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ESTIMATION OF GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE FOR GROWTH AND YIELD COMPONENTS IN TIKHUR (*CURCUMA ANGUSTIFOLIA* ROXB.)

Deo Shankar*, S. S. Rao, J. Singh[1] and S. C. Mukherjee[2]

Shaheed Gundadhoor College of Agriculture and Research Station (Indira Gandhi Krishi Vishwavidyalaya), Kumhrawand, Jagdalpur, Bastar - 494 005 (C. G.), India.

[1]College of Agriculture & RRS (Indira Gandhi Krishi Vishwavidyalaya), Boirdadar, Raigarh (Chhattisgarh), India.

[2]College of Agriculture (Indira Gandhi Krishi Vishwavidyalaya), Raipur - 492 006 (Chhattisgarh), India.

Abstract

An investigation was conducted to screen the superior tikhur genotypes and to identify the genetic divergence of quantitative characters under Bastar Plateau Agroclimatic Zone of Chhattisgarh, India. The experiment was conducted during *kharif* seasons 2010-11 and 2011-12 at Shaheed Gundadhoor College of Agriculture and Research Station (IGKV), Kumhrawand, Jagdalpur, Bastar (C.G.), India. The experiment was laid out in Randomized Complete Block Design (RCBD) with 20 genotypes of tikhur with three replications. The genotypes were grown randomly in each replication/block in a total of 60 plots of 3.0 m × 2.4 m each containing 60 plants per plot. Observations were recorded from ten randomly selected sample plants in each treatment and observed mean value used for statistical analysis. The IGSJT-10-2 showed highest mean performance for total rhizome yield 30.32 t.ha^{-1} followed by genotype IGSJT-10-1 (21.52 t.ha^{-1}) and IGJT-10-1 (21.18 t.ha^{-1}). The highest mean performance for starch recovery IGSJT-10-2 showed 16.57 per cent followed by genotype IGBT-10-4 starch recovery 15.80 per cent and IGBLT-10-1 starch recovery 15.52 per cent. Considerable genetic variation has been exhibited by genotypes involved in present investigation. The most variable characters are weight of secondary rhizome per plant, weight of mother rhizome per plant, total rhizome yield t/ha, number of mother rhizome per plant, weight of primary finger rhizome per plant and number of leaves per plant. High heritability coupled with high genetic advance was observed for weight of secondary finger rhizome per plant, weight of mother rhizome per plant, number of leaves per plant, total rhizome yield t/ha number of secondary finger rhizome per plant, weight of primary finger rhizome per plant estimated and that can be improved by direct selection.

Key words : Tikhur (*Curcuma angustifolia* Roxb.), starch recovery, rhizome yield, genetic variability, heritability, genetic advance.

Introduction

Tikhur (*Curcuma angustifolia* Roxb.) is an important annual herb of family zingibareceae. It is an important food (starch plant). Simultaneously, it is used as a medicine by tribal people of Chhattisgarh. It occurs abundantly found in Sal forest especially near the streams is a rich source of starch and has good demand by the industries as well as for human consumption especially in festivals in recent fast. It is found that over exploitation of the species that resulted in bringing it in valuable category of IUCN. Thus, it has necessitated the cultivation of this species in the farmer's field. Growing demand for various pharmaceutical and food industries for a quality raw material rich in starch contents, require thorough studies for selection of best genotype and varieties, which have high starch content, thus can only be met by selection of better natural source and then attempt for breeding better variety. Farmers are grown unidentified locally available genotypes of tikhur for rhizome production and starch has been recovered by traditional method only by the most tribal people of Chhattisgarh due to unrefined extraction process, farmers get less starch recovery from tikhur rhizome. However, several other constraints which also limits the starch recovery in this crop. Tikhur rhizomes are used as appetizer reducing burning sensations and stomach pains, removal of stone from kidney, useful for ulcer patient (Sharma, 2003) and rhizome pulp is used for treatment of headache as well

***Author for correspondence :** E-mail : deo1975ram@gmail.com

as it gives cooling effect (Nag *et al*., 2006). The rhizome pulp is a remedy for fever, joint pains and leucorrhoea. The starch obtained from the rhizomes is highly nutritious and easily digestible, therefore, it is recommended for infants, weak children and invalids. The starch of tikhur is used for the preparation of many sweet meals and herbal dishes like halwa, barfi, jalebi etc. It is used specially during fast (Vrata, Upwas). Farmers also prepare herbal drink "sarbat" through tikhur starch during summer due to its cooling effect (Singh and Palta, 2004). The rhizome of the Tikhur is light bitter, demulcent, non irritating, nutritive and fragrant. Rhizome pulp is used as a remedy for headache, joint pains, jaundice and leucoria (Hemadri and Rao, 1984), essential oil of tikhur rhizome is used against tape worm (Benerjee and Nigam, 1978).

