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RESEARCH ARTICLE :

Estimation of genetic parameters, correlation and path-co-efficient analysis of *Amaranthus dubius* mart

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SUMMARY : In the present study, 25 genotypes and check variety CO-1 of *Amaranthus dubius* Mart. Collected from different places in the Chhattisgarh State were evaluated for different horticultural traits for genetic variation, character association and genetic diversity. High to moderate GCV and PCV values were found for fibre content %, harvest index %, dry matter %, fresh leaf weight, number of branches/plant and leaf breadth. Higher estimates of heritability coupled with higher genetic advance were observed for fiber content %, number of leaves/plant and yield/plot. Association studies revealed that genetic correlation co-efficients were higher than their phenotypic correlation co-efficients in most cases. From the correlation and path analysis, it can be concluded that emphasis should be given to plant height, number of leaves/plant, petiole length and stem girth for selecting high yielding genotypes.

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BACKGROUND AND OBJECTIVES

Among leafy vegetables, Amaranthus (Amaranthus spp.) is an annual C_4 plant that grows best at warm temperature and high light intensities (El-Sharkawy *et al.* 1968) and is regarded as the most common crop grown in the Indo-Gangetic plains of eastern India. Amaranthus, belonging to the family Amaranthaceae is one of the most nutritious leafy vegetable widely cultivated throughout India. Leafy vegetables commonly refer to those vegetables whose leaves and petioles only are eaten. These vegetables are popular and important in oriental diets. Many leafy vegetables are excellent sources of vitamins A and C, minerals and fibers, with dark green leafy vegetables being a notable source of protein (Larkcom, 1991). Amaranthus leaves are alternate, simple and petiolate, with some red or greenish colour and they are mostly edible. The flower are very small purple or dark red or yellow-green.

The experimental site was located at Research and Instructional Farm, Department of Horticulture, College of Agriculture, Indira

Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) having with adequate facilities for irrigation and drainage are available. In Chhattisgarh, the life and economy of the tribal and local people are intimately connected with the natural vegetation. Leafy vegetables play a major role in the nutritional requirement of the tribal and local population in remote parts of the Chhattisgarh. The use of leafy vegetables as food has been formed an integral part of the culture and tradition of many indigenous communities of the world. It constitutes an essential component in the diet and food security of many tribal and local communities particularly people living around the forest fringe. It is estimated that in India about 800 species are consumed as wild edible plants over the country (Singh and Arora, 1978).

RESOURCES AND METHODS

The present investigation was conducted from July to September 2014-15 and 2015-16 at Research and Instructional Farm, Department of Horticulture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) having with adequate facilities for irrigation and drainage are available. Soil type at the experimental site was clay-loam in texture having pH 5.5. The experimental material consisted of 25 distinct genotypes of vegetable amaranthus comprising both leaf and stem types. Raipur district is situated in the central part of Chhattisgarh, agro-climatologically known as Chhattisgarh plains and lies between 21°16' N latitude and 81°36' E longitude with an altitude of 289.56 meters above the mean sea level. The experimental field was laid out as per the experimental design. Field was divided into small plots according to treatments and replications with randomized block design. The observations on different growth parameters and leaf yield attributes were recorded on ten randomly selected competitive plants from each plot of all replications. The method adapted to record different observations on growth as well as leaf yield contributing traits are given below in details. The following observations were recorded as per the NBPGR descriptor for germplasm and varietal evaluation of leafy vegetable crops as per (Joshi *et al.*, 2011).

Statistical analyses :

The observations were recorded as per the NBPGR descriptor for germplasm and varietal evaluation of leafy vegetable crops as per (Joshi *et al.,* 2011). Data were subjected to analysis of variance (Panse and Sukhatme 1978). The genotypic co-efficient of variation (GCV) and phenotypic co-efficient of variation (PCV) were calculated by the formula given by Burton (1952). For the estimates of heritability and genetic advance as percentage of mean, the method of Hanson *et al.* (1956) was followed. Later correlation co-efficients at genotypic and phenotypic levels were calculated (Johnson *et al.* 1955). Path co-efficient was done as per Dewey and Lu (1959).

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads :

Genetic variability and heritability analysis:

The variance analysis showed that genotypes differ significantly among themselves for all the characters under study. The co-efficient of variation (CV) were below 10% for all the characters studied confirming the reliability of the experiment and also suggesting less G x E interactions (Table 1). Genetic variability in the base population plays a very important role in any crop improvement programme. In the present study, GCV agreed closely with PCV for all the traits except plant height and leaf length but the magnitude of PCV was higher than GCV for all cases (Table 1). The small difference between PCV and GCV for almost all the traits indicated that the variability was primarily due to genotypic differences. Similar result have also been reported by previous workers (Shukla *et al.* 2006). The GCV ranged from 6.59 % to 36.8 %, while PCV ranged from 8.18 % to 37.11 % (year 2014-15 and 2015-16). High to moderate GCV and PCV values were found for fiber content %, harvest %, dry matter %, number of branches/plant, leaf breadth indicating the potential of simple selection for the improvement of these characters. High values of co-efficient of variation for yield per plant (Shukla *et al.* 2006) and number of leaf/plant (Anuja 2012a) have been observed.

