HortScience 14(1):31–32. 1979.

Variations in the Yielding Ability of Sweet Potato under Drought Stress and Minimum Input Conditions[1]

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Additional index words. Ipomoea batatas, intensive cropping

Abstract. **Evaluation of 381 sweet potato cultivars and 464 breeding lines for root yield under drought stress and minimum input conditions following a rice crop revealed certain genotypes that surpassed the tropical Asian yield average by at least 100%. Such genotypes appeared to possess both drought tolerance and good yielding ability.**

There are numerous rainfed areas in Asia where the present cropping intensity is low (4). In these areas, many hectares of paddy fields remain idle after the rice crop because the residual moisture in the field may be enough to germinate a seed, but insufficient to mature a crop. Besides, many farmers can neither obtain nor afford the fertilizer and pesticides needed to raise a second crop. Thus, a crop that can be planted immediately after the rice harvest and is able to yield well under minimum input conditions (i.e. low level fertility and management) and water stress should be useful (1, 5). In this paper we report field results of screening for sweet potato cultivars that are suitable for planting under such conditions. Screening of sweet potato cultivars under paddy field was also carried out by Carpena et al. (2) but their experimental plots were fertilized and weeded.

On November 15, 1974, 176 cultivars and 464 breeding lines were planted in a field previously planted to rice (first screening). After the rice harvest, the field was rotovated, bedded, and planted. No irrigation, pesticide or fertilizer were applied. The second screening of 114 cultivars and a third screening of 91 cultivars which have not been evaluated previously, were planted on November 19, 1975, and October 16, 1977, respectively. The materials which yielded at least 10 MT/ha in the first screening were separated into 2 groups; orange-fleshed and yellow- and white-fleshed and entered into preliminary trial (Trial I) on November 19, 1975, following the same procedure as described. On October 4, 1977, we planted these materials for further evaluation (Trial II). In this evaluation, however, no land preparation was made. Instead a hoe was used to dig a 15 cm-wide by 20 cm-deep hole where a sweet potato cutting having 8 nodes was planted. About a month later, the soil was hilled up around established plants through the use of plow and carabao. As in the previous trials, no irrigation, pesticide or fertilizer were applied.

The crops in the first screening depended on residual moisture and natural precipitation to meet their water requirements. Natural precipitation was 97 mm during the entire cropping season, with 604 mm of evaporation. Trial I and the second screening had 129 mm of natural precipitation with 646 mm of evaporation. The third screening had 110 mm natural precipitation and 50 mm of artificial precipitation (via furrow irrigation) with 586 mm of evaporation, whereas, in Trial II, there was 85 mm of natural precipitation and 50 mm of artificial precipitation (via furrow irrigation) with 518 mm of evaporation. Optimum yield is generally obtained with 530-660 mm of precipitation during the growing seasons (3).

In the first screening ten 30-cm cuttings per entry were planted, spaced at 1 m between rows and 0.3 m between hills. The second and third screening and Trials I and II had 20 cuttings each. The completely randomized design without replication was used for the first and second screening. The third screening had 2 replications in a randomized complete block design. Trials I and II were carried out also in a randomized complete block design with two and three replications for Trial I and Trial II, respectively.

Yield distributions of the 176 cultivars and 464 breeding lines varied from 0.33 to 17.8 MT/ha for the cultivar and 0.33 to 19.5 MT/ha for the breeding lines (Fig. 1). These high yields of 17.8 and 19.5 MT/ha were impressive, considering that the only inputs involved were minimal land preparation, planting of cuttings, and harvesting of sweet potato roots, Average yield in most tropical Asian countries is about 6 MT/ha (1).

On the average 70% of the cultivars

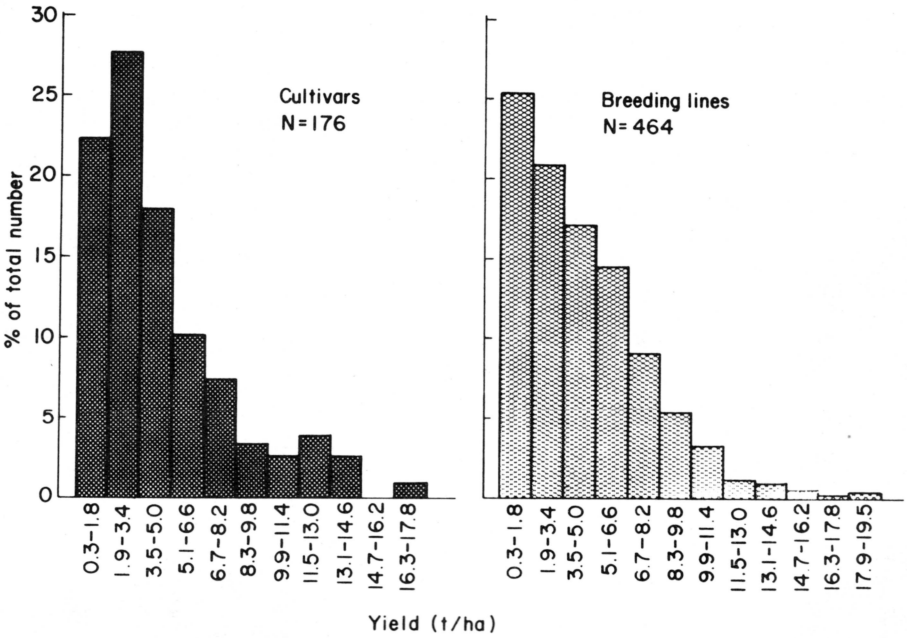

Fig. 1. Distributions in yield among cultivars and breeding lines under water drought stress and minimum input conditions. Mean of cultivars = 4.59 MT/ha; mean of breeding lines = 4.49 MT/ha.