In the past, tikhur was occurring to a large extent throughout the Sal forest of Chhattisgarh. But at present the unscientific manner of harvesting and over exploitation have brought its occurrence to the restricted patches. Inspite of being an important medicinal herb, information on its superior genotypes, starch extraction technique and value added product is lacking. No research work has been carried out to screen superior genotypes assessing its genetic diversity and variation.

Looking to the importance of the crop for people of the Chhattisgarh an investigation entitled "Estimation of genetic variability, Heritability and Genetic advance for growth and yield components in Curcuma angustifolia Roxb." was undertaken during the year of *kharif* seasons 2010-11 and 2011-12 at Shaheed Gundadhoor College of Agriculture and Research Station (IGKV), Kumhrawand, Jagdalpur, Bastar (C.G.), India.

Materials and Methods

The investigation was conducted at IGKV, Shaheed Gundadhoor College of Agriculture and Research Station (SG CARS), Kumhrawand, Jagdalpur, Bastar, Chhattisgarh, India during *Kharif* seasons of 2010-11 and 2011-12. Twenty indigenous genotypes (IGBT-10-1, IGKOT-10-1, IGDMT-10-1, IGDMT-10-2, IGMOT-10-1, IGSJT-10-1, IGJT-10-1, IGSJT-10-2, IGSJT-10-3, IGKT-10-1, IGSJT-10-4, IGBLT-10-1, IGBT-10-2, IGBT-10-3 (Local Check), IGNT-10-1, IGBT-10-4, IGBLT-10-2, IGKNT-10-1, IGDNT-10-1and IGBJT-10-1) of tikhur (*Curcuma angustifolia* Roxb.) collected from thirteen districts of Chhattisgarh *viz*., Bastar, Korba, Dhamtari, Rajnandgaon, Surguja, Jashpur, Korea, Bilaspur, Kondagaon, Narayanpur, Kanker, Dantewada and Bijapur during March 2010 to June 2010.

The experiment was laid out in Randomized Complete Block Design (RCBD) with 20 genotypes of tikhur with three replications. The experimental field was prepared by two ploughing upto a depth of 30 cm and FYM thoroughly mixed with soil as pH of soil was slightly basic in nature. Raised 30 cm planting beds as plot was made to overcome water logging condition and prepared proper drainage channels.

The genotypes were grown randomly in each replication/block in a total of 60 plots of 3.0 m x 2.4 m each containing 60 plants per plot and spacing was 60 x20 cm. The crop was grown under rainfed conditions. The harvested rhizomes were cleaned up and mother rhizomes and finger rhizomes were separated. The flesh colour of rhizomes, dry mater and starch recovery per cent were estimated in Horticulture laboratory. All the observations were taken from sprouting of rhizomes and up to maturity and estimated mean performance different variability parameters like range, mean, heritability, genetic advance and phenotypic and genotypic coefficients of variation.

Results and Discussion

i) Estimation of genetic variability

Results of the experiment are given in tables 1 to 8. Phenotypic variance was higher than the genotypic and environmental variances. Similarly, phenotypic coefficient of variation was higher in magnitude than the genotypic coefficient of variation also had higher genotypic coefficient of variation. In the pooled analysis (Table 3), the highest value of genotypic coefficient of variation was recorded for weight of secondary rhizome per plant (30.27) followed by weight of mother rhizome per plant (27.67), total rhizome yield t/ha (27.66), number of mother rhizome per plant (26.54), weight of primary rhizome per plant (26.22), number of leaves per plant (24.32) and thickness of secondary rhizome per plant (23.28), whereas days to maturity had the lowest genotypic coefficient of variation (2.36). The highest value of phenotypic coefficient of variation was recorded for weight of secondary rhizome per plant (50.09), followed by weight of mother rhizome per plant (38.02), total rhizome yield (37.21t/ha), number of mother rhizome per plant (33.85), number of secondary rhizome per plant (31.76), thickness of secondary rhizome per plant (27.53), number of primary rhizome per plant (26.95) and number of leaves per plant (25.69). The lowest phenotypic coefficient of variation had recorded for days to maturity (2.65).

