Agric. Res. J. Kerala, 1986, 24 (2) 163—168

SCREENING OF RICE VARIETIES FOR TOLERANCE TO ACIDITY*

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Acid soils support plants; but some plants do better than others. There are great differences in between species and also between cultivars in tolerance to acidity, high soluble aluminium or iron and low available phosphate. It has to be understood that the tolerance to acidity in acid soil situations involves two type of tolerance, namely tolerance to acidity or excessive of hydrogen ions in the medium per se and secondly, tolerance to higher concentration of aluminium, manganous ions and ferrous ions which are brought into solution by higher acidity as well as by reduced conditions prevailing in rice soils. Reducing conditions particularly bring into solution manganous and ferrous ions while acid conditions itself are good enough to bring out aluminium ions into solutions. In view of this, attempts to screen varieties for tolerance to acidity should include parameters to distinguish tolerance to acidity *per se* as well as tolerance to aluminium and such other metallic ion toxicities.

Materials and Methods

A pot culture experiment was carried out in a highly acid (pH 3.5) *kari* soil of Kuttanad (place of collection) with 39 rice varieties in order to screen out a variety tolerant to acidity. The physico-chemical characteristics of the soil were determined using standard methods described by Jackson (1958), Piper (1942), Black (1965) and Hesse (1971). Lime requirement was determined by Shoemaker *et al.* procedure as described by Hesse (1971). The seeds of rice varieties were collected from the Regional Research Station, Pattambi. The experiment was laid out in a completely randomised design with two replications. The varieties used are presented in Table 1.

Fifty grams of the soil was taken in petri-dishes and the percentage of germination of seeds was noted. The pH of the moist soil at the time of germination was 3.8. The percentage of germination on moistened filter paper in petri dishes was also noted.

Earthen pots were filled with 2 kg of dried powdered soil. Sufficient water was added to the pots to wet the soil and bring about a puddled condition. Application of N, P and K was done as per package of practices recommended by the Kerala Agricultural University (KAU, 1983). Six germinated seeds were sown in each pot on 15th May, 1982 and after two weeks seedlings were thinned out retaining only three seedlings in each pot. Plant protection and other cultural

* Part of Ph. D. thesis of the senior author submitted to Kerala Agricultural University, 1 986.

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operations were also done as per the recommendations of the Kerala Agricultural University. Waterto a height of 5 cm from the soil surface was maintained till 15 days before harvest. The crop was harvested at full maturity and yield data were recorded. D^2 statistics was applied for grouping the clusters as described by Cochran *et al*. (1957).

Results and Discussion

The physico-chemical characteristics of the soil used for this study are given in Table *2.* The reduction in germination percentage number of tillers and productive tillers per hill, grain, straw and root yields are presented in Table 3. The varieties were screened for tolerance to acidity using the method of D^2 statistics selecting the important characters of rice varieties given in Table 3. The three clusters thus formed were characterised as tolerant, medium tolerant and least tolerant varieties to acidity.

The varieties Jyothi, Thriveni, Jaya, MO 5, Annapoorna, Rohini, Culture-1999 and IR 8 were grouped in cluster I and characterised as tolerant varieties. Cluster II included the medium tolerant varieties PTB 31, PTB 32, PTB 10, PTB 29 PTB 22, PTB 30, PTB 26, PTB 28, PTB 9, PTB2, PTB 5, PTB 8, PTB 1, Mashoori, Culture 1907, Vyttila 2, Vyttila 1, IR 42, IR 5, Pankaj, Bharathi, Culture 2-3332-2, Aswathi, Jagannath, IR 20, Bhadra, Culture 1-5-4, Sabari and BR 51. The least tolerant varieties H 4 and Suvarnamodan were grouped in cluster III. The three clusters are graphically presented in Fig.1.

