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Evaluation of greater yam (*Dioscorea alata* L.) genotypes for growth, yield and quality characters under South Gujarat conditions

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Abstract
Field experiment was conducted during 2017-18 and 2018-19 at AICRP on tuber crops project, RHRS farm, ACHF, Navsari Agricultural University, Navsari to determine and evaluate the growth, yield and quality performance of greater yam genotypes under South Gujarat condition. Treatments comprised of 27 different genotypes and the experiment was laid out in randomized complete block design with three replications. The evaluation performance of different genotypes was assessed by analyzing data on vegetative growth, yield and quality. Results demonstrated that there is significant difference on performance of different greater yam genotypes. Based on the mean performance, the genotypes Sree Roopa and NGy-3 found to be elite for days to first sprouting whereas NGy-8 for the length of leaf, IGDa-3 for width of leaf and length of petiole, NGy-7 for vine diameter, NGy-12 for internode length, IGDa-4 for number of branches/vine and dry matter content of tubers, Da-11 for number of tubers/vine, length of tuber and starch, NGy-15 for weight of tuber, NGy-1 for width of tuber, NGy-17 for yield per vine and yield t/ha, NGy-16 for total sugars and NGy-14 for moisture content were found to be elite over the check Sree Karthika among all the 27 genotypes.

Keywords: *Dioscorea alata*, greater yam, genotypes, growth, yield, quality

Introduction
Yams belonging to Dioscoreaceae family are important climate resilient food security crops widely cultivated in India and Africa. In India, one of the major cultivated yam species is greater yam (*Dioscorea alata* L.). It provides a good source of dietary carbohydrates in tropical and subtropical regions. It is commonly known as Ratalu and Ghorkand in south Gujarat. Yam is the common term for a number of species in the genus *Dioscorea.* Yam is considered to be the third most important group of dietary staple for low income consumers. Yams were grown in India since very ancient times and *D. alata* is said to be of Indian Origin (George and Sunitha, 2018) [13]. It is a rich source of carbohydrates, certain vitamins and has high calorific value. Greater yam is a Kharif season crop and grown as rainfed crop. Freshly harvested tubers of Greater yam are consumed as boiled, baked, fried and as a vegetable like potato (Shankar and Singh, 2018) [24]. Yams and aroids are generally cultivated throughout India as vegetable crops in homestead or semi commercial scale covering an area of about 90,000 ha.

In India, greater yam is cultivated in the states of Andhra Pradesh, Kerala, West Bengal, Bihar, Odisha, North Eastern states, Uttar Pradesh, Tamil Nadu, Gujarat and Maharashtra (Chadha, 2002) [10]. In Gujarat, it is cultivated in Valsad, Navsari, Dangs, Panchmahals, Surat and Tapi districts. Yam plant is a vine cultivated for its large and edible underground tubers. Yams are cultivated for consuming by more than 100 million people especially in many developing countries like India (Lebot, 2009) [16]. In south Gujarat, tubers have more demand during festivals and marriage times. So there is a great need to identify superior genotypes for south Gujarat conditions there by it help in double the income of farmers. The development of *Dioscorea alata* accessions with high yield potential, better food quality and resistance to pests and diseases to meet the requirements of farmers would boost its extensive cultivation and significant increases in the production. Therefore, the objective of this study was to evaluate selected improved genotypes for growth, yield, quality and adaptation, with a view to selecting superior ones for introduction into the production system in the study area.

Materials and Methods

The experiment was laid out in randomized complete block design with three replications during 2017-18 and 2018-19. Plant density was arranged by varying row the spacing between plants, 90 x 90 cm, respectively. Twenty seven different greater yam genotypes including check were obtained from All India Co-ordinated Research Project on tuber crops, RHRS farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari. The recommended dosage of N, P and K at 80: 60:80 kg/ha was applied in the form of urea, single super phosphate and muriate of potash respectively, as per the package and practices standardized by CTCRI and all the necessary agronomic/cultural practices was done where necessary and as the crop requirement in uniform manner. Genotypes used for the experiment and their source of collection were presented in Table 1. Five plants were taken at random each in genotype and tagged for recording observations. Observations were recorded as per descriptor guidelines during 2017-18 and 2018-19, respectively and pooled mean was worked out. The quality characters were analysed by the standard methods described by Mc Cready *et al*. (1950) [17] for starch.