In both the years (2010-11 and 2011-12) and on pooled analysis, the maximum amount of genotypic coefficient of variation (GCV) was exhibited for weight

Table 1 : Mean performance of Tikhur (*Curcuma angustifolia* Roxb.) genotypes: Pooled analysis (2010-11 & 2011-12).

Genotypes	Characters																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
IGBT-10-1	95.57	13.67	35.98	14.05	2.12	169.83	85.98	52.46	127.70	24.51	1.40	6.77	6.93	3.48	1.86	1.81	23.30	13.90	14.46
IGKOT-10-1	86.34	18.97	39.59	15.73	2.64	170.17	87.31	50.32	105.56	26.66	1.77	10.23	8.33	3.12	1.54	1.77	30.66	12.99	13.57
IGDMT-10-1	118.76	9.83	53.78	20.92	3.52	173.67	88.04	54.37	131.21	40.19	1.53	6.37	10.70	3.83	1.80	1.61	25.33	12.17	16.82
IGDMT-10-2	107.02	9.30	43.89	13.92	2.38	173.83	88.28	32.71	97.08	39.40	1.43	6.70	9.97	2.98	1.65	1.94	27.04	9.46	13.37
IGMOT-10-1	98.62	8.17	38.07	15.18	3.16	168.83	82.60	42.80	118.26	38.43	2.07	8.17	9.20	3.14	1.87	1.82	25.62	13.08	15.09
IGSJT-10-1	108.61	10.17	38.28	14.48	2.68	160.00	92.13	57.43	170.12	42.01	1.57	8.73	10.40	3.59	2.00	1.27	25.72	13.87	21.52
IGJT-10-1	77.70	8.70	34.70	14.81	2.48	166.50	85.43	46.53	155.94	47.01	1.30	6.40	9.20	3.62	1.90	1.26	23.80	12.81	21.18
IGSJT-10-2	79.11	8.13	36.83	16.96	3.16	165.83	87.77	76.05	210.30	73.36	2.13	10.87	8.77	3.19	2.15	1.23	23.04	16.57	30.32
IGSJT-10-3	66.84	8.03	32.00	17.54	3.34	167.00	82.05	44.21	110.55	61.78	1.40	8.30	10.90	3.59	1.87	1.08	15.21	11.87	20.24
IGKT-10-1	86.48	9.07	39.97	13.58	2.35	167.50	78.38	39.33	137.90	62.58	1.33	7.20	10.83	3.27	1.82	1.60	22.64	13.72	17.87
IGSJT-10-4	88.41	9.50	39.08	16.18	2.73	166.17	88.36	39.38	153.28	33.41	1.90	8.97	8.03	3.26	1.89	1.05	23.23	15.44	19.25
IGBLT-10-1	74.14	9.17	27.28	16.48	3.33	166.00	88.35	37.59	117.88	37.03	1.87	5.57	9.03	2.77	1.76	1.01	30.11	15.52	17.46
IGBT-10-2	76.37	8.37	32.88	15.90	3.24	166.17	87.70	69.82	143.96	47.26	2.63	8.23	10.53	3.05	1.69	1.05	22.33	12.33	19.73
IGBT-10-3	66.43	11.10	29.85	17.28	3.40	160.50	86.20	66.92	160.04	45.85	1.40	8.40	11.03	2.82	1.58	1.10	23.03	11.23	20.12
IGNT-10-1	102.94	9.17	39.48	18.21	3.52	168.67	78.55	38.93	93.23	21.54	1.73	6.73	6.03	3.08	1.76	1.72	28.83	10.05	12.37
IGBT-10-4	99.77	12.40	44.07	14.56	2.69	172.00	83.00	66.29	170.84	39.02	3.13	6.83	9.73	3.53	2.15	1.21	26.82	15.80	16.56
IGBLT-10-2	73.00	10.53	35.75	15.71	3.51	170.67	83.12	20.97	56.63	26.09	1.60	5.90	6.27	2.86	1.52	0.98	31.58	13.59	8.11
IGKNT-10-1	77.60	10.67	36.77	18.60	3.41	176.67	88.36	55.50	116.99	37.75	1.43	6.33	7.17	3.60	2.01	1.44	35.61	12.65	10.17
IGDNT-10-1	84.57	12.00	39.59	12.55	1.97	169.50	86.89	44.78	103.93	22.85	1.33	6.17	5.13	3.54	1.71	1.15	32.12	10.84	12.20
IGBJT-10-1	77.13	9.43	32.74	13.21	2.77	167.33	80.13	28.83	72.69	33.13	1.33	5.97	8.50	2.86	1.46	1.00	33.03	11.86	14.12
General Mean	87.27	10.32	37.53	15.79	2.92	168.34	85.43	48.26	127.70	39.99	1.71	7.44	8.84	3.26	1.80	1.35	26.45	12.99	16.73
Sem	4.18	0.33	0.63	0.18	0.11	0.79	2.79	5.00	14.00	6.34	0.14	0.59	0.95	0.13	0.09	0.08	0.50	0.59	1.66
Sed	60.6	0.49	0.91	0.26	0.02	1.16	4.05	7.27	20.31	9.21	0.21	0.86	1.37	0.19	0.13	0.11	0.72	0.86	2.40
CV (%)	12.03	8.27	4.21	2.89	1.01	1.19	8.22	26.09	27.55	39.90	21.01	19.97	26.93	10.00	12.38	14.70	4.74	11.43	24.90
CD at 5%	12.04	0.98	1.81	0.52	0.03	2.30	8.05	14.43	40.33	18.29	0.41	1.70	2.73	0.37	0.26	0.23	1.44	1.70	4.77