Table 1
Rice varieties screened for tolerance to acidity

No.	Name	No.	Name	No.	Name
V1	Aswathy	V14	IR 5	V27	PTB 2
V2	Sabari	V15	Annapoorna	V28	PTB 5
V3	Bharathi	V16	Thriveni	V29	PTB 8
V4	Jaya	V17	Rohini	V30	PTB 9
V5	IR 8	V18	Jyothi	V31	PTB 10
V6	IR 20	V19	Culture 1999	V32	PTB 22
V7	IR 42	V20	Culture 2-3332-2	V33	PTB 26
V8	Culture 1-5-4	V21	Vyttila 1	V34	PTB 28
V9	BR 51	V22	Vyttila 2	V35	PTB 29
V10	Bhadra	V23	H 4	V36	PTB 30
V11	MO 5	V24	Mashoori	V37	PTB 31
V12	Pankaj	V25	Culture 1907	V38	PTB 32
V13	Jagannath	V26	PTB 1	V39	Suvarnamodan

The decrease in germination in soil as compared to in distilled water is taken as a measure of the effect of acidity *per se* while root and grain yields are considered as a long term parameter largely affected by aluminium concentration and partly by acidity as well. The observed decrease in the germination percentage of the varieties in the highly acid soil compared to the germination percentage in water revealed that the reduction in germination was significantly less in the tolerant varieties (Table 3 and Fig. 1). Plants are particularly sensitive to soil acidity *per se* at the initial stages of their growth, especially immediately after sprouting. At later stages, however, they are relatively more tolerant to highly acidic range of pH (Yagodin, 1984).

Table 2

Physico-chemical characteristics of soil used for the pot culture study

Sl. No.	Characteristics	
1	Moisture (%)	2.16
2	Sand (%)	45.97
3	Silt (%)	8.01
4	Clay (%)	43.90
5	pH (Dry soil)	3.50
6	pH (Flooded soil)	5.20
7	EC (mmho/cm)	0.66
8	Eh (mV)	+ 280.00
9	Organic carbon (%)	3.20
10	Fe_2O_3 (%)	6.26
11	Al_2O_3 (%)	8.95
12	Total N (%)	0.320
13	Total P_2O_5 (%)	0.094
14	Total K_2O (%)	0.396
15	Total CaO (%)	0.396
16	Total MgO (%)	0.104
17	Exchangeable aluminium (me/100 g)	9.60
18	Exchangeable hydrogen (me/100 g)	10.84
19	Total acidity (me/100 g)	20.44
20	CEC (me/100 g)	22.84
21	Effective CEC (me/100 g)	12.04
22	Al saturation of total CEC (%)	42.00
23	Al saturation of effective CEC (%)	79.70
24	Base saturation (%)	9.06
25	Lime requirement ($CaCO_3$, t/ha)	14.2

Table 3

Germination, growth and yield characters of rice cultivars grown in the highly acid soil

Sl. No.	Varieties	Reduction in germination	Average number of tillers/hill	Average number of productive tillers/hill	Grain yield (g/pot)	Straw yield (g/pot)	Root weight (g/pot)
1	Aswathy	12.5	3.5	3.0	5.3	13.8	3.3
2	Sabari	14.5	2.5	2.0	4.8	10.3	3.3
3	Bharathi	15.5	3.8	2.8	4.5	102	3.6
4	Jaya	6.5	5.8	4.5	8.4	13.6	5.5
5	IR 8	7.8	4.5	3.8	6,4	12.0	5.0
6	IR 20	195	3.5	2.3	3.5	11.6	4.8
7	IR 42	23.0	2.3	1.5	2.9	8.7	4.0
8	Culture 1-5-4	18.0	3.0	2.3	3.6	7.2	3.0
9	BR 51	16.0	6.0	4.0	4.0	8.8	3.2
10	Bhadra	155	6.5	4.5	4.7	7.7	3.3
11	MO 5	6.5	4.8	3.5	7.1	11.5	5.5
12	Pankaj	13.0	4.0	3.3	5.2	11.0	4.3
13	Jagannath	13.0	3.3	2.3	4.9	8.4	37
14	IR 5	19.5	3.8	2.8	3.5	9.2	2.8
15	Annapoorna	6.5	5.8	40	7.0	7.4	5.3
16	Thriveni	6.0	6.3	5.5	8.9	9.3	5.7
17	Rohini	6.5	6.3	4.8	6.9	11.1	4.9
18	Jyothi	5.5	7.8	7.5	10.9	15.0	6.4
19	Culture 1999	7.0	3.8	2.5	6.8	10.3	5.2
20	Culture 2-3332-2	12.5	4.5	2.3	5.4	9.9	4.1
21	Vytilla 1	16.5	4.0	2.0	4.0	8.8	4.1
22	Vytilla 2	17.0	4.3	2.3	3.8	7.8	4.1
23	H4	26.5	2.0	1.3	2.3	13.0	36
24	Mashoori	22.0	3.3	2.0	3.0	14.0	4.2
25	Culture 1907	16.0	3.5	2.3	4.4	15.0	4.6
26	PTB 1	20.5	3.8	2.5	8.3	15.0	3.5
27	PTB 2	18.5	3.3	2.0	3.5	13.0	4.1
28	PTB 5	16.0	2.8	2.0	4.1	145	3.9
29	PTB 8	17.0	4.0	1.8	3.8	15.8	4.0
30	PTB 9	17.0	50	2.3	3.9	13.5	4.2
31	PTE3 10	17.5	4.8	2.3	3.8	14.5	3.9
32	PTB 22	18.0	4.8	2.5	3.5	14.2	4.1
33	PTB 26	18.0	4.8	2.0	4.6	14.3	3.5
34	PTB 28	19.0	4.5	1.8	3.5	13.4	3.9
35	PTB 29	20.5	5.0	2.5	3.3	14.2	4.0
36	PTB 30	21.0	4.5	2.3	3.2	15.2	3.3
37	PTB 31	230	4.8	2.3	2.9	12.7	3.6
38	PTB 32	23.0	4.8	2.3	2.9	12.7	3.7
39	Suvarnamodan	28.0	2,3	1.3	2.0	7.9	2.6
	C D (0.05)	2.91	1.94	1.25	0.82	2.72	0.85