The total sugars were analysed by method outlined by Lane and Eyon (AOAC, 1965) [15] with the following formula;

$$\text{Total sugars (\%)} = \frac{\text{Factor (0.052) x Dilution}}{\text{Titre value x Weight of the sample}} \text{ x } 100$$

For recording dry matter content of tubers, after recording the fresh weight of tuber, the tubers were cut into small pieces with the help of stainless steel knife. The tuber samples were air dried and then kept in hot air oven at 60 ± 5ºC temperature for drying till constant weight was obtained and calculated the dry matter content

$$\text{Tuber dry matter (\%)} = \frac{\text{Dry weight}}{\text{Fresh weight}} \text{ x } 100$$

Moisture content of tuber was determined by drying the weighed tuber pieces at 105^0C for five hours and the loss of weight was expressed as moisture content. The total moisture content was calculated based on the following formula;

$$\text{Tuber moisture (\%)} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Fresh weight}} \text{ x } 100$$

Table 1: Source of experimental material

Sr. No.	Name of Genotypes	Place/Source of Collection
1.	NGy-1	Pipalgabhan, Chikhli, Navsari, Gujarat
2.	NGy-2	Pipalgabhan, Chikhli, Navsari, Gujarat
3.	NGy-3	Local Vegetable Market, Navsari, Gujarat
4.	NGy-4	Vasvari, Olpad, Surat, Gujarat
5.	NGy-5	Rumla, Chikhli, Navsari, Gujarat
6.	NGy-6	Kaliyari, Chikhli, Navsari, Gujarat
7.	NGy-7	Ghej, Chikhli, Navsari, Gujarat
8.	NGy-8	Boriyavi, Anand, Gujarat
9.	NGy-9	Rambhas Farm, Waghai, Gujarat
10.	NGy-10	Velvach, Killa-Pardi, Valsad, Gujarat
11.	NGy-11	Navagam, Navsari, Gujarat
12.	NGy-12	Nanidesad, Gandevi, Navsari, Gujarat
13.	NGy-13	Manekpur, Gandevi, Navsari, Gujarat
14.	NGy-14	Antroli, Surat, Gujarat
15.	NGy-15	Bhilod, Valiya, Bharuch, Gujarat
16.	NGy-16	Waghai, Gujarat
17.	NGy-17	Netrang, Kamrej, Surat, Gujarat
18.	IGDa-2	Raipur, Collected from CTCRI, Kerala
19.	IGDa-3	Raipur, Collected from CTCRI, Kerala
20.	IGDa-4	Raipur, Collected from CTCRI, Kerala
21.	Da-11	CTCRI, Thiruvananthapuram, Kerala
22.	Da-25	CTCRI, Thiruvananthapuram, Kerala
23.	Sree Roopa	CTCRI, Thiruvananthapuram, Kerala
24.	TRC	Port Blair, Collected from CTCRI, Kerala
25.	Sree Kirthi	CTCRI, Thiruvananthapuram, Kerala
26.	Konkan Ghorkand	Dapoli, Collected from CTCRI, Kerala
27.	Sree Karthika (Check)	CTCRI, Thiruvananthapuram, Kerala

Results and Discussion

Growth characters

The pooled data of two years on growth performance of the *Diascorea alata* genotypes are furnished in Table 2.

Days to first sprouting

Among all genotypes, Sree Roopa was recorded minimum number of days (9.67 days) to sprout which, was at par with Sree Karthika, TRC, NGy-17, NGy-4, NGy-16, Konkan Ghorkand, IGDa-2, IGDa-3 and Da-25. The genotype NGy-7 had taken maximum number of days (16.50 days) to sprout.