1. Plant height (cm)
2. Number of leaves /plant
3. Leaf length (cm)
4. Leaf Breadth (cm)
5. Leaf area index (LAI)
6. Days to maturity
7. Harvest index (%)
8. Weight of mother rhizome / plant (gm)
9. Weight of primary rhizome / plant (gm)
10. Weight of second. rhizome /plant (gm)
11. Number of mother rhizome/ plant
12. Number of primary rhizome /plant
13. Number of second. rhizome / plant
14. Thickness of mother rhizome / plant (cm)
15. Thickness of primary rhiz. / plant (cm)
16. Thickness of second. r rhiz. / plant (cm)
17. Dry matter % of rhiz. / plant
18. Starch recovery (%)
19. Total rhizome yield t/ha

Table 2 : Analysis of variance for growth parameters, rhizome yield and starch recovery in Tikhur (*Curcuma angustifolia* Roxb.): Pooled analysis (2010-11 & 2011-12).

	Mean Sum of Squires		
	Replication	**Genotype**	**Error**
Observations df	**2**	**19**	**95**
1. Plant height (cm)	54.86**	1309.62**	110.307
2. Number of leaves per plant	13.335	38.518**	0.729
3. Leaf length (cm)	2.929	196.577**	2.493
4. Leaf Breadth (cm)	0.304	25.424**	0.208
5. Leaf area index (LAI)	0.0047	1.483**	0.0008
6. Days to maturity	0.108	98.867**	4.011
7. Harvest index (%)	57.532	81.666**	49.323
8. Weight of mother rhizome per plant (gm)	55.364	1228.87**	158.522
9. Weight of primary finger rhizome per plant (gm)	226.186	7962.67**	1237.903
10. Weight of second. finger rhizome per plant (gm)	31.346	1134.33**	254.65
11. Number of mother rhizome per plant	0.036	1.372	0.129
12. Number of primary finger rhizome per plant	0.614	13.081**	2.209
13. Number of secondary finger rhizome per plant	1.461	18.901**	5.661
14. Thickness of mother rhizome per plant (cm)	0.130	0.609	0.160
15. Thickness of primary finger rhizome per plant (cm)	0.108	0.226	0.049
16. Thickness of second. finger rhizome per plant (cm)	0.025	0.635	0.0395
17. Dry matter per cent of rhizome per plant	0.0455	136.99**	1.571
18. Starch recovery (%)	43.543**	21.53**	2.205
19. Total rhizome yield t/ha	0.332	145.737**	17.338

*Significant at 5 % and **Significant at 1% levels.

of secondary rhizome per plant, weight of mother rhizome per plant, total rhizome yield t/ha, number of mother rhizome per plant, weight of primary rhizome per plant, number of leaves per plant and thickness of secondary rhizome per plant. High amount of GCV are indicative of inherent variability's arising due to genetic causes and are more helpful to breeders. Maximum amount of phenotypic coefficient of variation (PVC) was exhibited for weight of secondary rhizome per plant, weight of mother rhizome per plant, rhizome yield t/ha, number of mother rhizome per plant, number of secondary rhizome per plant thickness of secondary rhizome per plant, number of primary rhizome per plant and number of leaves per plant. High amount of PCV reflects the influence of environment on the character expression. Whereas low PCV and GCV was recorded for days to maturity. Similar findings have been reported in root crap by Biradar *et al.* (1978) in cassava and Lakshmi and Easwari Amma (1980) in Asian Greater yam, and Chattopadhyay *et al*. (2004) in turmeric.

