Agri. Res. J. Kerala 1969, 1 (1) : 1-6

NUTRITIONAL EFFECTS OF NITROGEN ON CERTAIN ANATOMICAL CHARACTERS OF RICE PLANT RELATED TO LODGING*

D. CHANDRAMONY, MARY K. GEORGE and P. KUMARA PILLAI
Division of Agricultural Botany, Agricultural College, Vellayani, Kerala

There is probably no important crop that is more influenced by environment than rice. A serious problem which has to be faced in this connection is that of lodging in the case of heavily manured crop. The character of lodging is known to be related to certain anatomical features of the plant (Ramiah and Dharmalingam 1934, Matsuo 1952, Bollich 1963, Russell 1958, Kawata-Shin-Ichiro *et al* 1962, Bhide and Bhalerao 1927). It is however not known how the different anatomical features governing lodging are affected by nitrogen. Results of studies conducted in these lines using 2 each of lodging and non-lodging rice strains and different doses of nitrogen are presented in this paper.

Material and Methods

The lodging varieties, Ptb. 10 and Ptb. 31, and the non-lodging varieties, Kaoshiung–18 and Vellayani 1 were used in these studies. Pot cultures of these varieties were raised in pots using red loam soil mixed with sand in the proportion of 3 : 1 and farm yard manure at the rate of 1000 lb/acre. Superphosphate and muriate of potash were applied at the rate of 80 Ib/acre. The four levels of nitrogen tested were 0,40,80 and 120 lb/acre. Each pot was filled with 40 lb of soil and three replications were given for each treatment. Each pot was sown with well germinated paddy seeds.

To make the anatomical studies, samples of stems and leaves of the plants were collected at the time of flowering and one month after flowering and fixed in formalin-aceto-alcohol mixture. The anatomical characters were studied from hand sections, stained in 0.5 percent aqueous solutions of safranin, haematoxylin and fast green. The characters studied were the cell size of parenchyma and sclerenchyma of the bundle sheath at the cortex region, length and breadth of the vascular bundles in the cortex including the bundle sheath, breadth of sclerenchyma band at the periphery of the stem, thickness of the culms, total number of vascular bundles at the cortex region of the stem and the total number of vascular bundles in the leaf including those at the midrib region.

Results and Discussion

Diameter of parenchyma cells

Table 1 shows that at the time of flowering and one month after flowering eventhough there were variations in the diameter of the parenchyma cells of the stem among the different varieties, there was no significant difference between the lodging and non-lodging varieties. The cell diameter increased progressively and significantly

* From M. Sc. (Ag.) thesis submitted to the University of Kerala in 1966

by increased application of nitrogen. Russell (1958) who bad made similar observations had concluded that increase in cell diameter and decrease in cell wall thickness increased the tendency of the plants to lodge.

Table 1

Mean diameter (in microns) of parenchyma cells of stems of different varieties of paddy receiving different doses of nitrogen

Doses of nitrogen lb/acre	Non-lodging		Lodging		Mean
	Kaoshiung 18	Vellayani 1	Ptb. 10	Ptb. 31	
		At the time of flowering			
0	55.4	70.3	71.9	64.7	63.6
40	60.1	81,5	72.6	62.1	66.9
80	69.9	79-2	766	73.9	72.6
120	66.7	91.1	77.2	83.2	77.1
Mean	61.1	78.1	72.3	68.8	
		After flowering			
0	76 :	70.3	70.9	77.9	71.6
40	75.9	69,3	77.9	80.9	73.7
80	79.5	69.3	80.9	80.9	75.4
120	84.2	80.5	77,2	76.2	77.1
Mian	76.6	70.3	74.4	76.6	
	C.D. (0.05) for comparison between marginal means = 3.6				
	C.D. (0.05) for other comparisons = 7.2				

Diameter of sclerenchyma cells

No significant difference in the diameter of sclerenchyma cells was evidenced between the lodging and the nonlodging varieties at the time of flowering. Table 2 shows that after flowering, the two non-lodging varieties, Kaoshiung 18 and Veliayani 1 possessed diameters significantly lesser than those of the two lodging varieties, Ptb. 31 and Ptb. 10. The diameters of cells in the two non-lodging varieties increased with increased nitrogen application. Ramiah and Dharmalingam (1934) had earlier noted thicker sclerenchyma cells in non-lodging varieties.