[1]Received for publication August 17, 1978. Journal Paper No. 39 (78-79) of the Asian Vegetable Research and Development Center., P.O. Box 42, Shanhua, Tainan 741, Taiwan. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper must therefore be hereby marked *advertisement* solely to indicate this fact.

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Table 1. Distribution of survival rates of cultivars under stress and minimum input conditions.

Survival range (%)	Distribution (%) Screening I n=176	II n=114	III n=91	Avg
0-20	0.6	1.8	0	0.8
21-40	0.6	5.3	0	2.0
41-60	3.4	10.5	3.3	5.7
61-80	21.6	21.9	20.9	21.5
81-100	73.8	60.5	75.8	70.0

evaluated in all screening had 81% or better survival rate (Table 1). These data indicate that several lines had sufficient drought tolerance to establish a good plant stand under paddy field conditions, even without supplemental irrigation. A random sample of 100 low yielding (<10 MT/ha) and 50 high yielding (>10 MT/ha) materials, showed that low yielding entries had fewer and lighter marketable roots (Table 2). We observed a similar trend in the rooting characteristics of culls. Thus, a plant type suitable for growing under low moisture and minimum input conditions should possess the ability to survive under drought stress and the ability to initiate and develop a large number of roots to maturity with at least part of its life cycle under these conditions.

In Trials I and II, yield superiority of the better yielding lines over the check was due either to root number or root weight or a combination of both (Table 3). Trial II data suggested that even without land preparation some entries, particularly orange-fleshed types, yield well. Selections 057-4, 272-9 and 0122-2 are outstanding examples of good yielders in the absence of land preparation prior to planting and under low level management conditions. In the yellow- and white fleshed category, only 'Tainung New 10' and 'Tainung 10' gave yields comparable to those obtained in Trial I.

Our findings suggest that sweet potato cultivars can produce a relatively large amount of food under water stress and low-level management conditions. Thus, it may be profitable for rice farmers in rainfed areas to follow rice with sweet potato, even without supplemental irrigation and additional costly inputs like fertilizer and pesticides. The effect of a large sweet potato crop on subsequent rice yields remains to be determined.

Table 2. Yield and root weight of 50 high and 100 low yielding entries under drought stress and minimum input conditions.

Category	Marketable No. of roots/ha[z]	Marketable Avg wt root (g)	Culls No. of roots/ha[z]	Culls Avg wt root (g)	Total No. of roots/ha[z]	Total Avg wt root (g)
High yielding	109,800	123**	70,900[NS]	30**	108,700**	76**
Low yielding	48,300	43	73,100	20	121,500	31

[z]Analysis made after square root transformation
*, **, NS Significant at 5% (*), 1% (**) level, non significant (NS) based on t-test.

Table 3. Yield and other traits of promising cultivars and breeding lines in Trials I and II under drought stress and minimum input conditions.

Cultivars	Pedigree or name	Trial I[z] Marketable yield (MT/ha)	Trial I[z] No. of roots/ha[x]	Trial I[z] Avg wt root (g)	Trial II[y] Marketable yield (MT/ha)	Trial II[y] No. of roots/ha[x]	Trial II[y] Avg wt root (g)
Orange-fleshed							
AIS 057-4	Tainung 57 (OP)	10	60,200	130	12	78,800	158
AIS 272-2	Red Tuber Tail x OK 6-3-106	8	54,200	123	5	44,600	127
AIS 272-9	Red Tuber Tail x OK 6-3-106	8	52,800	122	10	67,800	145
AIS 0122-2	B 6708 (OP)	8	45,000	148	12	61,300	211
AIS 016-2	HDK 12 (OP)	7	67,700	91	5	45,800	109
(I 171)	Tainung 63 (check)	2	28,000	64	2	29,800	80
	LSD 5%	3		60	4		55
Yellow- and white-fleshed							
I 117	PI 344129	13	97,400	132	4	35,000	142
I 115	PI 344123	11	76,300	154	-	-	-
I 5	Tainung New 10	8	53,900	145	7	45,800	168
I 18	Taiwan 2	8	73,700	113	-	-	-
I 154	Tainung 10	8	45,000	170	9	55,000	129
I 57	Tainung 57 (check)	4	47,700	90	2	18,200	112
	LSD 5%	3		52	3		39

[z]Planted Nov 19, 1975 and harvested Apr 21, 1976 (153 days); no fertilizer.
[y]Planted Oct 4, 1977 and harvested March 6, 1978 (152 days); no land preparation prior to planting.
[x]Analysis made after square root transformation.

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