ii) Heritability

Heritability in broad sense was calculated for all the 19 characters. In the pooled analysis (table 3) the magnitude of heritability ranged from 9.0% to 99.0%. The leaf area index had the high heritability estimate (99%) followed by leaf breadth (95%), dry matter per cent of rhizomes per plant (94%), leaf length (93%), number of leaves per plant (90%), Days to maturity (79%) and thickness of secondary rhizomes per plant (72%). The moderate heritability was estimated in the characters viz., plant height (64.4%), number of mother rhizome per plant (61.0%), starch recovery per cent (59.0%), total rhizome yield t/ha (55.0%) and weight of mother rhizome per plant (53.0%). The characters showed low heritability *viz*., weight of primary rhizome per plant (48.0%), number of primary rhizome per plant (45.0%), thickness of mother rhizome per plant (44.0%), weight of secondary rhizome per plant and also in thickness of primary rhizome per plant (37.0%), number of secondary rhizome per plant (28.0%) and harvest index per plant (9.0%).

In the year 2010-11, high heritability estimates were observed for leaf area index, plant height, leaf length, days to maturity, weight of secondary rhizome per plant weight of mother rhizome per plant, number of secondary finger rhizome per plant, leaf breadth, dry matter per cent of rhizome, weight of primary rhizome per plant, number of mother rhizome per plant, total rhizome yield t/ha, number of leaves per plant, number of primary rhizome per plant and starch recovery per cent. Thickness of primary rhizome showed lowest heritability (table 4).

Table 3 : Mean, range, variability, heritability and genetic advance for growth and yield components in Tikhur : Pooled analysis (2010-11 & 2011-12).

Characters	Mean	Range		GCV (%)	PCV (%)	h^2 (Broad Sense)	Expected genetic advance	Genetic advance in % of mean
		Min.	Max.					
1.	87.27	66.44	118.76	16.20	20.18	0.644	23.38	26.79
2.	10.32	8.03	18.97	24.32	25.69	0.90	4.89	47.45
3.	37.53	27.28	53.78	15.15	15.73	0.93	11.29	30.08
4.	15.79	12.55	20.92	12.98	13.30	0.95	4.12	26.10
5.	2.92	1.97	3.52	17.03	17.06	0.99	1.02	35.01
6.	168.34	160.00	176.67	2.36	2.65	0.79	7.32	4.35
7.	85.43	78.38	92.13	2.72	8.66	0.09	1.50	1.76
8.	48.26	20.97	76.03	27.67	38.03	0.53	20.02	41.48
9.	127.70	56.63	210.30	26.22	38.03	0.48	47.54	37.23
10.	39.99	21.54	73.36	30.27	50.09	0.37	15.08	37.70
11.	1.72	1.30	3.13	26.54	33.85	0.61	0.74	42.86
12.	7.44	5.56	10.87	18.09	26.95	0.45	1.86	25.01
13.	8.83	5.13	11.03	16.81	31.75	0.28	1.62	18.34
14.	3.26	2.77	3.82	8.89	13.37	0.44	0.40	12.17
15.	1.80	1.46	2.15	9.54	15.63	0.37	0.22	11.99
16.	1.35	0.98	1.94	23.28	27.53	0.72	0.55	40.56
17.	26.45	15.21	36.61	17.96	18.57	0.94	9.46	35.77
18.	12.99	9.46	16.57	13.82	17.94	0.59	2.85	21.93
19.	16.72	8.10	30.31	27.66	37.21	0.55	7.08	42.35

Table 4 : Mean, Range, Variability, Heritability and Genetic advance for growth and yield components in Tikhur (Year 2010-11).

