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Evaluation of elite breeding lines of arrowroot (*Maranta arundinacea* L.) for higher yield

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Abstract
Nutritionally, roots and tubers have a great potential to provide economical sources of dietary energy, in the form of carbohydrates. Arrowroot (*Maranta arundinacea* L.) is an important starchy plant that has the potential utilization for food, industry and medicine. The study was undertaken at the Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University to evaluate the growth and r yield characters of 13 elite arrowroot lines received from different parts of the country through All India Coordinated Research Project on Tuber Crops. The result showed some significant differences in growth characteristics and tuber yield. The significant differences for most of the morpho-physiological characteristics, plant height, number of tillers, number of tubers and tuber yield indicated the existence of genetic variability among populations. The significantly highest plant height was observed in TAr 18-8 (128.03 cm) which was on par with TAr 18-3, TAr 18-4, TAr 18-5, TAr 18-6, TAr 18-7 and TAr 18-14. The arrowroot lines TAr 18-5 and TAr 18-4 recorded significantly the highest value for the number of tubers (13.67) and biggest tuber weight (178.56 g). The significantly highest number of tubers per plant (9.44) and tuber yield (17.45 t/ha) were recorded in TAr 18-8.

Keywords: Evaluation, arrowroot, growth, yield

Introduction
Tuber crops occupy a remarkable position in the food security of the developing world due to their high calorific value and carbohydrate content. Some of them are already cultivated, but others are grown as a neglected group of economic plants (Sujatha and Renuga, 2013) [15]. The contribution of roots and tubers to the energy supply in different populations varies with the country. The relative importance of these crops is evident through their annual global production which is approximately 836 million tones [FAOSTAT, 2013] [7]. Asia is the main producer followed by Africa, Europe, and America. Asian and African regions produced 43 and 33%, respectively, of the global production of roots and tubers [FAOSTAT, 2013] [7]. On a global basic, approximately 45% of root and tuber crop production is consumed as food, with the remainder used as animal feed or for industrial processing for products such as starch, distilled spirit, alcohol and fermented beverages including beer and a range of minor products [FAO, 2004] [6]. Millions of people in many developing countries do not have enough food to meet their daily requirements and many more are deficient in one or more micronutrients. In many cases rural communities depend on wild resources including wild edible plants to meet their food needs in periods of food shortage [FAO, 2004] [6].

Arrowroot (*Maranta arundinacea* L.) is a perennial plant, harvested for its edible tubers, distributed on almost the whole tropical regions. The plant is a straight perennial herb with 1.0-1.5 m in high, superficial rooted with rhizomes growing into the soil. The best plant growth is in well drained on loamy or sandy soil and light shaded areas (Sujatha & Renuga, 2013) [15]. Some regions such as in India, Caribbean islands, Southeast Asia and South America, arrowroot was grown for food sources (Erdman and Erdman, 1984) [5]. *Maranta arundinacea* L. (Indian arrowroot plant) is an important starch yielding tuber crop plant which finds uses in traditional food and medicine from the early days of human civilization. It belongs to the family Marantaceae [Andersson, 1998] [1].

West Indian arrowroot (*Maranta arundinacea* L.) is an under-exploited tuber crop, the rhizomes of which are valued as food stuff and a source of starch. The rhizome contains 25-30% starch (CSIR, 1962) [3]. Arrowroot starch is used for the preparation of bakery products especially biscuits, as a base for face powder, in the preparation of specialized glues and in the manufacture of carbonless paper for computer printouts (CTCRI, 1996) [4]. The starch possesses demulcent and anti-diarrhoeal properties and is used in the treatment of intestinal disorders which adds medicinal value to the crop. The crop comes up well under shaded conditions and no serious pests and diseases are noted in the crop. Extraction of starch can be done even in households by adopting a simple procedure. It serves as a raw material for cottage industry by unemployed women and rural youth. It is in this context that the potential of this under-exploited crop should be evaluated. This plant requires special attention being a good source of starch as well as a medicinal plant and hence the present study has been designed to assess the morphological characters and yield potential of the elite lines received from different parts India through All India Coordinated Research Project on Tuber Crops.

Materials and Methods

Thirteen elite lines of *Maranta arundinacea* received from different parts of India through the All India Coordinated Research Project were used for the study (Table 1). The experiments were carried out in the experimental field of the Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Tamil Nadu, India. The experimental plot is located at 77°E longitude and 11°N latitude at an elevation of 426m from MSL. The experimental area has a tropical monsoon climate with southwest monsoon rains from June to August, northeast monsoon rains from October- November and dry spells from December to May with summer showers in March, April and May. Average temperature varies from 25°-38 °C and annual rainfall is about 650-700 mm. The experiments were laid out in randomized block design (RBD) with 3 replications.

The land was prepared by plowing and harrowing and the beds were subsequently raised using a ridge plow. Small pieces of rhizomes 4-7cm in length, with buds on them are used for planting. The rhizomes were planted vertically with the buds facing upwards, in a spacing of 30 x 15 cm spacing. Applied FYM @ 10t/ha and NPK @ 50:25:75 kg/ha as per the recommendations of Central Tuber Crops Research Institute, Thiruvananthapuram (Ravindran *et.al*., 2013) [13]. Weeding was carried out regularly and optimum soil moisture was maintained. Data on growth, yield and rhizome characters were recorded by destructive sampling at maturity. The data of five plants were recorded for morphological and physiological characteristics including plant height, number of tillers, Number of leaves per tiller, leaf area, length of rhizome, diameter of rhizome, number of rhizome, biggest rhizome weight and rhizome yield, recorded at the end of 8 months. Analysis of variance was carried out to find out the significance of variability.

