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Study on the Effect of Different Urea Fertilizer Rates and Plant Populations on the Severity of Bacterial Blight (BB) of Rice

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Abstract

To study the effect of different urea fertilizer rates and plant populations on disease severity of bacterial blight of rice and yield lasses related to disease, the experiments including three plant populations (110000, 150000, 190000) and five urea fertilizer rates (0,56 lb, 112 lb, 168 lb and 224 lb per acre) were conducted at Central Agriculture Research Institute farm in 1999 and 2000 rainy seasons. Manawthukha was used as a test variety that is susceptible to bacterial blight of rice. The disease severity could be increased by the application of urea. Although urea 112 lb per acre gave moderate disease severity than without urea, its yield is highest. The higher disease severity also showed the related effect of plant population of 150000 and above. However the combination of urea 224 lb per acre with the population of 190000 and 150000 gave the highest severity of bacterial blight disease and the minimum grain yield. The application of urea 224 lbs per acre can cause yield reduction ranging from 18.67 percent to 27.57 percent over the application of urea 112 lb per acre.

Keywords: rice, bacterial blight, fertilizer rates, urea, plant density

1 Introduction

Bacterial blight (BB) caused by *Xanthomonas oryzae* pv. *oryzae* is one of the major diseases of rice in rice -growing countries of Asia. Yield losses in severely infected fields ranged from 20 % to 30 % (Ou, 1985) and data showed that yield loss may reach about 81 % (Singh *et al.*, 1977). Bacterial Blight disease on rice was reported from Japan and the Philippines almost seventy five years ago. Now this disease is found to occur all over the country in many of exotic and indigenous rice varieties, and is considered a severe menace to rice production in Myanmar. The varieties, Manawthukha (Mahsuri M), Shwewatun (IR 5 Mutant), Manawhari (Mahsuri), Kyawzeya, Inmayebaw, Yebawlatt

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(Photosensitive) and Ayeyamin which occupy about 50 % of the area sown in rainy season are susceptible to bacterial blight disease. The major problems to increase disease are cultivation over a large acreage of susceptible varieties, use of rice after rice cropping pattern, heavy application of nitrogen fertilizer and planting of dense population. The experiments were, therefore, conducted to know the effect of different rates of urea fertilizer and different plant populations on the severity of Bacterial Blight disease and yield loss related to disease.

2 Materials and Methods

2.1 Field experiment

The experiments were conducted in the field of Plant Pathology Division, Central Agriculture Research Institute, Yezin during 1999 and 2000 rainy seasons. The experimental plots were laid out in strip plot design with three replications.

Five urea fertilizer rates (0,56 lb, 112 lb, 168 lb, and 224 lb/ac) and three plant populations [110000 (9" $\times$6"), 150000 (8" $\times$5") and 190000 (8" $\times$4")] were used as horizontal factor and vertical factor respectively. The plot size for each treatment was 12 $\times$ 10 feet.

2.2 Test Variety

Manawthukha that is susceptible to bacterial blight disease was used as a test variety.

2.3 Fertilizer application

Triple super phosphate (TSP), muriate of potash (MOP) and gypsum at the rate of 56 lb, 56 lb and 100 lb/ac were respectively used as basal application at land preparation. 1/2 dose of urea for each treatment was used as basal and the remaining 1/2 dose was used at maximum tillering stage. Proper controls were maintained throughout the course of these experiments.

2.4 Disease evaluation

Disease evaluation was made by measuring disease severity (the area affected plant tissue expressed as a percentage of total area assed). The disease severity of natural infestation was scored at booting stage according to the Standard Evaluation System of IRRI (1996).

Table 1: Disease severity standard evaluation system of IRRI (1996)

Disease score	*Lesion area (%)*	*Disease reaction*
1	1-5	R
3	6-12	MR
5	13-25	MS
7	26-50	S
9	51-100	HS

2.5 Yield data

At harvest, filled grains per panicle, unfilled grains per panicle, thousand-seed weight, yield per plot and yield per acre were measured.

