



E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(4): 1287-1290
Received: 04-05-2017
Accepted: 05-06-2017

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Study on genetic variability, heritability and genetic advance in tapioca (*Manihot esculenta* L.) under Allahabad Agro -Climatic conditions

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Abstract

The present investigation was carried out to study the genetic variability, heritability and Correlation for 15 traits in Tapioca. The experimental material comprised of 15 genotypes of Tapioca (*Manihot esculenta* L.) Wider variability was observed for Plant Height (cm), Number of Leaves per plant, Number of Branches per plant, Number of tubers per plant(kg), Tuber yield per plant (kg),Tuber yield per plot (kg), Tuber yield per hectare (tones), Tuber diameter(cm),Tuber Length(cm),Stem diameter (cm). All these characters also recorded high Genetic variability heritability and Correlation. Hence selection will be effective for these traits.

Keywords: Genetic Variability, heritability and genetic advance

Introduction

Tapioca (*Manihot esculenta* Crantz) is from the family *Euphorbeaceae*. It is among the most important root crops worldwide and provides food for one billion people (Bokanga, 2001) [6]. It is an important food crop in developing countries, and it is the fourth source of calories, after rice, sugar cane and maize worldwide (Akinwale *et al.*, 2010) [2]. And is diploid ($2n=36$). Polyploids with $2n=54$ and 72 are also available. It is a perennial shrub producing 5-10 cylindrical tubers per plant. Being a member of family Euphorbiaceae, it produces latex. The stem is woody and variously branched. Two distinct types are present – one without branching at the top and the other with spreading nature. Leaves are palmately lobed with 5-9 lobes. Tapioca is monoecious in nature and cross-pollinated. Female flowers are a few in numbers and are borne in the base of inflorescence and male flowers are borne above. Female flowers open about 10 days before male flower anthesis. Stigma is receptive from 6.30 a.m. and continues up to 2.30 p.m. Plants when raised from seeds produce typical tap root system. Since crop is mainly propagated by vegetative means by stem cuttings, numerous adventitious roots develop, of which a few develop into tubers. Tubers are composed of a thin peridium, white a few develop into tubers. Tubers are composed of a thin peridium, white or purple cortex known as rind and central massive flesh rich in starch (25-40%). Bitterness often encountered in a few varieties and at certain stage is due to a bitter principle cyanogenic glucoside (HCN). Tapioca is the most important starchy root crop grown in the tropics and is mainly cultivated in southern peninsular India. Introduced during seventeenth century by Portuguese, the crop played a significant role to overcome food shortage among the low income group of people in Kerala. In India crop is cultivated in southern peninsular region, particularly Kerala, Tamil Nadu and Andhra Pradesh Underground tuber is rich in starch and mainly consumed after cooking. Processed products like chips, sago and vermicelli made of tapioca are also popular in the country. Being easily digestible, it forms an important ingredient in poultry and cattle-feeds. It is also widely used for production of industrial alcohol, starch and glucose.

Materials and Methods

The experiment was carried out at the Horticulture Research Farm, Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad U.P. The experiment was conducted in Randomized Block Design having 15 genotypes collected from Kerala in three replications. The allocation of treatments of the individual plots using random number in each replications with spacing 1×1 m row to row and plant to plant respectively. Four plants from each replication were taken for recording observation on 10 characters *viz.* Plant Height (cm), Number of Leaves per plant,

Number of Branches per plant, Number of tubers per plant (kg), Tuber yield per plant (kg), Tuber yield per plot (kg), Tuber yield per hectare (tonnes), Tuber diameter (cm), Tuber Length (cm), Stem diameter(cm).

Results and Discussion

Variability parameters

The extent of variability with respect to ten quantitative characters in fifteen genotypes measured in term of mean performance, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability, genetic advance and genetic advance as percent of mean are given in Table 2. And Analysis of variance revealed significant differences among genotypes for all the traits studies indicating presence of significant variability in the materials which can be exploited through selection (Table 1). These results are similar with the findings of Bharti *et al.* (2002) [5] Dar and Sharma (2011) [7].