Length of leaf (cm)

NGy-8 recorded the maximum length of leaf (15.63 cm) and it was at par with the genotypes, NGy-10, Da-11, NGy-3, NGy-4, Da-25, NGy-17, NGy-16, IGDa-2, IGDa-3, NGy-7, NGy-6, NGy-5, NGy-12, NGy-13, NGy-2, Sree Karthika, NGy-14, NGy-1, IGDa-4, Sree Kirthi and NGy-9. The minimum length of leaf (11.37 cm) was recorded in the genotype Konkan Ghorkand. Similar trend has been reported by Adeigbe *et al*. (2015) [1] in *Dioscorea dumetorum.*

Width of leaf (cm)
The genotype IGDa-3 recorded the highest width of leaf (12.43 cm) and significantly superior over the check. The genotypes IGDa-2 and NGy-16 were at par with it. The minimum width of leaf (8.00 cm) was recorded in Sree Kirthi.

Length of petiole (cm)
Genotype IGDa-3 recorded highest length of petiole (12.73 cm) and it was found to be significantly superior over the check, which was statistically at par with the genotypes NGy-16, IGDa-2, NGy-17, Da-25 and Da-11. The minimum length of petiole (8.67 cm) was recorded in genotype Konkan Ghorkand.

Vine diameter (cm)
Higher vine diameter (6.13 cm) was observed under the genotype of NGy-7 and it was superior over the check, it was near to genotypes NGy-12, NGy-9 and NGy-8. Genotype Da-11 recorded the minimum vine diameter (4.17 cm). Similar kind of variations in stem diameter was reported by Mulualem and Ayenew (2012) [19] in cassava.

Internode length (cm)
The maximum internode length was recorded (18.02 cm) in genotype NGy-12 and it significantly superior over check, it was at par with the genotypes NGy-4, Konkan Ghorkand, NGy-6, NGy-8, NGy-9, IGDa-3, NGy-7, NGy-1 and NGy-10. Genotype Da-11 was recorded the lowest internode length *i.e.* 13.14 cm. The above results are in conformity with the results obtained by Sheela *et al.* (2016) [25] in greater yam.

Number of branches/vine
The genotype IGDa-4 recorded maximum number of branches/vine (5.27) and was at par with NGy-14, NGy-12, Sree Kirthi, NGy-8, IGDa-3, Sree Karthika, Da-11 and Da-25. The genotype NGy-2 recorded lowest number of branches/vine (3.40). Bassey and Akpan (2015) observed significant variation for number of branches per vine.

Table 2: Pooled mean performance of greater yam genotypes for growth characters under study

Genotypes	Days to first sprouting	Length of leaf (cm)	Width of leaf (cm)	Length of petiole (cm)	Vine diameter (cm)	Internode length (cm)	Number of branches/vine
NGy-1	12.17	14.29	9.63	10.37	4.80	16.22	4.00
NGy-2	11.33	14.73	9.30	10.23	5.44	14.99	3.40
NGy-3	14.17	15.47	9.23	9.53	4.47	15.36	3.66
NGy-4	10.67	15.47	10.17	10.47	5.33	17.94	4.17
NGy-5	15.00	14.90	9.34	10.31	5.24	15.67	3.72
NGy-6	11.50	15.10	10.07	10.23	4.79	17.20	3.55
NGy-7	16.50	15.17	10.03	10.60	6.13	16.67	3.96
NGy-8	12.83	15.63	9.40	10.33	5.64	16.95	4.92
NGy-9	11.67	13.74	9.05	9.73	5.65	16.95	4.32
NGy-10	13.50	15.60	9.53	10.47	5.21	16.15	3.81
NGy-11	15.17	13.50	8.50	9.20	4.83	14.70	3.67
NGy-12	15.33	14.87	9.93	11.57	5.69	18.02	5.12
NGy-13	11.83	14.80	9.47	10.30	4.77	16.12	4.63
NGy-14	15.50	14.47	9.97	11.47	5.55	16.07	5.22
NGy-15	11.83	13.19	8.24	8.97	4.62	14.19	4.23
NGy-16	10.67	15.25	11.73	12.43	4.71	16.01	4.25
NGy-17	10.00	15.40	11.12	12.17	4.72	16.56	4.42
IGDa-2	11.00	15.25	11.82	12.38	4.33	15.03	4.46
IGDa-3	11.00	15.23	12.43	12.73	4.76	16.79	4.86
IGDa-4	11.83	13.92	8.83	10.23	4.99	15.26	5.27
Da-11	13.67	15.57	11.02	12.02	4.17	13.14	4.77
Da-25	11.00	15.43	10.63	12.03	4.83	15.95	4.76
Sree Roopa	9.67	13.11	9.36	10.23	4.55	14.98	4.36
TRC	10.00	12.37	9.37	9.30	4.26	14.70	4.46
Sree Kirthi	13.33	13.84	8.00	9.63	4.92	14.54	4.97
Konkan Ghorkand	10.83	11.37	9.65	8.67	4.58	17.46	4.25
Sree Karthika (Check)	9.83	14.69	9.82	10.20	4.46	15.75	4.86
S.Em (±)	0.55	0.56	0.38	0.39	0.19	0.65	0.26
C.D. (0.05)	1.55	1.58	1.07	1.10	0.52	1.82	0.73
C.V. (%)	11.00	9.47	9.52	9.06	9.24	10.02	14.50