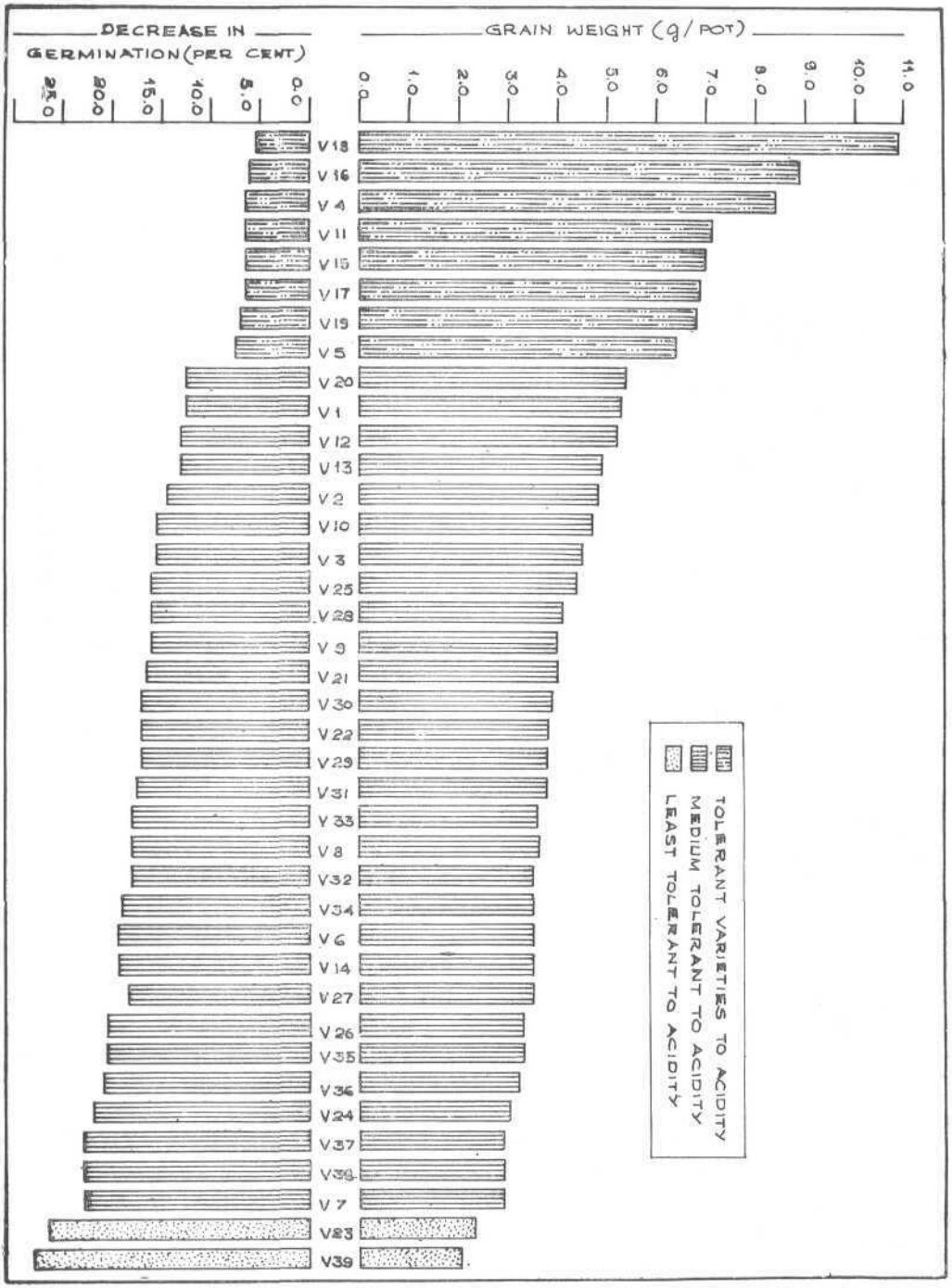

Fig 1. Categorisation of the screened rice varieties in terms of tolerance to acidity based on two major parameters

Grain yield has been found to be significantly higher in tolerant cultivars while poor yields have been recorded in least tolerant varieties (Fig 1). At the initial stages of growth, acidic reaction seriously upsets carbohydrate and protein metabolism. However, this adversely reflects on the initiation of generative organ which is reported generally to have a remote effect on fertilization and grain forming with subsequent reduction in yield in the less tolerant varieties (Yagodin, 1984).

The yield as a basis of classification of the varieties towards tolerance to acidity (acidity *per se* plus Al and other toxicities) reveals that Jyothi is the most tolerant variety while Suvarnamoden the least tolerant. According to Yagodin (1984) the sensitivity of plants to acidic pH of the medium and to the mobile forms of aluminium is not always in a strict relationship with one another. This has thus attributed to the differential sensitivity of the plants to the presence of mobile forms of aluminium in the stem which arises out of their dissimilar capacity to immobilize them even when they are in the roots. More tolerant varieties and crops to aluminium toxicity are the plants capable of immobilizing aluminium even when they are in the root system itself as a result of which aluminium does not reach the growing points and generative organs as it happens in the less tolerant varieties.

Jyothi variety showed the maximum dry weight of straw, most of the tall varieties studied recorded nearly similar straw yields. This may be due to the genetic character which could not be suppressed by the acidity. The dry weight of roots of varieties was significantly more in the tolerant varieties. The adverse effects of high acidity are largely due to increased solubility of aluminium and the presence