



Evaluation of Yam Bean for Yield and Proximate Composition

B. Vimala and Bala Nambisan

Central Tuber Crops Research Institute, Sreekariyam, Thiruvananthapuram 695 017, Kerala, India

Corresponding author: B. Vimala, e-mail: vimalactcri@yahoo.co.in

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Abstract

Sixty yam bean accessions were evaluated for tuber yield and biochemical characters at Central Tuber Crops Research Institute, Thiruvananthapuram, India. The mean yield data of two years' preliminary yield trial showed that the tuber yield ranged from 9.1 to 27.8 t ha⁻¹. Dry matter of tuber varied from 9.0 to 15.0%. The starch content ranged from 3.0 to 6.0% and sugar varied from 2.5 to 4.0%. The results of the advanced yield trial conducted for three years with 16 accessions selected from preliminary yield trial indicated that six accessions recorded an yield of >25.0 t ha⁻¹. Highest yield of 29.0 t ha⁻¹ was observed in the accession EC 100566.

Key words: Yam bean, yield, evaluation, dry matter, starch

Introduction

Tropical tuber crops are an important source of dietary energy and are considered as secondary staples after cereals. They have the potential to substitute cereals owing to their high carbohydrate and calorie content. Among the tropical tuber crops, yam bean (*Pachyrrhizus erosus* (L.) Urban) which belongs to the family *Leguminosae* is cultivated for its edible tubers. The genus *Pachyrrhizus* includes five species, of which two are wild and *P. ahipa* (Wedd.) Parodi, *P. tuberosus* (Lam.) Spreng and *P. erosus* (L.) Urban are cultivated species. Yam bean (*P. erosus*) is widely grown throughout the tropical regions of the world (Sorenson, 1988). The crop is well suited to small and marginal holdings and has the capacity to withstand biotic and abiotic stresses. It comes up well in comparatively marginal lands and does not require great care. It has great potential in areas where the farmers belong to small and marginal categories (Nath et al., 2008). The plant is a native of Mexico and parts of Central America from where it was introduced to other tropical areas. It is widely cultivated in Mexico, China, Singapore, Philippines, Hawaii, Indonesia and India. In

India, it is grown in parts of West Bengal, Bihar, Orissa, Assam, Tripura and Manipur. The under ground part of the plant is perennial but the aerial portion is annual. Tubers of yam bean are white, turbinate or broad, spindle shaped with easily peelable skin. The flesh of the tuber is white, crispy, juicy, refreshing, sweet and can be eaten raw, cooked or deep fried. The tubers after peeling are consumed as a salad. They are also used as a fodder. The mature tuber yields starch, which is similar to arrowroot starch (CSIR, 1966). The pods are poisonous due to the presence of 'rotenone' and related toxic substances. The powdered seeds are used as an insecticide in tropical countries (Pursglove, 1981).

Yam bean is propagated through seeds. Sometimes tubers are used as planting material when a particular genotype is maintained. It grows well on light sandy soil. The seeds are sown with the onset of monsoon. The crop matures within 5-6 months after planting. Yam bean fixes nitrogen and hence increases the soil fertility (Poonpipat, 1984). In the germplasm of minor tuber crops at Central Tuber Crops Research Institute (CTCRI),

Thiruvananthapuram, 63 accessions of yam bean are maintained (Vimala and Nambisan, 2005). The objective of the study was to evaluate the yam bean accessions for tuber yield and proximate composition and to identify high yielding accessions from the germplasm.

