varieties were individually confined with 0, 25, 50 and 100 nymphs of 1-2 day old WBPH. The plants were caged with mylar film cages (20 x 90 cm) after release and the populations were maintained until harvest. Population of WBPH and damage rating were made a week before harvest. The biometric characters *viz.*, plant height, weight and root length and weight were observed after harvest (Ho *et al.*, 1982).

RESULTS AND DISCUSSION

Using modified seedling screening technique, all the five rice varieties were tested for their reaction to WBPH. Of them, ARC 10550 was found to be resistant with a damage grade of 1 and Co 22, Co 13 and Triveni were moderately resistant with grade 5 (Table 1).

Table 5. Effect of different levels of WBPH population on weight of rice varieties

	Plant weight (g)				
	WBPH population (No./hill)				
Varieties	0	25	50	100	Mean
CO 22	116.76 b (10.81)	31.86 ghi (5.56)	33.84 fghi (5.80)	32.50 ghi (5.59)	53.74 b (6.94)
ARC 10550	131.57 a (11.47)	38.93 ef (5.22)	31.82 ghi (5.58)	34.89 fgh (5.85)	59.30 a (7.28)
CO 13	118.83 b (10.90)	37.81 efg (6.10)	43.91 e (6.49)	31.00 ghi (5.55)	57.89 a (7.26)
ACM 9	74.17 c (8.61)	22.06 j (4.64)	20.31 jk (4.42)	15.12 k (3.87)	32.91 d (5.38)
Triveni	56.91 d (7.54)	31.41 ghi (5.59)	29.24 hi (5.40)	28.43 i (5.28)	39.50 c (5.95)
Mean	99.65 C (9.87)	32.41 B (5.62)	31.82 A (5.34)	28.39 A (5.23)	

CD (P = 0.05) : Varieties = 0.14
Population = 0.11
Interaction = 0.56

Mean of three replications. Figures in parentheses are transformed values; Means followed by a common (small and capital) letter s

Table 6. Effect of different levels of WBPH population on the root length of rice varieties

	Root length (cm)				
	WBPH population (No./hill)				
Varieties	0	25	50	100	Mean
ARC 10550	26.10	22.00	21.00	19.87	16.68 e
	(5.90)	(5.41)	(5.29)	(5.14)	(4.08)
CO 22	26.23	20.27	21.13	19.23	16.28 d
	(5,91)	(5.19)	(5.30)	(5.06)	(4.02)
CO 13	25.60	18.20	20.40	19.70	15.73 c
	(5.84)	(4.92)	(5.20)	(5.23)	(3.96)
ACM 9	17.00	13.43	13.33	10.90	10.25 a
	(4.76)	(4.23)	(4.40)	(3.80)	(3.19)
Triveni	21.40	16.27	14.80	16.80	12.99 b
	(4.01)	(3.53)	(3.31)	(3.55)	(3.60)
Mean	17.45	13.55	13.59	12.98	
	(4.16) C	(3.67) B	(3.66) B	(3.58) A	

CD (P = 0.05) : Varieties = 0.035
Population = 0.028
Interaction = 0.14

Mean of three replications. Figures in parentheses are transformed values; Means followed by a common (small and capital) letter(s) are not significantly different at 5% level.

The moderately resistant varieties had slightly higher grade than that of the resistant variety at all the three insect levels. Among the varieties tested, ACM 9 was the most sensitive to insect feeding damage with a significant reduction in the plant vigour, when the insect population increased from 25 to 100 per plant. This trend was not observed in the resistant check ARC 10550. Among the varieties tested ACM 9 recorded a over all high damage rating of 6 .13 followed by Triveni (5.25) as against 4.13 in resistant variety ARC 10550 at the time of harvest (Table 2). This indicates that the resistant and moderately resistant varieties are able to support a certain increase in the population of insects in the field. At higher population level (100 / plant), the damage rating was higher in all the test varieties. Among the two insect levels *viz.*, at 25, 50 / plant, the difference in damage rating were not significant. The population trend in test varieties at the time of harvest showed that there were