Results and Discussion

Variance analysis showed considerable variability among all arrowroot populations, which was highly significant (Table 1 and 2). The significant differences for most of the morphological and yield characteristics *viz.*, number of leaves per tiller, leaf area, length of rhizome, diameter of rhizome, number of rhizome, biggest rhizome weight and rhizome yield indicated the existence of genetic variability among populations. Plants require optimum environmental conditions to grow and produce maximum tuber yields *viz.* soil type and contents, water availability, altitude, climate, air temperature, humidity, light intensity, etc. (Sitompul & Guritno, 1995) [14]. The same plant species will show various morphology if environmental factors are more dominant in affecting plant than genetic factors and vice versa (Suranto, 1991) [16].

The significantly highest plant height was observed in TAr 18-8 (128.03 cm) which was on par with TAr 18-3, TAr 18-4, TAr 18-5, TAr 18-6, TAr 18-7 and TAr 18-14. The significant maximum number of leaves (15.72) and leaf area (244.67 cm^2) also recorded in TAr 18-8. The number of leaves per tiller varied from 6.26 to 15.72. The arrowroot lines TAr 18-5 and TAr 18-4 recorded significantly the highest value for the number of tubers (13.67) and biggest tuber weight (178.56 g). The significantly highest number of tubers per plant (9.44) and tuber yield (17.45 t/ha) were recorded in TAr 18-8. Differential variability of quantitative characters in the case of cultivated plants and its application in crop improvement has been discussed by different workers in crops like coffee [Nikhila *et.al*., 2002, Raghu *et.al*., 2003] [9, 12], medicinal plants [Misra *et.al*., 1998] [8], cardamom [Radhakrishnan *et.al*., 2006a, Radhakrishnan *et.al*., 2006b] [10, 11], cassia [Chandramohanan and Mohanan, 2005] [2] and vanilla [Umamaheswari and Mohanan, 2004] [17].

Table 1: Evaluation of elite entries of arrowroot for growth characters

Genotypes	Plant height (cm)	Number of Tillers	Number of leaves per tiller	Leaf area (cm^2)
TAr 18-1	116.67	6.35	14.97	238.85
TAr 18-2	117.59	9.60	10.12	168.46
TAr 18-3	122.23	8.63	7.45	149.21
TAr 18-4	127.17	10.28	11.59	225.71
TAr 18-5	126.25	13.67	9.64	179.56
TAr 18-6	121.22	11.45	8.94	182.44
TAr 18-7	121.47	9.73	10.49	199.65
TAr 18-8	128.03	9.38	15.72	244.67
TAr 18-9	118.59	8.16	9.57	186.32
TAr 18-10	116.52	9.39	10.25	197.11
TAr 18-12	98.08	8.82	6.26	125.47
TAr 18-14	125.14	12.43	12.78	212.59
TAr 18-15	115.97	10.51	11.37	211.74
SED	4.31	0.37	0.53	8.82
CD	9.25	0.80	1.15	18.91

Table 2: Evaluation of elite entries of arrowroot for yield characters

Entries	Length of rhizomes (cm)	Diameter of rhizomes (cm)	Number of rhizome/plant	Biggest rhizome weight (g)	Rhizome yield (t ha^{-1})
TAr 18-1	32.67	1.52	9.25	157.65	17.28
TAr 18-2	14.26	1.76	8.45	125.04	15.47
TAr 18-3	17.28	1.62	6.99	126.99	14.46
TAr 18-4	19.87	2.56	9.17	178.56	17.12
TAr 18-5	28.46	1.89	8.36	138.44	15.38
TAr 18-6	25.44	3.11	7.04	139.17	15.02
TAr 18-7	24.97	2.67	8.65	114.49	16.15
TAr 18-8	31.49	2.98	9.44	171.36	17.45
TAr 18-9	29.46	2.47	7.49	158.45	15.34
TAr 18-10	14.98	2.94	8.56	156.73	16.07
TAr 18-12	15.46	1.79	5.96	91.05	11.31
TAr 18-14	17.19	1.59	9.07	151.96	17.12
TAr 18-15	22.54	1.88	8.73	151.16	16.46
SED	2.24	0.12	0.30	4.95	0.56
CD	4.81	0.26	0.64	10.61	1.20

Conclusion

Arrowroot (*Maranta arundinaceae*), commonly known as 'West Indian Arrowroot' grows to about one-and-a-half-meter height and produces long, fleshy and cylindrical subterranean rhizomes, which taste like, corn when boiled. It is primarily grown for its quality starch, which is valued particularly for infants and invalids. The same plant species will show various morphologies if environmental factors are more dominant in affecting plants than genetic factors and vice versa. In the current study, out of thirteen arrowroot entries evaluated, the significantly highest number of tubers per plant (9.44) and tuber yield (17.45 t/ha) were recorded in TAr 18-8.

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