The highest value of Genotypic coefficient of variation (GCV) was recorded for Tuber length (55.60), followed by Tuber per plot (55.60), Tuber yield per plant (47.38), Plant height 120 DAP(27.22), No. of branches 120 DAP moderated PCV were noted (20.08), Plant height 150 DAP (19.82), No. of branches 150 DAP (17.98), Plant height 90 DAP (17.90), No. of leaves per plant 120 DAP (16.79), Plant height 180 DAP (14.98), No. of leaves per plant 150 DAP(14.56), No. of branches 90 DAP (14.50), No. of branches 180 DAP (13.83), No of tuber per plant (12.97),low PCV were observed Tuber yield per ha (tonne) (9.19), No. of leaves per plant 60 DAP (8.97), No. of leaves per plant 90 DAP (8.66), No. of leaves per plant 180 DAP (8.14), Stem diameter (6.96), No. of leaves per plant 30 DAP (5.72), Tuber diameter (4.06), Plant height 60 DAP (3.26), Plant height 30 DAP (1.74).

Highest magnitudes of Phenotypic coefficient of variation (PCV) were recorded for Higher magnitudes of PCV were recorded for Tuber length (61.40), Tuber yield per plant

(49.92), Plant height 120 DAP(38.64), No. of branches 120 DAP(33.85), No. of branches 150 DAP(33.34), No. of branches 180 DAP (25.13), and moderate PCV were noted Plant height 150 DAP (20.97), No of tuber per plant (19.95), Plant height 90 DAP (18.18), No. of leaves per plant 120 DAP (17.99), Plant height 180 DAP (15.61), No. of branches 90 DAP (15.47),and low PCV were observed No. of leaves per plant 150 DAP (15.37), Tuber yield per ha (tonne) (12.63), Stem diameter (11.44), No. of leaves per plant 90 DAP (11.21), No. of leaves per plant 60 DAP (10.00), No. of leaves per plant 180 DAP(9.75), Tuber diameter (9.57), No. of leaves per plant 30 DAP (7.69), Plant height 30 Dap (6.43), Plant height 60 DAP (3.56).

According to Johnson *et al.* (1955) [11] and Panse (1957) [13] with the help of GCV and PCV alone, it is not possible to determine the amount of variation which is heritable. The heritability along with genetic advance is more meaningful and helps in predicating the resultant effect of selection on phenotypic expression. Highest Heritability estimate was observed for Plant height 90 DAP(96.89), Plant height 180 DAP (92.06), Tuber yield per plant (90.08), No. of leaves per plant 150 DAP (89.76), Plant height 150 DAP (89.34), No. of branches 90 DAP (87.84), No. of leaves per plant 120 DAP(87.16), Plant height 60 DAP (83.92), Tuber yield per plot (81.99)Tuber length (81.99), No. of leaves per plant 60 DAP (80.49), No. of leaves per plant 180 DAP (69.80), No. of leaves per plant 90 DAP (59.66), No. of leaves per plant 30 DAP (55.29),moderate PCV were noted Tuber yield per ha (tonne) (52.96), Plant height 120 DAP (49.63), No of tuber (plant) (42.27), Stem diameter (37.03), No. of branches 120 DAP (35.17),low PCV were observed No. of branches 180 DAP(30.29), No. of branches 150 DAP (29.08), Tuber diameter (17.96), Plant height 30 DAP (7.37).Heritability estimates in the broad sense quantifies the relative magnitudes of genotypic and phenotypic variances for traits and serves as a predictive role in selection procedures (Allard, 1960) [3]

Table 1: Analysis of variance for Tapioca yield

Characters		Mean sum of squares		
		Replication (d.f.= 2)	Treatments (d.f.= 14)	Error (d.f.= 28)
Plant height	30 DAP	1.682	2.838**	2.291
	60 DAP	0.492	6.574**	0.395
	90 DAP	4.36	469.34**	4.97
	120 DAP	165.571	1950.618**	493.033
	150 DAP	21.774	779.020**	29.809
	180 DAP	1.240	468.314**	13.083
No. of leaves per plant	30 DAP	0.156	0.466**	0.099
	60 DAP	1.901	17.077**	1.276
	90 DAP	27.976	55.116**	10.137
	120 DAP	11.041	201.554**	264.17
	150 DAP	6.997	147.021**	5.384
	180 DAP	4.647	76.405**	9.631
No. of branches	90 DAP	0.001	0.163**	0.007
	120 DAP	0.1897	0.706**	0.269
	150 DAP	0.1085	0.655**	0.294
	180 DAP	0.014	0.845**	0.367
No of tuber /plant		0.555	0.551**	0.517
Stem diameter		0.018	0.036**	0.039
Tuber diameter		0.102	0.148**	0.107
Tuber length		2.381	3.488**	6.316
Tuber yield per plant		0.007	0.701**	0.074
Tuber yield per ha (tonne)		3.846	2.814**	1.928
Tuber yield per plot		6.176	10.521**	2.153