Yield Characters
The data on yield characters were collected in 2017-18 and 2018-19 and pooled mean was worked out and are furnished in Table 3.

Number of tubers/vine
The highest number of tubers/plant (2.23) was recorded in genotypes of NGy-4 and Da-11 and they were significantly superior over the check, and it was at par with Da-25 and NGy-16. The minimum number of tubers/plant (1.11) was recorded in genotype Konkan Ghorkand. Significant similar variations for number of tubers/plant were reported by Mulualem and Ayenew (2012) [19], Adeigbe *et al.* (2015) [1], Bassey and Akpan (2015) [6] and Panja *et al.* (2016) [21].

Weight of tuber (g)
The maximum weight of tuber (1260.81 g) was obtained from the NGy-15 and it was statistically at par with Da-25, NGy-17, IGDa-2, IGDa-3 and NGy-7, these genotypes are significantly superior over the check Sree Karthika. The minimum weight of tuber 591.14 g was noticed from the Konkan Ghorkand. Similar results were reported by Adeigbe *et al.* (2015) [1], Bassey and Akpan (2015) [6] and Panja *et al.* (2016) [21].

Length of tuber (cm)

Genotype Da-11 recorded the maximum tuber length (47.04 cm) and it was at par with genotypes IGDa-3 and Da-25 only; whereas, the minimum tuber length (17.59 cm) was recorded with the genotype NGy-5 these are superior over the check. Similar results were reported by Bassey and Akpan (2015) [6], Panja *et al.* (2016) [21], Nageswari and Palaniswamy (2011) [20], Pushpalata *et al.* (2011) [22] and Adeigbe *et al.* (2015) [1].

Width of tuber (cm)

The maximum width of tuber (49.77 cm) was obtained from the plants of genotype NGy-1 and was statistically at par with the genotypes NGy-5 and NGy-10 only. The minimum width of tuber 22.37 cm was recorded in the genotype IGDa-4. The above results are in conformity with the results obtained by Sheela *et al*. (2016) [25], Pushpalata *et al.* (2011) [22], Adeigbe *et al.* (2015) [1] and Panja *et al.* (2016) [21].

Tuber yield/vine (kg)

The results showed that genotype NGy-17, recorded the maximum tuber yield/plant (1.848 kg) and it was superior genotype over rest of the genotypes, while the lowest tuber yield/plant (0.699 kg) was recorded in Konkan Ghorkand genotype. The above results are in conformity with the results obtained by Panja *et al.* (2016) [21].

Tuber yield (t/ha)

The maximum tuber yield (21.13 t/ha) was noticed under the genotype of NGy-17, which was found to be superior over other genotypes. However, the genotype Konkan Ghorkand observed the minimum tuber yield (7.01 t/ha).

Similar results were reported by Allolli *et al.* (2012[b]) [2], Desai *et al.* (2013) [12], Mhaskar *et al.* (2013) [18], Allolli *et al.* (2012[a]) [3], Bassey and Akpan (2015) [6]. The variation in different parameters among the genotypes may be due to genetic potentiality and adaptability (Bhuiyan and Ahmed, 2001) [9]. The variation in the yield parameters may be due to the potential of the genotypes to express differently due to variation in soil and climatic conditions of the area of collection (Chongtham *et al.,* 2013) [11], apart from the genetic variation.