2.6 Data analysis

Data were statically analysed by using standard analysis of variance and means were separated with Duncan's multiple range test as described by STEEL and TORRIE (1981).

3 Results

The results of 1999, rainy season experiment are shown in Table 2. At the different rates of urea, although filled grains per panicle, unfilled grains per panicle and thousand-seed weight were not significantly different, disease score and yield per acre were differing statistically significant form control (Table 2).

Table 2: Effect of different rates of urea fertilizer and different plant populations on disease severity of BB and yield of *Manawthukha* (rainy season, 1999).

Treatments	Disease score	filled grains per panicle	unfilled grains per panicle	1000 seed wt (g)	Yield (bsk/ac)
Urea rates					
0	1.64 ^{d}	83.58 ^{a}	20.10 ^{a}	18.92 ^{a}	71.32 ^{c}
56 lb/ac	2.62 ^{c}	88.26 ^{a}	24.10 ^{a}	19.01 ^{a}	87.37 ^{ab}
112 lb/ac	3.84 ^{b}	101.47 ^{a}	25.42 ^{a}	19.31 ^{a}	91.28 ^{a}
168 lb/ac	4.80 ^{a}	92.20 ^{a}	25.58 ^{a}	19.12 ^{a}	81.41 ^{abc}
224 lb/ac	4.89 ^{a}	94.64 ^{a}	26.90 ^{a}	19.47 ^{a}	76.92 ^{bc}
r	+0.984	-0.611	+0.913	+0.855	-0.702
Plant Population					
9"×6" (110000)	3.20 ^{a}	99.41 ^{a}	24.42 ^{a}	19.27 ^{a}	81.49 ^{a}
8"×5" (150000)	3.41 ^{a}	87.48 ^{b}	23.79 ^{a}	19.19 ^{a}	84.91 ^{a}
8"×4" (190000)	4.07 ^{a}	89.19 ^{b}	25.05 ^{a}	19.04 ^{a}	78.53 ^{a}
r	+0.85	-0.792	+0.500	-0.990	-0.611
CV%	17.97	9.29	9.51	4.81	10.20

Values followed by the same letter are not signiflcantly different ($P = 0.05$) according to Duncan's multiple range test.

BB disease scores of different rates of urea were higher than that of control plot (without application of urea). The rates of urea 168lb per acre and 224lb per acre gave the most severe disease damage (Table 2). The best yields were obtained in the use of urea 56 lb and 112 lb per acre. The application of urea 168 lb and 224 lb per acre showed lesser yield than the application of urea 112 lb per acre (Table 2).

In the case of plant population, the disease severity and yield were not significantly difference among treatments. However, the dense plant population (190000) gave the

highest disease score and the minimum yield among all plant populations tested (Table 2).

Highly significant correlations were obtained between different rates of urea and disease score ($r = +0.98$), untilled grains per panicle ($r = +0.91$) as well as between plant populations and disease score ($r = +0.85$). Different urea rates and plant populations also showed weakly significant negative correlation with filled grains per panicle ($r = -0.61$). Thousand-seed weight showed positive correlation with different urea rates, whereas that showed negative correlation with plant populations.

The results of 2000 rainy season experiment were presented in Table 3. The results showed that statistical analysis of disease score, Thousand-seed weight, unfilled grain per panicle and yield per acre were significantly different among different urea rates. The application of urea 168 lb and 224 lb per acre indicated the highest disease severity, increase number of unfilled grains per panicle, and reduction of yield per acre (Table 3).

All parameters recorded were not significantly different among plant population except disease score. The population of 150000 and 190000 gave the enhanced disease severity (Table 3).

Table 3: Effect of different rates of urea fertilizer and different plant populations on disease severity of BB and yield of *Manawthukha* (rainy season, 2000).

