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Productivity Co-efficient of Tuber Yield and Dry Matter Percentage in the Tubers of Different Collections of Greater Yam (*D. alata* L.) Found in Orissa

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Abstract: A study was under taken to quantify the productivity co-efficient of tuber yield and estimate the dry matter percentage in different collections of *D. alata* from C1 to C22. The productive co-efficient was the highest in intermediate group (454) followed by pyramidal (401) and the lowest was in cylindrical group (378) whereas in colour group the productive co-efficient was 355, 456, 489 and 427,respectively for white, cream, yellowish pink and violet coloured tuber. The dry matter was the highest in the tubers of C-18 (33.33%) followed by C-13 (32.75) and significant difference was observed in these two cultivars. The lowest dry matter content however was observed in C-3 (24.91%) which was significantly the lowest as compared to the rest of the collection. The mean value was 29.19, 30.43 and 28.09%,respectively in pyramidal, intermediate and cylindrical type and 29.70, 28.56, 30.47 and 26.81%, respectively in White, Cream, Yellowish pink and Violet flesh colour group.

Key words: Greater Yam % Dry matter % Productive potential % Stacking % Different collection

INTRODUCTION

Root and tuber crops are the most important food crops after cereals. They have the highest rate of dry matter production per day and are major calorie contributors. Tuber crops not only enrich the diet of the people but also possess medicinal properties to cure many ailments or check their incidence [1]. Many tropical tuber crops are used in the preparation of stimulants, tonics, carminatives and expectorants. India holds a rich genetic diversity of tropical root and tuber crops viz. Cassava, Sweet potato, Aroids, Yams and several minor tuber crops. The Indo-Burma region is the centre of origin of taro and Asiatic edible yams. The two hot spots of global biodiversity viz. North Eastern Himalayas and Western Ghats are particularly rich in wild relatives of tropical root and tuber crops [2]. Root crops occupy nearly 50 million hectares of arable land and account for a global production of 560 million tones. Nigeria alone accounts for 70% of the total yam production. In terms of the productivity and gross return, yam ranks second among all the root and grain producing food crops [3]. It also ranks second in dry matter and energy production per hectare [4,5].

Yams belong to the genus *Dioscorea* of family *Dioscoreaceae*,an important members of the oldest monocot. More than 600 species have been reported under this genus [6].Out of so many species of *Dioscorea* only ten species have been domesticated and commercially cultivated. In India so far 26 species of *Dioscorea* have been reported [7]. Among the *Dioscoreas D. alata* is the leading species grown globally as well as all over the state of Orissa. It is highly polymorphic in relation to shape and colour of the tuber. Basing on the shape of the tuber and colour of the cortex or flesh, some selections were made from the collections of *D. alata* on different parts of the state.Out of the collections only 22 cultivars were included in the present study.Detail information of these 22 cultivars of *D. alata* are presented in Table 3 [8].

MATERIALS AND METHODS

Highly polymorphic *D. alata* were collected from different parts of Orissa during the year 2004-05 and 2005-06. Basing on the shape of the tuber and colour of the cortex or flesh, some selections were made.Out of the collections only 22 cultivars were included in the present study. All the 22 collections were grouped under three shape types namely (1) Pyramidal (2) Cylindrical (3)Intermediate (those in between pyramidal and cylindrical types) and four flesh colours namely (1) White,

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Table 1: *D. alata* collections based on shape of the tuber

Sl. No	Shape of tuber	Total collection	Code number of different *D. alata* collections
1	Pyramidal shape	9	C1, C7, C18, C19, C11, C12, C13, C3, C20
2	Intermediate shape	5	C5, C6, C2, C15, C21
3	Cylindrical shape	8	C4, C14, C8, C16, C17,C 9, C10, C22

Table 2: *D.alata* collections based on colour of the tuber

Sl.No	Colour of flesh	Total collection	Code number of different *D. alata* collections
1	White	11	C1, C7, C18, C19, C5, C6, C4, C14, C8, C16, C17.
2	Cream	4	C11, C2, C9, C10
3	Yellowish pink	3	C12, C13, C15.
4	Violet or pink	4	C3, C20, C21, C22