Materials and Methods

The materials for the present study comprised of 60 yam bean accessions maintained at CTCRI, Thiruvananthapuram. Out of these, 28 accessions were collected from CTCRI (Regional Centre), Bhubaneswar, Orissa and 32 accessions from Rajendra Agricultural University, Dholi, Bihar. Preliminary Yield Trial was conducted with 60 accessions at CTCRI, Thiruvananthapuram for two years (2003-2004). The trial was planted during June-July. Each accession was planted in 15 mounds (60 seeds) and four seeds were sown on each mound. The spacing between and within rows was 75cm. The crop was raised as per the package of practices standardized by CTCRI (Mohankumar et al., 2000). The crop was harvested during November-December. Proximate analysis of the tuber was carried out by standard procedures (AOAC, 2000). An Advanced Yield Trial was conducted for three years (2005-2007) with 16 promising accessions selected from the Preliminary Yield Trial. The experiment was planted in Randomised Block Design with three replications. The plot size was 7.5x1.5 m accommodating 80 plants per replication. The flower buds were removed periodically from all the accessions to get good tuber yield and the trials were harvested five months after planting. The tuber weight was recorded at the time of harvest. The statistical analysis of the yield data was carried out as per the procedure given in Panse and Sukhatme (1967).

Results and Discussion

Yam bean plant is a coarse, hairy, herbaceous climbing or trailing root crop. The leaves are alternate, trifoliate and large with toothed leaflets. The flowers are bluish violet, arranged in a terminal or axillary raceme. Its smooth, hairy fruits are pods usually 7-15 cm long, containing 8-10 yellow, brown or red-square, more or less flattened seeds. It is a self-pollinated crop and genetic variability for agronomically important characters are lacking in this crop. The studies showed that in all the accessions the flower buds initiated two months after planting. Only one accession, DL-33 produced white

flowers and in the other accessions the flowers were violet in colour. All the buds were removed periodically because flowering and pod formation adversely affected the tuber bulking. Negative correlation between tuber yield and pod formation has been observed by Mohankumar et al. (2000). Mishra et al. (1993) also reported that deflowering is essential for obtaining good size quality tubers. Each seed of yam bean produces a single plant, which bears a single tuber. It was found that tubers are simple or compound, lobed, round, oblong, turnip-shaped or elongated. The variations observed in the tuber shape are shown in Fig.1.

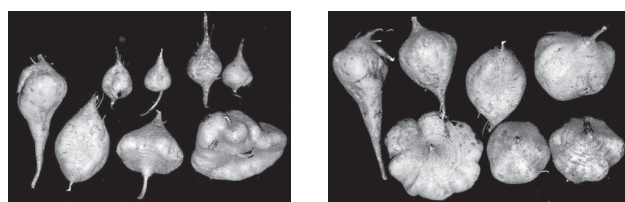


Fig.1. Morphological variability of yam bean tubers

The preliminary yield evaluation for two years and the results of the proximate analysis are given in Tables 1 and 2. The yield data indicated that the mean yield of 60 accessions ranged from 9.1 to 27.8 t ha⁻¹. Only three accessions produced <10.0 t ha⁻¹. In 18 accessions the yield ranged from 10.1 to 15.0 t ha⁻¹ and in 14 accessions it was 15.1 to 20.0 t ha⁻¹, 15 accessions produced 20.1 to 25.0 t ha⁻¹ yield. Only 10 accessions produced >25.0 t ha⁻¹. The highest yield of 27.8 t ha⁻¹ was observed in the accession DL-17. Nedunchezhiyan et al. (2002) reported that yam bean genotypes did not show significant difference in tuber yield. Among the four genotypes, L-19 was found to be the most suited genotype for Bhubaneswar region and highest yield of 5.75 t ha⁻¹ was obtained at 90 days when the crop was sown during the second week of August. Ramaswamy et al. (1980) reported that the yield of two best performing Mexican lines at 220-245 days was 14.00 to 18.66 t ha⁻¹ at the plant density of 66,650 plants per ha. Roy et al. (1976, 1980) observed an increase of fresh tuber yield from 24.2 to 28.5 t ha⁻¹ with corresponding increase in total dry matter, tuber protein and starch with the application of higher dose of fertilizer, N @ 40 kg ha⁻¹. Pure crop of yam bean showed higher fresh tuber weight and maximum tuber bulking rate during 80-100 days after planting, while fresh weight increased with the age of the crop (Panda et al., 2000).