Treatments	Disease score	filled grains per panicle	unfilled grains per panicle	1000 seed wt (g)	Yield (bsk/ac)
Urea rates					
0	5.56 ^{d}	77.56 ^{a}	18.99 ^{b}	19.59 ^{a}	71.22 ^{bc}
56 lb/ac	7.62 ^{c}	77.87 ^{a}	27.90 ^{ab}	18.98 ^{b}	90.05 ^{a}
112 lb/ac	7.73 ^{c}	77.66 ^{a}	29.19 ^{ab}	18.42 ^{b}	87.28 ^{a}
168 lb/ac	8.26 ^{b}	74.77 ^{a}	35.98 ^{a}	18.44 ^{b}	76.92 ^{b}
224 lb/ac	8.99 ^{a}	69.92 ^{a}	35.37 ^{a}	18.39 ^{b}	68.42 ^{c}
r	0.99	-0.83	0.94	0.46	-0.51
Plant Population					
9"×6" (110000)	7.45 ^{b}	76.75 ^{a}	29.86 ^{a}	18.99 ^{a}	79.54 ^{a}
8"×5" (150000)	7.66 ^{a}	74.92 ^{a}	29.63 ^{a}	18.46 ^{a}	77.81 ^{a}
8"×4" (190000)	7.78 ^{a}	73.79 ^{a}	28.96 ^{a}	18.84 ^{a}	78.97 ^{a}
r	0.98	-0.99	0.84	-0.89	-0.61
CV%	1.95	11.88	16.18	2.92	2.93

Values followed by the same letter are not signiflcantly different ($P = 0.05$) according to Duncan's multiple range test.

The results of interaction between different rates of urea and plant populations on the severity of bacterial blight of rice were shown in Table 4 and Table 5.

Table 4: Interaction between different rates of urea fertilizer and different plant populations on disease severity of BB disease (rainy season, 1999).

Urea rates	*Disease score*			*Mean*
	Plant populations			
	110000 (9"×6")	*150000 (8"×5")*	*190000 (8"×4")*	
0	1.20 ^{h}	1.33 ^{gh}	2.40 ^{fg}	1.64 ^{d}
56 lb/ac	2.13 ^{fgh}	2.53 ^{f}	3.20 ^{ef}	2.62 ^{c}
112 lb/ac	4.27 ^{bcde}	3.33 ^{def}	3.93 ^{cde}	3.84 ^{b}
168 lb/ac	4.53 ^{abcd}	4.60 ^{abc}	5.27 ^{ab}	4.80 ^{a}
224 lb/ac	3.87 ^{cde}	5.27 ^{ab}	5.53 ^{a}	4.89 ^{a}
Mean	3.20 ^{a}	3.41 ^{a}	4.06 ^{a}	
CV%				17.97

Table 5: Interaction between different rates of urea fertilizer and different plant populations on disease severity of BB disease (rainy season, 2000).

Urea rates	*Disease score*			*Mean*
	Plant populations			
	110000 (9"×6")	*150000 (8"×5")*	*190000 (8"×4")*	
0	5.20 ^{h}	5.60 ^{g}	5.87 ^{f}	5.56 ^{c}
56 lb/ac	7.43 ^{e}	7.70 ^{de}	7.73 ^{cd}	7.62 ^{b}
112 lb/ac	7.67 ^{de}	7.67 ^{de}	7.87 ^{cd}	7.73 ^{b}
168 lb/ac	8.00 ^{c}	8.33 ^{b}	8.43 ^{b}	8.26 ^{a}
224 lb/ac	8.97 ^{a}	9.00 ^{a}	9.00 ^{a}	8.99 ^{a}
Mean	7.45 ^{b}	7.66 ^{a}	7.78 ^{a}	
CV%				18.5

The combined use of urea 224 lb per acre with 190000 plant populations gave the highest disease score followed by urea 224 lb per acre with 150000 plant population and urea 168 lb per acre with 190000 plant populations (Table 4). Urea 168 lb per acre and 224 lb per acre gave highly susceptible reaction among all plant population (110000, 150000, 190000) tested (Table 5). The lowest disease score was obtained in the non application of urea with 110000 plant populations (Table 4 and 5).