Table 3: General Information on different cultivars of *D. alata* L.used in this investigation

Collection No.	Locality	Local name	Skin colour	Peel colour	Flesh colour	Consistency	Flavour
Pyramidal							
C-1	Bhanjanagar	Kala Hatikhoja	Black	White	Chalky white	Grainy	Sweet
C-7	Nayagarh	Dhala Hatikhoja	Light black	White	Chalky white	Grainy	Sweet
C-18	Panikoili	Hatikhoja	Dull white	Cream	White	Less grainy	Mild
C-19	Baghamari	Hatikhoja	Dark brown	Cream white	White	Less grainy	Mild
C-11	Hinjilikatu	Hatikhoja	Dull brown	Yellowish	Cream	Fleshy	Poor
C-12	Keonjhar	Hatikhoja	Light brown	Yellowish pink	Yellowish pink	Fleshy	Poor
C-13	Balasore	Hatikhoja	Light brown	Yellowish	Yellowish pink	Less grainy	Sweet
C-3	Chhatrapur	Nail Hatikhoja	Redish brown	Deep pink	Violet	Grainy	Mild
C-20	Dhenkanal	Dantla Hatikhoja	Redish brown	Pink	Violet	Grainy	Mild
Intermediate							
C-5	Pottangi	-	Light brown	Cream white	White	Grainy	Mild
C-6	G.Uddaigiri	-	Dark brown	Yellowish white	White	Fleshy	Mild
C-2	Bhawaiptna	-	Whitish brown	Yellowish white	Cream	Fleshy	Mild
C-15	Nilgiri	-	Dull brown	Pinkish white	Yellowish pink	Fleshy	Mild
C-21	Koraput	-	Black	Pink	Violet	Grainy	Sweet
Cylindrical							
C-4	Khurda	-	Whitish brown	Whitish pink	Chalky white	Grainy	Sweet
C-14	Dasapalla	-	Dull white	White	Chalky white	Grainy	Sweet
C-8	Publbani	-	Deep brown	Yellowish white	White	Fleshy	Mild
C-16	Rayagada	-	Dull brown	White	White	Mild grainy	Sweet
C-17	Hindil	-	Whitish brown	Yellowish white	White	Grainy	Sweet
C-9	Muniguda	-	Dull white	Yellowish white	Cream	Grainy	Sweet
C-10	Pipli	-	Dark brown	Yellowish pink	Cream	Mild grainy	Sweet
C-22	Belghar	-	Black	Black	Violet	Grainy	Sweet

(- Stands for no specific local names)

(2) Cream, (3) Yellowish pink (4) Violet. Detail information of these 22 cultivars of *D. alata* are presented in Table 1 and 2.

These 22 collections (C1-C22) were grown in the experimental garden, P.G.Deptt. of Botany Utkal university as per the standard agronomic practices with stacking and non stacking system and harvesting of the tuber was done after all the vines dried and it was done around 300 days after planting. There were three replications and in each replication 22 treatments were randomly distributed. In each treatment 16 plants were grown besides border rows. Observations were recorded in four randomly selected plants [9-11].

Dry Matter: Dry matter in tuber was calculated by taking 100 gms of freshly harvested tuber from a representative sample of tuber and drying the sample at 40^0C till a constant weight was obtained and the value was expressed in percentage [12-14].

Yield/plant: Immediately after harvest the tubers from observation plants were cleaned of soils adhered to it and weighed. Mean was taken for tabulation of data.

Yield/plot: The total yield per plot was calculated by adding the yield of 16 plants including the observation plants

Table 4: Yield of tuber per plant and plot (4 m x 4 m) in different collections of *Dioscorea alata* L.