of exchangeable hydrogen in the soil. In this soil, the exchangeable aluminium and exchangeable hydrogen were 9.6 and 10.84 me/100 g soil respectively, which cause a total acidity of 22.44 me/100 g soil (Table 2). Poor growth of several crops in acid soils has been considered to be the direct consequence of a high degree of saturation of the exchange complex with aluminium (Sanchez, 1976). Al saturation of effective CEC accounts 79.7 per cent in this soil. Excess of aluminium affects primarily the root system (Caronel, 1980 and Alice, 1984) as shown from root morphological studies of culture solution experiments. Thus, in respect of all the characters studied, Jyothi variety performed well in a highly acid soil. The screening studies have found solution for comparing acidity tolerance to all these toxicities by selecting suitable plant types and varieties.

Summary

A pot culture experiment wss conducted to screen out the most tolerant variety that could be grown in a highly acid soil from among 39 varieties cultivated in Kerala. The varieties were screened for tolerance to acidity using the method of D^2 statistics, selecting the important characters and thus three clusters were formed. They were characterised as tolerant, medium tolerant and least tolerant varieties to acidity. Among the tolerant varieties, Jyothi variety ranked first.

സംഗ്രഹം

കേരളത്തിലെ പ്രധാനപ്പെട്ട 39 നെല്ലിനങ്ങൾക്ക് അമ്ലമണ്ണിലുള്ള സഹനശീലത്തെക്കുറിച്ച് പഠിക്കുകയുണ്ടായി. ജ്യോതിനെല്ലിനമാണ് കൂടുതൽ സഹനശക്തിയുള്ളതെന്നു കാണപ്പെട്ടു.

Acknowledgement

Thanks are due to Dr. P. K. Gopalakrishnan, Associate Dean and Dr. A. I. Jose, Professor and Head of Department of Soil Science and Agricultural Chemistry, College of Horticulture, Vellanikkara, for the necessary facilities provided for this work. The senior fellowship awarded to the first author by the Indian Council of Agricultural Research is gratefully acknowledged.

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