Table 1. Preliminary evaluation of yam bean for yield and proximate composition

Accessions	Yield (t ha ⁻¹) (Mean of 2 years)	Dry matter (%) (on fresh wt. basis)	Starch (%) (on fresh wt. basis)	Sugar (%) (on fresh wt. basis)
EC100540	12.0	9.1	5.1	2.5
EC100541	19.1	11.8	5.8	3.5
EC100543	13.1	10.4	5.7	3.2
EC100544	18.7	13.5	5.7	2.8
EC100545	26.2	9.8	4.5	3.8
EC100546	14.9	8.9	5.1	3.8
EC100547	15.4	15.1	6.7	3.8
EC100548	13.1	15.0	6.7	3.5
EC100549	11.1	13.1	5.6	4.0
EC100550	24.6	13.6	6.9	3.4
EC100551	11.7	8.0	4.3	3.2
EC100552	13.2	13.5	8.0	3.2
EC100558	9.1	14.4	6.0	3.2
EC100560	25.6	12.0	6.1	3.1
EC100561	14.4	12.9	5.7	2.6
EC100562	9.6	14.7	6.4	2.9
EC100563	9.3	13.5	6.5	2.9
EC100565	11.2	7.9	4.7	3.0
EC100566	26.0	15.0	5.2	2.8
EC100567	13.6	7.9	4.3	2.7
EC100568	15.1	9.8	5.6	3.2
EC100569	24.6	8.1	4.6	3.1
Rajendra Local	24.9	13.1	5.7	2.1
L-1	14.6	13.2	3.6	2.2
L-3	14.1	14.0	5.1	3.1
L-19	24.3	12.5	5.1	2.8
IC-25112	16.8	14.1	3.9	4.0
IC-2517	14.6	10.0	5.1	3.2

It was found that the germplasm accessions did not show much variability in the dry matter and starch content of tubers. The dry matter varied from 7.5 to 15.7%. Majority of accessions (40) had a dry matter content of 10.0 to 15.7%, while 20 accessions had <10.0%. The starch content varied from 3.0 to 6.9%. In 32 accessions, the starch content was 5.1 to 6.9% and in 28 accessions, it was <5.0%. Sugar content varied from 2.2 to 4.4%. In 35 accessions, sugar content ranged from 3.0 to 4.4%

Table 2. Preliminary evaluation of yam bean for yield and proximate composition

Accessions	Yield (t ha ⁻¹) (Mean of 2 years)	Dry matter (%) (on fresh wt. basis)	Starch (%) (on fresh wt. basis)	Sugar (%) (on fresh wt. basis)
DL-I	13.8	9.0	4.7	4.0
DL-2	25.6	10.3	5.6	2.6
DL-3	25.1	14.7	6.7	4.4
DL-4	20.3	15.7	6.8	3.4
DL-5	14.9	15.5	6.5	2.9
DL-6	14.2	7.8	3.4	3.7
DL-7	15.8	12.8	6.0	3.2
DL-10	17.8	9.9	4.3	2.7
DL-13	15.8	10.9	3.7	3.1
DL-14	18.2	13.4	4.6	2.2
DL-16	18.3	11.0	4.9	3.1
DL-17	27.8	15.0	4.2	3.2
DL-18	22.1	14.1	4.6	3.1
DL-19	20.6	11.1	5.1	3.2
DL-20	25.1	10.4	4.8	3.1
DL-21	24.7	8.5	4.4	2.5
DL-22	22.2	10.2	4.8	3.9
DL-25	26.2	7.6	4.2	3.8
DL-26	25.2	10.2	4.8	3.9
DL-27	15.8	7.5	3.5	2.6
DL-28	22.9	7.7	4.1	2.5
DL-29	26.2	7.6	4.2	3.8
DL-30	24.8	10.0	4.5	2.6
DL-33	22.9	7.7	4.1	2.5
PH-6	21.0	9.7	5.7	2.9
PH-7	22.2	12.4	5.7	2.4
PH-9	18.2	8.7	3.9	2.8
PH-10	18.2	14.8	6.5	2.9
PH-11	18.7	14.1	6.0	2.9
PH-14	13.5	9.7	5.7	2.9
PH-22	10.1	10.3	4.3	3.2
PH-33	24.1	12.6	3.0	3.1

and in 25 accessions it was <3.0. In the present study, it was observed that the tubers contained more water. The low dry matter and starch content may be due to the presence of more water content in the tuber. However, Mishra et al. (1993) reported that the tuber contains