Table 2

Mean diameter (in microns) of sclerenchyma cells of stems of different varieties of paddy receiving different doses of nitrogen observed after flowering.

Doses oi nitrogen lb/acre	Non-lodging		Lodging		Mean
	Kaoshiung 18	Veliayani 1	Ptb. 10	Ptb. 31	
0	8.0	7.8	9.4	9.4	8.7
40	8.1	7.8	8.1	9.6	8.4
80	7.1	7.3	10.1	9.7	87
120	9.6	8.2	8.0	9.4	8.8
Mean	8.2	7.9	8.9	9.5	
	C.D. (0.05) for comparison between marginal means = 0.2				
	C.D. (0.05) for other comparisons = 0.4				

B readth of sclerenchyma band at the periphery of the stem

Measurements revealed that eventhough the breadth of the band differed considerably between the varieties, there was no significant difference between the lodging and the non-lodging varieties at both the stages of sampling. This character thus appeared to be a varietal character.

Length of vascular bundles

It may be seen from Table 3 that both at the time of flowering and after flowering the overall varietal variation and the variation between lodging and non-lodging varieties in relation to the length of vascular bundles were significant; those of the non-lodging varieties were shorter than those of the lodging strains. There was a steady increase in the length of vascular bundles corresponding with increased doses of nitrogen applications. Kawata–Shin–Ichiro *e.t at* (1962) had also observed shorter vascular bundles for non-lodging varieties.

Table 3

Mean lengths of vascular bundles (in microns) of stems of different varieties of paddy receiving different doses of nitrogen.

Doses of nitrogen lb/acre	Non-lodging		Lodging		Mean
	Kaoshiung 18	Vellayani 1	Ptb. 10	Ptb. 31	
		At the time of flowering			
0	184,5	161.0	170.9	196.4	172.8
40	180.2	193.4	179.2	196.4	181.6
80	195.0	186.5	186.5	186.8	182.9
120	181.2	194.4	207.6	191.4	187.8
Mean	179.6	178.2	180.4	186.9	
		After flowering			
0	193.0	186.5	165.3	184.8	176.9
40	191.7	183.5	187.1	186.1	181.4
80	201.9	150.2	212.9	190.4	183.1
120	183.2	187.1	190.7	209.6	186.8
Mean	186.6	171.4	183.3	186.9	

C.D. (0.05) for comparison between marginal means = 5.3 (at flowering) and 4.1 (after flowering)

C.D. (0.05) for other comparisons = 10.6 (at flowering) and 8.3 (after flowering)

Breadth of vascular bundles in the stem

Table 4 shows that both at the time of flowering and after flowering there was significant variation in the breadth of vascular bundles of the different varieties and due to changes in the levels of nitrogen. There was also significant difference

between lodging and non-lodging varieties. At the time of flowering the breadth of vascular bundles in general increased significantly at the level of nitrogen at 40 lb per acre. Further increase in the nitrogen application significantly reduced the breadth. After flowering, eventhough the different levels of nitrogen showed a progressive increase in breadth, it was not significant.

Table 4

Mean breadth of vascular bundles (in microns) of stems of different varieties of paddy receiving different doses of nitrogen.