Characters	Mean	Range		GCV (%)	PCV (%)	h^2 (Broad Sense)	Expected genetic advance	Genetic advance in % of mean
		Min.	Max.					
1.	67.82	45.08	95.40	17.523	17.811	0.968	24.086	35.516
2.	7.69	5.27	16.40	33.327	35.393	0.887	4.975	64.646
3.	35.27	24.73	51.80	16.589	16.931	0.960	11.808	33.484
4.	15.58	12.30	20.75	13.161	13.581	0.939	4.094	4.094
5.	2.91	1.96	3.52	17.052	17.106	0.994	1.021	35.017
6.	168.8	160.0	178.33	3.075	3.139	0.960	10.475	6.206
7.	88.52	83.14	93.61	2.958	3.571	0.686	4.469	5.049
8.	47.17	17.88	87.11	33.840	34.761	0.948	32.012	67.863
9.	119.99	52.02	203.62	33.032	34.487	0.917	78.207	65.174
10.	41.22	12.23	95.57	49.899	51.223	0.949	41.281	100.136
11.	1.68	1.07	2.733	27.889	29.490	0.895	0.915	54.374
12.	7.09	4.40	10.33	23.969	25.587	0.878	3.281	46.253
13.	8.41	3.60	12.33	30.742	31.699	0.941	5.167	61.419
14.	3.144	2.63	3.98	10.570	12.650	0.698	0.572	18.194
15.	1.77	1.44	2.34	10.552	15.982	0.436	0.254	14.353
16.	1.35	0.98	1.91	21.540	26.015	0.686	0.495	36.740
17.	26.45	15.21	35.48	17.953	18.529	0.939	9.481	35.836
18.	12.53	9.26	16.76	16.614	18.124	0.840	3.931	31.375
19.	16.23	7.62	27.20	33.257	35.290	0.888	10.477	64.564

Table 5 : Mean, range, variability, heritability and genetic advance for growth and yield components in Tikhur (Year 2011-12).

Characters	Mean	Range		GCV (%)	PCV (%)	h^2 (Broad Sense)	Expected genetic advance	Genetic advance in % of mean
		Min.	Max.					
1.	106.72	82.10	142.12	19.98	20.41	0.96	43.01	40.30
2.	12.94	10.80	21.53	18.61	19.91	0.88	4.64	35.87
3.	39.79	29.83	55.76	13.75	14.66	0.88	10.57	26.55
4.	16.00	12.79	21.08	12.67	13.02	0.95	4.06	25.38
5.	2.92	1.98	3.54	16.99	17.01	0.99	1.02	34.98
6.	167.88	160.0	175.0	1.95	2.03	0.93	6.49	3.87
7.	82.34	65.23	94.22	7.24	12.11	0.36	7.35	8.30
8.	49.35	23.01	90.27	36.68	40.78	0.81	33.54	67.96
9.	135.41	55.59	216.98	36.91	40.48	0.83	93.87	69.33
10.	38.76	10.94	93.88	46.35	48.72	0.91	35.20	90.82
11.	1.75	1.13	3.53	32.49	37.44	0.75	1.01	58.07
12.	7.79	4.93	11.40	25.32	27.97	0.82	3.68	47.22
13.	9.26	3.60	16.33	29.38	31.73	0.86	5.19	56.04
14.	3.37	2.69	4.020	10.19	13.96	0.54	0.52	15.34
15.	1.83	1.37	2.23	11.616	15.28	0.58	0.33	18.19
16.	1.36	0.98	1.97	22.86	28.94	0.62	0.51	37.22
17.	26.45	15.21	35.77	18.08	18.62	0.94	9.57	36.17
18.	13.45	9.66	16.38	10.13	17.75	0.33	1.60	11.91
19.	17.22	7.30	33.44	37.91	38.81	0.95	13.14	76.26

1. Plant height (cm)
2. No. of leaves /plant
3. Leaf length (cm)
4. Leaf Breadth (cm)
5. Leaf area index (LAI)
6. Days to maturity
7. Harvest index (%)
8. Wt. of mother rhizome / plant (gm)
9. Wt. of primary rhizome / plant (gm)
10. Wt. of second. rhizome /plant (gm)
11. No. of mother rhizome/ plant
12. No. of primary rhizome /plant
13. Number of second. rhizome/plant
14. Thick. of mother rhizome/plant (cm)
15. Thick. of primary rhiz./plant (cm)
16. Thick. of second. rhiz./plant (cm)
17. Dry matter % of rhiz. /plant
18. Starch recovery (%)
19. Total rhizome yield t/ha

Table 6 : Relationship between different parameters Tikhur (*Curcuma angustifolia* Roxb.) rank procedure (Year: pooled Analysis, 2010-11 & 2011-12).