Table 3. Tuber yield from advanced yield trial in yam bean

Accessions	Tuber yield (t ha ⁻¹)			Mean
	2000	2001	2002	
DL-2	18.8	15.8	14.6	16.4
DL-3	27.0	28.5	25.2	26.9
DL-17	20.7	18.6	16.5	18.6
DL-20	27.9	29.0	26.3	27.6
DL-21	26.7	25.8	24.9	25.8
DL-25	23.0	24.0	18.5	21.8
DL-26	17.0	21.0	16.7	18.2
DL-29	26.8	27.6	26.2	26.9
DL-30	18.1	18.3	17.0	17.8
DL-33	24.8	17.8	18.0	20.2
EC100550	17.8	16.8	14.5	16.4
EC100560	15.9	14.7	12.3	14.3
EC100566	29.3	29.5	28.6	29.1
EC100569	19.3	22.6	19.8	20.6
L-19	23.0	24.5	16.8	21.4
Rajendra				
Local	26.3	26.7	25.0	26.0
CD (0.05)	5.24	4.86	5.31	

20.0 to 25.0% dry matter, 15.0 to 20.0% starch and 3.0 to 4.0% sugar. Total dry matter and accumulation of protein also increased due to higher application of N, sugar content with P and starch content with K (Roy et al., 1980).

The results of the advanced yield trial conducted for three years are given in Table 3. The data showed that there was significance difference in yield among the accessions. The pooled mean yield data of three years indicated that the yield varied between 14.3 and 29.1 t ha⁻¹. In six accessions, the yield ranged between 14.0 and 18.0 t ha⁻¹, while in four accessions, it varied between 20.0 and 22.0 t ha⁻¹. Only six accessions recorded >25.0 t ha⁻¹ and the highest yield of 29.0 t ha⁻¹ was recorded in the accession EC100566 (Fig.2) followed by DL-20 (27.6 t ha⁻¹, Fig.3), DL-29 and DL-3 (26.9 t ha⁻¹). Unnikrishnan and Sreekumari (1984) reported that evaluation of 11 accessions of yam bean led to the identification of one high yielding accession, L-19, which gave an yield of 29.0



Fig.2. Tubers of accession EC 100566



Fig.3. Tubers of accession DL-20

t ha⁻¹. In the present study, the mean of three years' yield data showed that L-19 recorded 21.0 t ha⁻¹. A high yielding selection 'Rajendra Mishrikand' yielding 40.0 t ha⁻¹ was identified and released by the Rajendra Agricultural University, Pusa, Bihar (Singh et al., 1981). Pure crop of yam bean showed better fresh tuber weight, tuber bulking rate and efficiency through periodical observation. However, the maximum tuber bulking rate was recorded during 80-100 days after planting, while fresh weight increased with the age of the crop (Panda et al., 2000). When the crop was sown late in October-November and harvested in December-January comparatively lower yield was obtained due to smaller size tubers (Sen et al., 1996). Roy et al. (1976, 1980) observed an increase of fresh tuber yield from 24.2 to 28.5 t ha⁻¹ with corresponding increase in total dry matter, tuber protein and starch with the application of higher dose of fertilizer (N @ 40 kg ha⁻¹). The results of the present study indicated that the six high yielding

accessions identified from the germplasm evaluation can be cultivated in the areas, especially in the eastern region of India, where the crop is more important.

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