	Yield /plant(Kg)			Yield /plot(Kg)		
Collection	I	II	Pooled	I	II	Pooled
C-1	2.79	2.20	2.49	43.83	34.96	39.39
C-7	2.30	1.85	2.07	38.33	28.93	33.63
C-18	3.30	2.23	2.22	36.16	36.58	36.37
C-19	1.88	1.87	1.87	30.83	30.26	30.54
C-11	2.31	2.20	2.25	38.16	34.53	36.34
C-12	2.51	2.23	2.37	41.66	35.60	38.63
C-13	1.88	1.74	1.81	29.83	51.00	40.41
C-3	3.26	2.99	3.12	53.00	48.93	50.96
C-20	1.53	1.47	1.50	24.83	25.00	24.91
Intermediate						
C-5	3.43	3.11	3.27	55.10	51.00	53.05
C-6	2.83	2.49	2.66	46.33	40.00	43.16
C-2	2.57	2.38	2.48	42.00	37.96	39.98
C-15	1.43	1.57	1.50	25.50	27.26	26.38
C-21	1.43	1.37	1.40	23.66	35.16	29.41
Cylindrical						
C-4	2.00	2.01	2.00	34.33	25.56	29.94
C-14	2.40	2.24	2.32	23.66	22.43	23.04
C-8	3.10	2.83	2.96	51.00	45.43	48.26
C-16	2.83	2.70	2.76	47.00	42.83	44.91
C-17	2.56	2.44	2.50	42.50	41.66	42.08
C-9	1.63	1.54	1.58	27.16	24.83	25.99
C-10	2.26	1.13	2.19	37.00	34.70	35.85
C-22	1.72	1.75	1.73	26.66	27.33	26.99
F test	Sig. **	Sig. **	-	Sig.**	Sig.**	-
S.E.(m) +	0.114	0.113	-	1.86	1.30	-
C.D. (0.05)	0.230	0.229	-	3.57	3.17	-

Table 5: Yield in Kg/plant, t/ha, productivity coefficient and shortfall under no staking system in different collections of *Dioscorea alata* L.

	Yield/plant(Kg)					
Collection	I	II	Pooled	Yield t/ha	Productive coefficient	Shortfall from staked crop
Pyramidal						
C-1	0.308	0.225	0.266	2.660	343.33	3660.25
C-7	0.250	0.266	0.258	2.580	330.00	3073.00
C-18	0.233	0.235	0.234	2.340	290.00	3398.50
C-19	0.233	0.226	0.229	2.290	281.66	2800.00
C-11	0.325	0.341	0.333	3.220	455.00	3230.83
C-12	0.366	0.366	0.366	3.660	510.00	3413.83
C-13	0.325	0.333	0.329	3.290	448.33	3661.50
C-3	0.415	0.375	0.395	3.950	558.33	4650.50
C-20	0.306	0.291	0.298	2.980	396.66	2098.50
Intermediate						
C-5	0.375	0.358	0.366	3.660	510.00	4916.00
C-6	0.325	0.275	0.300	3.000	400.00	3996.33
C-2	0.375	0.391	0.383	3.830	538.33	3526.17
C-15	0.391	0.341	0.366	3.660	510.00	2137.83
C-21	0.241	0.258	0.249	2.490	315.00	2648.50
Cylindrical						
C-4	0.216	0.220	0.218	2.180	263.33	2755.83
C-14	0.258	0.236	0.247	2.470	311.66	1988.34
C-8	0.416	0.391	0.403	4.030	572.66	4355.84
C-16	0.250	0.261	0.255	2.550	325.00	4253.50
C-17	0.235	0.225	0.230	2.300	283.33	3999.83
C-9	0.291	0.308	0.299	2.990	398.33	2209.33
C-10	0.325	0.316	0.320	3.200	433.33	3201.00
C-22	0.291	0.358	0.324	3.240	440.00	2271.83
F test	Sig.**	Sig.**	-	-	-	-
S.E.(m) +	23.33	25.48	-	-	-	-
C.D. (0.05)	41.18	51.42	-	-	-	-

Table 6: Drymatter content (%) in different collections of *D. alata* L.