S. no.	Character	GCV	PCV	h^2 (B)	Exp. GA	GA as % of mean	Total
1.	Plant height (cm)	12	10	8	2	11	43
2.	Number of leaves per plant	6	9	5	9	1	30
3.	Leaf length (cm)	13	14	4	5	10	46
4.	Leaf Breadth (cm)	15	17	2	10	12	56
5.	Leaf area index (LAI)	10	13	1	15	9	48
6.	Days to maturity	19	19	6	7	18	69
7.	Harvest index (%)	18	18	19	14	19	88
8.	Weight of mother rhizome per plant (gm)	2	2	12	3	4	23
9.	Weight of primary finger rhizome per plant (gm)	5	3	13	1	7	29
10.	Weight of second. finger rhizome per plant (gm)	1	1	16	4	6	28
11.	Number of mother rhizome per plant	4	5	9	16	2	36
12.	Number of primary finger rhizome per plant	8	8	14	12	13	55
13.	Number of secondary finger rhizome per plant	11	6	18	13	15	63
14.	Thickness of mother rhizome per plant (cm)	17	16	15	18	16	82
15.	Thickness of primary finger rhizome per plant (cm)	16	15	17	19	17	84
16.	Thickness of second. finger rhizome per plant (cm)	7	7	7	17	5	43
17.	Dry matter per cent of rhizome per plant	9	11	3	6	8	37
18.	Starch recovery (%)	14	12	10	11	14	61
19.	Total rhizome yield t/ha	3	4	11	8	3	29

Table 7 : Relationship between different parameters Tikhur (*Curcuma angustifolia* Roxb.) rank procedure (Year 2010-11).

S. no.	Character	GCV	PCV	h^2 (B)	Exp. GA	GA as % of mean	Total
1.	Plant height (cm)	11	12	2	4	11	40
2.	Number of leaves per plant	3	2	13	10	4	32
3.	Leaf length (cm)	14	14	3	5	13	49
4.	Leaf Breadth (cm)	15	16	8	12	19	70
5.	Leaf area index (LAI)	12	13	1	15	12	53
6.	Days to maturity	18	19	4	7	17	65
7.	Harvest index (%)	19	18	17	11	18	83
8.	Weight of mother rhizome per plant (gm)	2	4	6	3	2	17
9.	Weight of primary finger rhizome per plant (gm)	5	5	10	1	3	24
10.	Weight of second. finger rhizome per plant (gm)	1	1	5	2	1	10
11.	Number of mother rhizome per plant	7	7	11	16	7	48
12.	Number of primary finger rhizome per plant	8	9	14	14	8	53
13.	Number of secondary finger rhizome per plant	6	6	7	9	6	34
14.	Thickness of mother rhizome per plant (cm)	16	17	16	17	15	81
15.	Thickness of primary finger rhizome per plant (cm)	17	15	19	19	16	86
16.	Thickness of second. finger rhizome per plant (cm)	9	8	18	18	9	62
17.	Dry matter per cent of rhizome per plant	10	10	9	8	10	47
18.	Starch recovery (%)	13	11	15	13	14	66
19.	Total rhizome yield t/ha	4	3	12	6	5	30

High heritability estimate was found for leaf area index in the year 2011-12 (table 5) followed by plant height, total rhizome yield t/ha, leaf breadth dry matter per cent of rhizomes day to maturity, weight of secondary finger rhizome per plant, leaf length, number of leaves per plant, number of secondary rhizome per plant, weight of primary rhizome per plant, number of primary rhizome per plant, weight of mother rhizome per plant, and number of mother rhizome per plant. Starch recovery showed lowest heritability in the pooled analysis.

High heritability estimate was observed for leaf area index followed by leaf breadth, dry matter per cent of rhizomes per plant, leaf length number of leaves per plant, days to maturity by and thickness of secondary rhizomes per plant. Harvest index had the lowest heritability. These findings are similar with the results obtained by Jones *et al*. (1969) on root crops, Thamburaj and Muthukrishanan (1976) in sweet potato and Lakshmi and Amma (1980) in Asian greater yam. The characters having high magnitude of heritability have immense value for selection, because it indicates low environmental influence on that character.

The traits possessing low heritability are difficult to improve through phenotypic selection due to masking influence of environment on the genotype effect for improvement in such traits multilocational testing are desirable to achieve desired results.

iii) Genetic advance as per cent of mean

In the pooled analysis, the magnitude of genetic advance as per cent of mean ranged from 1.76% to 47.45%. The number of leaves showed moderate genetic advance (47.45%) followed by number of mother rhizome per plant (42.86%), total rhizome yield t/ha (42.35%), weight of mother rhizome per plant (41.48%), thickness of secondary finger rhizome per plant (40.56%), weight of secondary finger rhizomes per plant (37.70%), weight of primary finger rhizome per plant (37.23%), dry matter per cent of rhizomes per plant (35.77%), leaf area index (35.01%) and leaf length 30.08%). The characters which showed low magnitude of genetic advance as per cent of mean were plant height (26.79%), leaf breadth (26.10%), number of primary finger rhizomes per plant (25.01%), starch recovery per cent (21.93%), number of secondary finger rhizome per plant (18.34%), thickness of mother rhizome per plant (12.17%), thickness of primary finger rhizomes per plant (11.99%), days to maturity (14.35%) and harvest index had the lowest genetic advance as per cent of mean (1.76%).