* Significant at 5% level of probability, ** Significant at 1% level of probability

Table 2: Mean performance of Tapioca genotypes for different quantitative characters

Genotypes	Plant height						No. of leaves per plant					
	30 Das	60 DAP	90 DAP	120 DAP	150 DAP	180 DAP	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	180 DAP
Sreeswama	23.77	43.67	75.23	93.47	93.60	101.67	6.08	27.50	40.47	48.11	46.90	54.90
Sreesahya	23.94	43.97	84.13	98.82	98.65	67.40	6.50	28.25	39.08	48.83	50.42	59.67
Sreevishakam	23.20	44.50	74.58	87.41	87.30	87.97	5.58	26.00	44.64	44.97	45.12	52.77
Sreeapoorna	23.89	43.96	75.98	101.67	101.63	101.80	6.00	29.42	50.33	57.70	56.20	66.37
Sreeprakash	23.91	46.73	68.87	83.82	83.53	83.77	5.50	23.33	39.47	43.47	43.85	53.93
H 97	25.60	45.33	75.44	87.33	81.37	88.20	6.42	24.57	44.41	47.83	46.47	55.70
Sreejaya	24.37	40.91	69.73	77.01	83.27	82.91	6.58	24.67	46.92	49.25	47.90	57.73
Vijaya	26.13	42.75	62.52	69.44	67.07	69.20	6.75	26.50	43.05	46.42	44.73	54.50
MVD 1	25.87	43.35	47.80	50.89	49.98	54.93	6.17	25.39	39.58	36.86	38.00	49.07
CO 1	23.37	42.71	83.08	100.27	90.43	90.83	6.33	24.38	49.50	49.39	48.33	58.93
CO 2	24.27	43.27	77.88	88.24	77.07	82.20	6.00	20.33	52.03	56.78	55.00	64.50
H 226	23.80	43.33	71.17	82.59	82.57	84.20	6.33	28.75	48.33	59.25	57.50	66.43
H 165	25.80	44.97	77.23	75.79	74.17	79.17	5.67	26.83	48.33	49.42	47.10	57.00
Sreerakha	25.17	46.36	39.39	50.73	43.57	87.29	6.33	24.00	41.75	26.17	29.65	56.00
Vellayaniharasha	23.97	44.64	59.68	67.17	81.93	71.97	5.58	23.83	43.00	50.33	50.53	61.70
Mean	24.47	44.03	69.51	80.98	79.74	82.23	6.12	25.58	44.73	47.65	47.18	57.95
SE	1.24	0.51	1.82	18.13	4.46	2.95	0.26	0.92	2.60	2.51	1.89	2.53
CD5%	2.53	1.05	3.73	37.03	9.13	6.05	0.53	1.89	5.33	5.14	3.88	5.19
CV	6.19	1.43	3.21	27.42	6.85	4.40	5.14	4.42	7.12	6.45	4.92	5.36
Max	26.13	46.73	84.13	101.67	101.63	101.80	6.75	29.42	52.03	59.25	57.50	66.43
Min	23.20	40.91	39.39	50.73	43.57	54.93	5.50	20.33	39.08	26.17	29.65	49.07