Table 3: Pooled mean performance of greater yam genotypes for yield characters under study

Genotypes	Number of tubers/vine	Weight of tuber (g)	Length of tuber (cm)	Width of tuber (cm)	Tuber yield/vine (kg)	Tuber yield (t/ha)
NGy-1	1.46	949.05	19.00	49.77	1.228	18.39
NGy-2	1.67	750.57	33.78	27.87	0.951	11.68
NGy-3	1.38	676.05	28.73	25.40	0.898	11.02
NGy-4	2.23	952.43	35.94	27.97	1.251	15.89
NGy-5	1.63	931.78	17.59	48.30	1.207	16.59
NGy-6	1.70	1045.76	35.78	29.30	1.429	17.89
NGy-7	1.44	1125.91	34.79	28.56	1.311	18.71
NGy-8	1.71	931.80	33.93	27.92	0.949	17.24
NGy-9	1.40	1056.39	18.00	44.51	1.226	10.96
NGy-10	1.19	945.50	17.79	47.00	0.911	10.51
NGy-11	1.53	903.99	20.45	39.47	1.201	8.95
NGy-12	1.38	1017.05	38.16	30.78	1.311	17.48
NGy-13	1.52	915.98	32.69	25.57	0.999	12.41
NGy-14	1.61	957.64	36.24	28.50	1.150	16.31
NGy-15	1.50	1260.81	37.91	29.78	1.292	18.25
NGy-16	2.03	1091.85	37.19	28.84	1.608	17.95
NGy-17	1.55	1156.20	40.93	30.87	1.848	21.13
IGDa-2	1.72	1139.97	38.97	29.17	1.639	18.23
IGDa-3	1.71	1160.14	43.92	30.00	1.545	17.33
IGDa-4	1.46	833.81	37.78	22.37	1.218	13.82
Da-11	2.23	1064.14	47.04	31.89	1.655	17.36
Da-25	2.12	1150.41	42.41	27.57	1.629	17.06
Sree Roopa	1.46	991.93	36.86	27.97	1.454	15.61
TRC	1.59	818.38	37.64	26.18	0.961	12.73
Sree Kirthi	1.76	727.35	35.33	27.56	0.832	10.38
Konkan Ghorkand	1.11	591.14	18.83	25.23	0.699	7.01
Sree Karthika (Check)	1.55	1009.15	30.86	41.55	1.036	14.07
S.Em (±)	0.08	49.48	2.07	1.72	0.066	1.55
C.D. (0.05)	0.23	138.77	5.79	4.83	0.185	4.35
C.V. (%)	12.34	12.51	15.38	13.26	13.02	12.66

Quality characters

The pooled mean data pertaining to different quality characters are furnished in Table 4.

Starch (%)

The highest starch content (28.34%) was observed in the genotype Da-11 and statistically it was at par with NGy-4, IGDa-2 and IGDa-4, these are significantly superior over the check. The Genotype Sree Kirthi was recorded the lowest starch content 19.04%. Baah *et al.* (2009) [5], Behera *et al.* (2009) [7], Pushpalata *et al.* (2011) [22], Jyothi (2016) [14] and Anwar (2016) [4] observed significant variation for starch.

Total sugars (%)

The genotype NGy-16 has recorded highest total sugars (3.19%) and which showed significantly superior with other genotypes. Here also the genotype NGy-4 has been recorded lowest total sugars (0.94%). Similar trends were reported by Reddy *et al.* (2017) [23], Jyothi (2016) [14], Anwar (2016) [4] and Baah *et al.* (2009) [5].

Dry matter content of tubers (%)

Out rightly the maximum dry matter content (33.53%) was observed in the genotype IGDa-4 and which was at par with NGy-6, NGy-16, NGy-10, IGDa-3 and NGy-3, they found to be significantly superior over the check. The lowest dry matter content (25.38%) was recorded in the genotype NGy-14. These results are in conformity with the findings of Baah *et al.* (2009) [5] and Behera *et al.* (2009) [7], Singh *et al.* (2014) [26], Reddy *et al.* (2017) [23] and Jyothi (2016) [14].