Doses of nitrogen lb/acre	Non-lodging		lodging		Mean
	Kaoshiung 18	Vellayani 1	Ptb. 10	Ptb. 31	
		At the time of flowering			
0	127.4	98.7	81.5	139.6	108.4
40	130.4	110.2	63.0	162.0	112.9
80	135.6	105.3	86.1	98.3	103.1
120	90.8	110.9	81.5	94.1	91.4
Mean	117.8	103.0	75.7	119.8	
		After flowering			
0	115.5	96.4	99.7	123.4	105.4
40	108.2	109.2	77.9	94.1	94.4
80	127.1	86.5	88.8	119.1	102.2
120	104.3	110.6	112.5	118.1	108.0
Mean	110.3	97.6	91.8	110.2	

C.D. (0.05) for comparison between marginal means
= 1.8 (at the time of flowering)
= 2,2 (after flowering)

C.D. (0.05) for other comparisons
SB 3.5 (at the time of flowering)
= 5.9 (after flowering)

Culm thickness

At both the stages of flowering the variations in culm thickness with reference to the varieties and rate of nitrogen application were found to be significant. After flowering there was no significant difference in the culm thickness between the lodging and the non-lodging varieties. At the stage of flowering culm thickness was significantly reduced at 120 lb of nitrogen per acre while after flowering it was significantly reduced at 40 and 80 lb nitrogen per acre levels.

Number of vascular bundles in the stem

It may be seen from Table 5 (which gives the average values of the samples taken at both the occasions) that the number of vascular bundles significantly differed with varieties. Between lodging and non-lodging varieties also there was significant difference. The non-lodging varieties possessed greater number of vascular bundles.

Nitrogen had no significant effect in altering the number of vascular bundles in the stem. Bhide and Bhalerao (1927) had earlier reported that there were more number of vascular bundles in the non-lodging varieties than in lodging varieties.

Table 5

Mean number of vascular bundles in the stems of different varieties of paddy receiving different doses of nitrogen.

Doses of nitrogen (lb/acre)	Non-lodging		Lodging		Mean
	Kaoshiung 18	Vellayani 1	Ptb. 10	Ptb. 31	
0	60.0	52.5	53.0	52.5	54.5
40	63.0	57.5	54 0	51.5	56.5
80	60.5	58.5	54.5	56.0	57.3
120	57.5	53.5	56.5	55.0	55.6
Mean	60.3	55.5	54.5	55.3	

C.D. (0.05) for comparison between means of treatment combinations = 5.9
C.D. (0.05) for comparison between varieties = 2.9

Number of vascular bundles in the leaf

Table 6 which gives the average values of the samples taken at both the occasions shows that there was significant variation in the number of vascular bundles in the leaves of the different varieties. The difference between the lodging and the non-lodging varieties was also significant. Eventhough nitrogen had no significant effect on the number of the vascular bundles, it had a tendency to increase the number of vascular bundles at higher levels.

Table 6

Mean number of vascular bundles in the leaves of different varieties of paddy receiving different levels of nitrogen.

Doses of nitrogen (Ib/acre)	Non-lodging		Lodging		Mean
	Kaoshiung 18	Vellayani 1	Ptb 10	Ptb. 31	
0	50.0	56.0	43.0	57.0	51.5
40	55.5	63.5	41.0	54.5	53.6
80	54.0	59.5	48.0	59.5	55.2
120	60.0	65.0	44.5	64.0	58.3
Mean	54.8	61.0	44.1	58.7	

C.D. for comparison between means of treatment combinations = 11.0
C.D. for comparison between means of varieties = 5.5

Summary

Studies were made on the anatomical characters of rice plants in relation to lodging and non-lodging varieties and rates of nitrogen application.

The non-lodging varieties possessed smaller sclerenchyma cells and greater number of vascular bundles of smaller length than the lodging varieties. Size of parenchyma cells, breadth of sclerenchyma band, length of vascular bundles and number of vascular bundles in the leaf showed a positive correlation with the nitrogen applied at higher levels. Number of vascular bundles in the stem was not significantly altered by nitrogen application.

Acknowledgement

Grateful acknowledgements are due to Dr. C K. N. Nair (erstwhile) Principal and Additional Director of Agriculture (Research) and to Professor P. Kumara Pillai, Head of the Division of Botany, Agricultural College and Research Institute, Vellayani, for their constant help and encouragement during the course of this investigation. Thanks are due to Professor E. J. Thomas, Professor of Statistics, for his help in the statistical analysis of the data.

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(Accepted: 2-8-1969)