Continued-----

Genotypes	No. of branches				No of tuber /plant	Stem diameter	Tuber diameter	Tuber length	Tuber yield per plant	Tuber yield per ha (tonne)	Tuber yield per plot
	90 DAP	120 DAP	150 DAP	180 DAP							
Sreeswama	2.17	3.03	4.18	5.18	2.25	27.80	2.72	27.80	1.56	16.57	5.34
Sreesahya	1.67	2.42	3.17	4.92	2.27	29.75	2.76	29.75	1.87	16.11	6.29
Sreevishakam	1.35	1.35	2.30	3.97	2.29	27.82	2.87	27.82	1.53	16.15	5.12
Sreeapoorna	1.61	2.45	3.17	4.92	2.17	28.83	3.07	28.83	2.16	14.97	8.67
Sreeprakash	1.67	1.86	2.45	4.42	2.17	27.07	3.29	27.07	1.79	16.43	5.44
H 97	1.61	2.02	2.23	4.18	1.99	29.67	2.98	29.67	1.55	14.87	4.72
Sreejaya	1.33	1.42	2.42	4.58	2.03	29.48	2.98	29.48	1.54	16.35	6.19
Vijaya	1.33	1.92	2.58	4.35	2.09	29.85	2.88	29.85	1.49	15.35	5.54
MVD 1	1.50	2.11	3.33	4.97	2.26	28.83	2.98	28.83	1.49	16.30	4.45
CO 1	1.33	1.33	2.77	4.77	2.07	30.58	3.33	30.58	1.55	16.50	3.62
CO 2	1.27	1.35	2.53	5.50	2.00	27.70	3.28	27.70	1.51	15.40	4.58
H 226	1.67	1.67	2.77	4.57	2.17	30.00	2.69	30.00	1.57	16.04	4.25
H 165	1.60	1.60	2.70	5.20	2.29	28.44	2.71	28.44	1.47	14.25	4.48
Sreerakha	1.75	2.17	3.27	5.18	2.30	30.40	3.18	30.40	3.35	18.27	10.88
Vellayaniharasha	1.70	1.83	3.43	4.50	2.15	28.53	2.77	28.53	1.60	16.90	4.90
Mean	1.57	1.90	2.89	4.75	2.17	28.98	2.97	28.98	1.74	16.03	5.63
SE	0.07	0.42	0.49	0.59	0.16	2.05	0.267	2.05	0.22	1.13	1.20
CD5%	0.14	0.87	1.01	1.20	0.33	4.20	0.547	4.20	0.46	2.32	2.45
CV	5.40	27.26	20.98	15.15	9.08	8.67	11.035	8.67	15.72	8.66	26.06
Max	2.17	3.03	4.18	5.50	2.30	30.58	3.33	30.58	3.35	18.27	10.88
Min	1.27	1.33	2.23	3.97	1.99	27.07	2.69	27.07	1.47	14.25	3.62

Table 3: Genetic parameter of yield and yield attributing traits of Tapioca.

Sl. No.	Characters	Mean	Range		Coefficient of variance		h ² (b.s.) (%)	Genetic Advance	Genetic Advance as % mean
			Min.	Max.	GCV (%)	PCV (%)			
1	plant height(cm)	82.23	54.93	101.80	14.98	15.61	92.06	24.35	29.61
2	Number of leaves/plant	57.95	49.07	66.43	8.14	9.75	69.80	8.12	14.01
3	Number of branches/plant	4.75	3.97	5.50	13.83	25.13	30.29	0.45	15.68
4	Number of tubers per plant(kg)	2.17	1.99	2.30	12.97	19.95	42.27	0.82	17.37
5	Tuber yield /plant(kg)	1.74	1.47	3.35	47.38	49.92	90.08	0.46	92.63
6	Tuber yield/plot(kg)	2.45	2.11	3.32	4.32	36.5	40.67	1.16	46.34
7	Tuber yield /hectare(t)	16.03	14.25	18.27	9.19	12.63	52.96	2.21	13.78
8	Tuber diameter(cm)	2.97	2.69	3.3	4.06	9.57	17.96	1.03	3.54
9	Tuber length(cm)	28.98	27.07	30.58	55.60	61.40	81.99	5.84	103.71
10	Stem diameter(cm)	28.98	27.07	30.58	4.06	11.44	37.03	0.19	8.72

Conclusion

On the basis of performance of 15 genotypes was found superior in term of yield attributing traits. That is genotype gave maximum plant height 101.80 (cm), Number of

Leaves/plant 66.43(cm), Number of Branches/plant 5.50 (cm), Number of tubers/plant 2.30 (kg), Tuber yield /plant 3.35 (kg), Tuber yield/hectare 18.27(tones), Tuber diameter 3.33(cm), Tuber yield/plot 3.35(kg), Tuber Length 30.58(cm),

Stem diameter 30.58(cm). Plant height, Tuber yield per plant, Tuber length recorded high estimates of GCV and PCV.

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