In the pooled analysis the highest GA percentage of mean was recorded for number of leaves per plant and rest of the characters showed moderate and low GA percentage of mean. The harvest index had the lowest genetic advance as per cent of mean. These findings are in agreement with those obtained with root crops by Kamalam (1977) in sweet potato (Biradar *et al*., 1978)

Table 8 : Relationship between different parameters Tikhur (*Curcuma angustifolia* Roxb.) rank procedure (Year 2011-12).

S. no.	Character	GCV	PCV	h^2 (B)	Exp. GA	GA as % of mean	Total
1.	Plant height (cm)	9	9	2	2	8	30
2.	Number of leaves per plant	10	10	9	11	11	51
3.	Leaf length (cm)	13	15	8	6	13	55
4.	Leaf Breadth (cm)	14	17	4	12	14	61
5.	Leaf area index (LAI)	12	13	1	15	12	53
6.	Days to maturity	19	19	6	9	19	72
7.	Harvest index (%)	18	18	18	8	18	80
8.	Weight of mother rhizome per plant (gm)	4	2	13	4	4	27
9.	Weight of primary finger rhizome per plant (gm)	3	3	11	1	3	21
10.	Weight of second. finger rhizome per plant (gm)	1	1	7	3	1	13
11.	Number of mother rhizome per plant	5	5	14	16	5	45
12.	Number of primary finger rhizome per plant	7	8	12	13	7	47
13.	Number of secondary finger rhizome per plant	6	6	10	10	6	38
14.	Thickness of mother rhizome per plant (cm)	16	16	17	17	16	82
15.	Thickness of primary finger rhizome per plant (cm)	15	14	16	19	15	79
16.	Thickness of second. finger rhizome per plant (cm)	8	7	15	18	9	57
17.	Dry matter per cent of rhizome per plant	11	11	5	7	10	44
18.	Starch recovery (%)	17	12	19	14	17	79
19.	Total rhizome yield t/ha	2	7	3	5	2	19

in cassava (Lakshmi and Amma, 1980) in Asian greater Yam.

Summary and Conclusion

Relationship between genetic parameters of variation for developmental traits and economic characters were examined through rank procedure (tables 6, 7 and 8) on pooled basis and both the years, indicating maximum variability for weight of mother rhizome per plant and the lowest for harvest index (%). The other characters showed the lowest variability thickness of primary finger rhizome per plant and thickness of mother rhizome per plant.

Hence, on the basis of genetic parameters of variation it could be concluded that the characters like, weight of secondary finger rhizomes per plant, weight of mother rhizome per plant. Number of secondary finger rhizome per plant, weight of primary finger rhizome per plant, number of mother rhizome per plant, total rhizome t/ha and number of leaves per plant had high heritability coupled with GA percentage of mean. According to Panse (1957) such associations are attributing to additive gene effects and consequently a high genetic gain from selection would be anticipated.

The practical applicability of these findings would be profitably realized in selection programmes in the segregating populations. High heritability estimates of traits reflects the fixable components of the genotype which may show transgressed variation and at the same time, there would be no need to select very large number of single plants, only a few would be sufficient to give the expected genetic gain in the next generation of selection for these traits. The same characters also showed maximum variation on the basis of genetic parameters estimated. Direct selection for this two attributes in the available genotypes or germplasm collection can be utilized to gain immediate improvement of the population. As the variability for the harvest index and days to maturity was the lowest, there is no scope for the selection of genotype of tikhur for more biological yield along with early and late maturity with the other desirable combination of characters.

Considerable genetic variation has been exhibited by genotypes involved in present investigation. Weight of secondary rhizome per plant, weight of mother rhizome per plant, total rhizome yield t/ha, number of mother rhizome per plant, weight of primary rhizome per plant and number of leaves per plant are the most variable characters. Occurrence of high heritability coupled with high genetic advance as per cent of mean for the characters *viz*., weight of secondary finger rhizomes per plant, weight of mother rhizome per plant, number of leaves per plant, total rhizome yield t/ha, number of secondary finger rhizome per plant, weight of primary finger rhizome per plant can be improved by direct selection.

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