Table 7. Effect of different levels of WBPH population on the root weight of rice varieties

	Root weight (g)				
	WBPH population (No./hill)				
Varieties	0	25	50	100	Mean
ARC 10550	15.77	8.37	9.15	7.51	10.20 c
	(3.97)	(2.09)	(2.29)	(1.88)	(3.15)
CO 22	14.86	9.65	10.87	9.24	11.15 e
	(3.85)	(3.10)	(3.29)	(3.04)	(3.32)
ACM 9	11.11	7.05	6.65	6.13	7.13 a
	(3.33)	(2.63)	(2.56)	(2.44)	(2.74)
CO 13	12.80	9.90	9.64	9.27	10.40 d
	(3.57)	(3.13)	(3.10)	(3.04)	(3.21)
Triveni	11.13	7.89	8.23	7.18	8.61 b
	(3.34)	(2.80)	(2.87)	(2.67)	(2.92)
Mean	13.13 D	8.57 B	8.91 C	7.86	
	(3.61)	(2.91)	(2.97)	(2.78) A	

CD (P = 0.05) : Varieties = 0.047
Population = 0.037
Interaction = 0.187

Mean of three replications. Figures in parentheses are transformed values; Means followed by a common (small and capital) letter(s)

considerable variations among ACM 9 (44.19) Co 22 (39.94) and ARC 10550 (37.65). Varieties Co 13 and Triveni were on par with ARC 10550 (Table 3).

The plant vigour, height and weight were significantly low in all the five test varieties. The mean plant height recorded in various test varieties was comparatively low (Table 4). Similarly, in all the test varieties, the mean plant weight, root length and weight were considerably very low when compared to the check plants at'O' level. On an average, 50 per cent reduction in plant weight, 8-10 cm reduction in root length and 3-5 gm loss in root weight were recorded in all the test entries (Table 5,6 and 7). The higher population level of WBPH caused a significant reduction in the plant height, weight, root length and weight in all the test varieties. But among the five varieties tested, Triveni had the ability to compensate for the damage caused by higher WBPH population. This was clearly evidenced from the less reduction in the mean plant weight 36.5 gm as against 56.51 gm in the uninfested plant.

Based on the results of the study, it is clearly evident that tolerance is an ideal component in any pest management programme. Thus, the resistant/moderately resistant varieties were able to support/tolerate the different levels of population as evidenced by a higher plant height and weight. This also coincides with the higher root length and root weight of ARC 10550 (16.68 cm and 10.20 gm Table 6 & 7) as against (10.25 cm and 7.73 gm) in ACM 9. The overall results showed that a population of 25 WBPH/plant was sufficient to cause a considerable reduction in plant height, weight, root length and weight in all the varieties.

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(Received: March 1989 Revised: January 1996).

Madras Agric. J., 83(1): 24-26 January 1996

EFFECT OF AMENDMENTS ON SOIL PROPERTIES AND YIELD PARAMETERS UNDER MAIZE - BLACK GRAM CROPPING SEQUENCE IN SOILS WITH SURFACE CRUSTING

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ABSTRACT

Trials were conducted for ameliorating the red lateritic soils of Vamban with organic and inorganic amendments under maize - black gram cropping sequence. The results revealed that application of pressmud (5 t/ha) significantly increased the grain yield of maize. While soil pH was significantly increased due to pressmud (5 t/ha) and lime (2 t and 4 t /ha), soil hardness was only marginally influenced. Application of amendments did not influence soil available nitrogen and phosphorus, but FYM (5 t/ha) significantly increased the soil available potassium. There was indications of the residual effect of amendments on the subsequent crop.

KEY WORDS : Amendments, Soils, Surface Crusting, Soil Properties Yield

Soil crusting is a major factor causing poor seedling emergence of several crops. In semi-arid tropics, millets are generally grown in soils of poor physical structure, for example, Alfisols, which are