Collection	Dry matter content in tuber (%)		
Pyramidal	I	II	Pooled
C-1	32.48 (28.83)	31.82 (27.80)	32.15 (28.31)
C-7	34.03 (31.33)	34.30 (31.76)	34.17 (31.54)
C-18	35.71 (34.06)	34.00 (32.60)	35.26 (33.33)
C-19	31.04 (26.60)	30.70 (26.08)	30.82 (26.34)
C-11	32.43 (28.76)	32.26 (28.50)	32.35 (28.63)
C-12	31.94 (28.00)	32.47 (28.83)	32.21 (28.41)
C-13	34.69 (32.41)	35.12 (33.10)	34.90 (32.75)
C-3	29.66 (24.5)	30.22 (25.33)	29.94 (24.91)
C-20	32.24 (28.66)	32.22 (28.43)	32.23 (28.54)
Intermediate			
C-5	33.82 (31.00)	34.03 (32.41)	33.92 (31.71)
C-6	34.69 (32.33)	34.75 (32.50)	34.67 (32.41)
C-2	33.67 (30.73)	33.56 (30.58)	33.61 (30.65)
C-15	33.33 (20.20)	33.62 (30.33)	33.47 (30.26)
C-21	31.52 (27.33)	31.30 (27.00)	31.41 (27.16)
Cylindrical			
C-4	32.41 (28.75)	32.37 (28.66)	32.39 (28.70)
C-14	32.62 (29.08)	32.58 (29.00)	32.60 (29.04)
C-8	32.41 (28.73)	32.26 (28.50)	32.34 (28.61)
C-16	31.73 (27.66)	32.16 (28.33)	31.94 (27.99)
C-17	32.79 (29.33)	32.15 (28.33)	32.47 (28.80)
C-9	31.16 (26.76)	31.09 (26.66)	31.12 (26.71)
C-10	31.89 (26.16)	33.43 (30.38)	32.66 (28.27)
C-22	31.11 (26.70)	31.17 (26.58)	31.14 (26.64)
'F' test	Sig.**	Sig.**	Sig.**
S.E (m) +	0.485	0.413	0.326
C.D (0.05)	0.980	0.835	0.640

N.B.: Data in parenthesis are actual value and analyzed data are angular value

Yield t/ha: Yield in tones per hectare was calculated on the basis of plot yield.

Productive Coefficient: Productive coefficient was calculated using the formula developed by Oyolu [15].

$$\frac{\text{Gross yield} - \text{Seedrate}}{\text{Seed rate}} \times \frac{100}{1}$$

Yield/Non-staked Plant: In a similar environment and horticultural practice very close to the main plot, 2 lines of 5 plant each of collections/species were grown without staking and the tubers were harvested at the same harvesting date when the experimental plot was harvested and data recorded for yield under no staking.

RESULTS AND DISCUSSION

Yield t/ha: More than 30 tons yield of tubers was obtained with C-3, C-5 and C-8 whereas, per hectare yield of above twenty tons was obtained with eleven collections. Out of nine collects under pyramidal group seven collections yielded more than 20 tons. Three out of five cultivars in intermediate group yielded more than 20 tons of tuber and only four out of eight types in cylindrical group yielded more than 20 tons of tuber per hectare. The average yield figure for colour groups were 24.10, 21.58, 21.95 and 20.66 tone of tuber produced per hectare, respectively in White, Cream, Yellowish pink and violet group [16].

Productive Potential: The productive co-efficient was more than 2000 in all cases and the highest was observed with C-5 (5426) followed by C-3 (5208) and C-14 (2300) had the lowest productive co-efficient. The productive co-efficient was 3371, 3444 and 3128, respectively in pyramidal, intermediate and cylindrical types whereas, the value was 3563, 3041, 3070 and 2916, respectively in White, Cream, Yellowish pink and Violet groups [17]

Yield under No Staking: Significant difference was observed for yield under no staking system among different collections. The yield was 2.290 to 3.950 t/ha in pyramidal group, 2.490-3.830 t/ha in intermediate group and 2.180-4.030 t/ha in cylindrical group. The highest yield was obtained in C-3 (3.95 t/ha) followed by C-12 (3.66 t/ha) and C-5 (3.66 t/ha). Average yield for pyramidal, intermediate and cylindrical groups was 3.0, 3.32 and 2.87 tone per hectare, respectively [18, 19]. On the other hand the average yield was, respectively 2.73, 3.33, 3.53 and

3.16 tone per hectare in white, cream and yellowish pink and violet group. Although the yield/plant was very little and it was highest in C-3 (0.395 Kg) and lowest in C-4 (0.218 Kg).