Moisture content of tubers (%)

The maximum moisture content of tuber (74.62%) was observed in the NGy-14 and it was remained at par with NGy-1, NGy-2, NGy-4, NGy-11, NGy-12, NGy-13 and Sree Karthika. On the other hand the lowest moisture content (66.47%) was recorded in the genotype IGDa-4. Similar results were reported by Baah *et al.* (2009) [5].

Table 4: Pooled mean performance of greater yam genotypes for biochemical characters under study

Genotypes	Starch (%)	Total sugars (%)	Dry matter content of tubers (%)	Moisture content of tubers (%)
NGy-1	23.21	2.32	26.99	73.01
NGy-2	25.15	1.95	26.15	73.85
NGy-3	24.44	2.10	31.92	68.08
NGy-4	26.13	0.94	27.07	72.93
NGy-5	24.97	2.04	29.08	70.92
NGy-6	23.00	1.29	33.19	66.81
NGy-7	25.10	1.41	29.84	70.16
NGy-8	24.89	1.73	30.40	69.60
NGy-9	23.31	1.21	29.11	70.89
NGy-10	24.07	1.14	32.20	67.80
NGy-11	25.12	2.87	27.80	72.20
NGy-12	25.02	1.62	26.79	73.21
NGy-13	24.03	1.73	28.13	71.87
NGy-14	25.30	1.29	25.38	74.62
NGy-15	25.02	2.86	31.02	68.98
NGy-16	24.85	3.19	32.73	67.27
NGy-17	25.13	1.50	30.23	69.77
IGDa-2	25.94	1.63	28.75	71.25
IGDa-3	24.11	1.80	32.20	67.80
IGDa-4	25.98	1.87	33.53	66.47
Da-11	28.34	1.71	28.50	71.50
Da-25	21.04	2.45	29.00	71.00
Sree Roopa	19.23	1.93	30.31	69.69
TRC	22.88	2.32	30.40	69.60
Sree Kirthi	19.04	2.06	30.59	69.42
Konkan Ghorkand	22.40	1.78	30.28	69.73
Sree Karthika (Check)	25.32	2.23	27.88	72.12
S.Em (±)	0.90	0.07	1.69	2.10
C.D. (0.05)	2.51	0.20	4.74	5.90
C.V. (%)	9.08	9.40	7.00	3.66

Components of variation estimated for growth, yield and quality traits based on pooled data indicated wide range of variability in days to first sprouting (9.67 to 16.50 days), length of leaf (11.37 to 15.63 cm), width of leaf (8.00 to 12.43 cm), length of petiole (8.67 to 12.73 cm), vine diameter (4.17 to 6.13 cm), internode length (13.14 to 18.02 cm), number of branches per vine (3.40 to 5.27), number of tubers per vine (1.11 to 2.23), weight of tuber (591.14 to 1260.81 g), length of tuber (17.59 to 47.04 cm), width of tuber (22.37 to 49.77 cm), tuber yield per plant (0.699 to 1.848 kg), tuber yield tonne per hectare (7.01 to 21.13 t/ha), starch (19.04 to 28.34%), total sugars (0.94 to 3.19%), dry matter content of tubers (25.38 to 33.53%) and moisture content of tubers (66.47 to 74.62%). A wide range of variations existing for various quantitative traits has also been reported in greater yam by various workers (Baah *et al*., 2009 [5]; Behera *et al*., 2009 [7]; Beyene, 2016 [8]; Jyothi, 2016 [14]; Sheela *et al*., 2016) [25]; in *D. dumentorum* (Adeigbe *et al*., 2015) [1]; (Bassey and Akpan, 2015) [6] in Guinea white yam and Anwar (2016) [4] in wild yams. The studies suggest that it can possible to isolate superior genotypes during the selection process.

Conclusion

Based on the experimental findings it can be concluded that among the greater yam genotypes having higher amount of biochemical compounds could be promoted for commercial cultivation to ameliorate various health problems, for food and nutritional security in India. Considering the yield potential (>18 tonne tuber yield per hectare over the check Sree Karthika) the genotypes namely NGy-1, NGy-7, NGy-15, NGy-16, NGy-17 and IGDa-2 can be promoted for commercial cultivation under south Gujarat condition.

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