The results shown in Table 6 and 7 indicated the interaction between different rates of urea and plant populations on yield per acre of Manawthukha variety. Urea 112 lb per acre gave the best yield (95.37 baskets) combined with the population of 150000 and 93.25 baskets combined with 110000 plant populations. Urea 56 lb per acre combined with 110000 plant populations also gave 92.38 baskets per acre (Table 6). Besides, urea 56 lb per acre gave the best yield (95.08 baskets / ac) application with 110000 plant populations (Tab1e 7). However, the used of without urea, urea 168 lb per acre and 224 lb per acre gave the lowest yields among three plant populations tested (Table 7).

Urea 168 lb and 224 lb per acre caused the yield reduction of 12.12% and 18.67% in 1999 rainy season experiment and of 13.46% and 27.57% in 2000 rainy season experiments respectively over the application of urea 112 lb per acre (Table 8).

Table 6: Interaction between different urea rates and plant populations on yield (bsk/ac) of *Manawthukha* (rainy season, 1999).

Urea rates	*Yield (bsk/ac)*			*Mean*
	Plant populations			
	110000 (9"×6")	*150000 (8"×5")*	*190000 (8"×4")*	
0	63.61 ^{d}	84.82 ^{abc}	65.52 ^{d}	71.32 ^{c}
56 lb/ac	92.38 ^{ab}	85.66 ^{abc}	84.08 ^{abc}	87.37 ^{ab}
112 lb/ac	93.25 ^{ab}	95.37 ^{a}	85.23 ^{abc}	91.28 ^{a}
168 lb/ac	78.26 ^{bcd}	79.37 ^{abcd}	86.35 ^{abc}	81.41 ^{abc}
224 lb/ac	79.95 ^{abcd}	79.34 ^{abcd}	71.46 ^{cd}	76.92 ^{bc}
Mean	81.49 ^{a}	84.91 ^{a}	78.53 ^{a}	
CV%				10.20

Table 7: Interaction between different urea rates and plant populations on yield (bsk/ac) of *Manawthukha* (rainy season, 2000).

Urea rates	*Yield (bsk/ac)*			*Mean*
	Plant populations			
	110000 (9"×6")	*150000 (8"×5")*	*190000 (8"×4")*	
0	68.82 ^{g}	69.60 ^{g}	75.21 ^{f}	71.22 ^{bc}
56 lb/ac	95.08 ^{a}	88.96 ^{bc}	86.12 ^{cd}	90.05 ^{a}
112 lb/ac	86.84 ^{bcd}	84.19 ^{d}	90.81 ^{b}	87.28 ^{a}
168 lb/ac	77.73 ^{ef}	79.41 ^{e}	73.61 ^{f}	76.92 ^{b}
224 lb/ac	69.22 ^{g}	66.91 ^{g}	69.14 ^{g}	68.42 ^{c}
Mean	79.54 ^{a}	77.81 ^{a}	78.97 ^{a}	
CV%				2.92

Table 8: Yield of *Manawthukha* affected by different rates of urea related to disease severity of bacterial blight.

Urea rates	*1999, rainy season*		*2000, rainy season*	
	Yield (bsk/ac)	*% of yield decrease over 112 lb urea per ac*	*Yield (bsk/ac)*	*% of yield decrease over 112 lb urea per ac*
0	71.32	27.99	71.22	22.54
56 lb/ac	87.37	4.48	90.05	+3.07
112 lb/ac	91.28	0.00	87.28	0.00
168 lb/ac	81.41	12.12	76.92	13.46
224 lb/ac	76.92	18.67	68.42	27.57

4 Conclusion

Based on the results from these observations, it can be concluded as follows:

(1) The disease severity of bacterial blight of rice could be increased by the application of nitrogen fertilizer.

(2) Use of higher level of nitrogen fertilizer can cause the higher disease severity of bacterial blight of rice.

(3) Maximum yield with minimum level of disease severity could be obtained with the use of:
urea 56 lb per acre with a population range from 110000 to 150000 plants per acre (or) urea 112 lb per acre with 150000 plant population.

(4) To maintain a tolerable disease severity and to minimize yield losses, the use of urea above 112 lb per acre should be avoided.

References

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