Productive Potential (No Staking): Productive co-efficient was below 600 under no staking system against more than 2000 under staking system. The highest productive co-efficient was observed in C-3 (558.33) and C-4 (263.33) had lowest value. The highest short fall in C-5 (4916.0), whereas the lowest short fall was observed in C-14 (1988). The productive co-efficient was the highest in intermediate group (454) followed by pyramidal (401) and the lowest was in cylindrical group (378) whereas in colour group the productive co-efficient was 355, 456, 489 and 427, respectively for white, cream, yellowish pink and violet coloured tuber [20,21].

Dry Matter in Tuber: Significant difference was observed for the dry matter content in tubers of different collections of *D. alata* in both the years of observations and also in the pooled analysis presented here. The dry matter was the highest in the tubers of C-18 (33.33%) followed by C-13 (32.75) and significant difference was observed in these two cultivars. The lowest dry matter content however was observed in C-3 (24.91%) which was significantly the lowest as compared to the rest of the collection. The mean value was 29.19, 30.43 and 28.09%, respectively in pyramidal, intermediate and cylindrical type and 29.70, 28.56, 30.47 and 26.81%, respectively in White, Cream, Yellowish pink and Violet flesh colour group[22].

CONCLUSION

The highest yield per plant was recorded in C-5 (3.27 Kg) followed by C-3 (3.12 Kg). Those yielded 2 Kg above are C-1, C-18, C-11, C-12, C-6, C-2, C-4, C-14, C-8, C-16, C-17 and C-10. Collections either cylindrical in shape or having white flesh are high yielder. Similar result was observed for plot yield. Besides environment, the yield is dependant on size of planting material, portion from which the planting material collected nutritional management, staking etc. as reported by Alvarez and Hahn [23]; Ferguson *et al.*. [13]. Cylindrical white flesh cultivars are tastier. Considering this, high yielders from this group were selected by early man and continued to grow by vegetative method. C-3, C-5 and C-8 yielded more than 30 t/ha tuber. They respectively belong to pyramidal, intermediate and cylindrical shape groups. Out of them, C-5 and C-8 belong to White colour group and C-3 is from Pink group. The present study concludes that yield is contributed by several traits but not by the shape or colour of tuber. It is a fact that early selection was based on better yielding cultivars with white flesh. Sivan [24] believed agro-climatic conditions play the important role in yam production. Abruna *et al.* [25] stated that closer spacing gives higher yield. Lyonga and Ayuktaken [26] reported planting on ridges and 100 gm planting material from top yielded highest. Ramirez and Rodriguez [27] reported that seal top cultivars are high yielders (40.17 t/ha). The present finding holds good as C-3, C-5 and C-8 are seal top cultivars. However, Martin [28] reported that a *D.alata* cultivar should produce more than 20 t/ha yield. Degras [29] strongly advocated mutational and intraclonal variation forms play important role for development of good yielders [10,30].

Short supply of staking material poses a major constraint in yam production. Higher stakes are used to produce ceremonial yams of larger size [31]. In forest area, 60 man days may be required to collect staking material for one hectare. It may be very high in plains. Therefore, research is being done to develop yams requiring modest or no staking. All collections were evaluated under without staking. C-3 and C-8 with higher productive potential performed better without staking. But the productivity potential was greatly reduced as compared to staked crop. The same was 558.33 and 571.0,respectively in C-3 and C-8 against more than 5000 in staked crop. Collections loaded with high anthocyanin pigments produce stronger sprouts and performed better under without staking. Growing yam with live stakes has been reported by Coursey [6]

D. alata cultivars are used as staple food in many communities of tropical world. As per Egbe *et al.* [8] *D. alata* cultivars in average contain 24.47% dry matter and 72.6% starch, 8.24% protein and 0.24% fat in dry matter. In the present study C-18 had the highest dry matter (33.33%) and the lowest was in C-3 (24.91%). Average dry matter was the highest in intermediate shape and collections with white flesh. It is concluded that collections vary greatly for the dry matter and starch content [33,34].

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