Traits with high broad sense heritability estimates suggest that they have high genetic potential; the effect of the environment in determining them is low. The values of heritability estimates were high for all the characters except yield/plot, plant height, leaf length and harvest % (year 2014-15) and plant height, yield/plot, petiole length

Table 1: Genetic parameter of variability for yield and its component character in *Amaranthus dubius* Mart.: Year-2014-15 and 2015-16

Characters	Mean		Range		GCV %		PCV %		Heritability (h^2%)		GA % of mean	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Plant height (cm)	97.34	95.17	84.76 to111.58	86.00 to100.35	6.59	3.80	8.18	5.69	65.06	44.69	10.96	5.24
Number of leaves plant^{-1}	19.75	18.25	14.67 to 28.33	13.93 to 27.33	21.38	17.22	22.11	18.40	93.51	87.62	42.59	33.21
Number of Branches plant^{-1}	3.50	3.50	2.00 to 4.67	2.00 to 5.67	22.02	22.66	23.19	26.58	90.12	72.71	43.14	39.81
Leaf length (cm)	3.39	3.04	2.60 to 4.00	2.14 to 4.03	11.93	17.59	14.19	21.09	70.71	69.52	20.65	30.22
Leaf breadth (cm)	3.07	3.09	1.69 to 4.47	1.88 to 4.97	22.28	24.31	22.98	25.68	94.02	89.63	44.63	47.41
Petiole Length (cm)	2.59	2.71	1.70 to 3.53	1.90 to 3.97	13.62	13.26	14.69	16.49	86.01	64.62	26.25	21.95
Stem Girth (mm)	7.90	7.95	5.67 to 10.67	5.63 to 11.67	15.92	18.58	16.22	18.72	96.39	98.52	32.28	37.98
Fresh leaf weight (g)	141.72	130.69	87.43 to 195.50	95.87 to 199.11	22.41	17.18	22.81	17.35	96.47	98.09	44.61	35.06
Dry matter %	13.57	14.98	9.70 to 22.91	9.92 to 21.05	22.87	22.35	24.93	22.73	84.18	96.69	43.26	45.27
Duration of Crop	36.94	36.41	29.0 to 45.00	30.00 to 45.00	14.13	14.00	14.77	14.03	91.46	99.64	27.86	28.79
Harvest %	5.75	4.93	3.38 to 8.91	3.40 to 8.07	28.25	17.44	31.04	21.66	82.84	64.89	52.87	28.94
Fibre content %	9.91	9.22	3.75 to 15.67	2.02 to 15.83	36.80	45.42	37.11	45.53	98.35	99.50	75.18	93.31
Yield/plot (kg)	2.54	2.66	1.74 to 2.94	1.77 to 3.37	8.46	11.64	13.83	16.25	37.38	51.25	10.63	17.16

Table 2: Genotypic and phenotypic correlation coefficient between yield and its component characters in *Amaranthus dubius* Mart.: Year- 14-15

Character		01 Plant height (cm)	02 No. of leaves plant^{-1}	03 No of branches plant^{-1}	04 Leaf length (cm)	05 Leaf breadth (cm)	06 Petiole length (cm)	07 Stem girth (mm)	08 Fresh leaf weight (g)	09 Dry matter %	10 Duration of crop	11 Harvest index %	12 Fibre content %	13 Yield plot^{-1} (kg)
1	G	1.000	0.030	0.222	0.493*	0.356	0.095	0.390*	-0.209	0.705**	-0.158	-0.180	0.112	0.530**
	P	1.000	-0.001	0.131	0.353	0.272	0.066	0.306	-0.169	0.563**	-0.091	-0.083	0.072	0.597**
2.	G		1.000	0.096	-0.177	0.097	0.472*	0.182	0.200	0.042	-0.352	0.125	-0.086	0.475*
	P		1.000	0.100	-0.147	0.078	0.425*	0.182	0.198	0.034	-0.324	0.080	-0.075	0.042
3.	G			1.000	0.135	-0.015	-0.098	0.116	-0.084	0.280	0.142	-0.341	-0.040	0.275
	P			1.000	0.083	-0.004	-0.107	0.114	-0.071	0.224	0.112	-0.304	-0.031	0.184
4.	G				1.000	0.527**	-0.160	-0.008	-0.021	0.348	-0.215	0.000	0.437*	0.155
	P				1.000	0.437*	-0.096	-0.015	-0.003	0.276	-0.187	0.007	0.356	0.065
5.	G					1.000	0.037	-0.147	0.309	0.127	-0.217	0.255	0.303	0.025
	P					1.000	0.015	-0.144	0.298	0.107	-0.192	0.232	0.292	-0.007
6.	G						1.000	0.397*	0.213	-0.090	-0.481*	0.019	0.030	0.418*
	P						1.000	0.350	0.196	-0.053	-0.416*	0.030	0.022	0.201
7.	G							1.000	0.055	0.245	-0.037	0.208	0.292	0.397*
	P							1.000	0.056	0.217	-0.038	0.176	0.288	-0.111
8.	G								1.000	-0.380	-0.133	0.668**	0.206	0.137
	P								1.000	-0.386	-0.130	0.621**	0.211	0.088
9.	G									1.000	0.086	-0.370	0.106	-0.006
	P									1.000	0.085	-0.340	0.081	-0.023
10.	G										1.000	-0.008	-0.283	-0.342
	P										1.000	0.031	-0.270	-0.259
11.	G											1.000	0.083	-0.591**
	P											1.000	0.080	-0.615**
12.	G												1.000	0.333
	P												1.000	0.213

Table 3: Genotypic and phenotypic correlation coefficient between yield and its component characters in *Amaranthus dubius* Mart.: Year-2015-16

Character		01 Plant height (cm)	02 No. of leaves plant^{-1}	03 No of branches plant^{-1}	04 Leaf length (cm)	05 Leaf breadth (cm)	06 Petiole length (cm)	07 Stem girth (mm)	08 Fresh leaf weight (g)	09 Dry matter %	10 Duration of crop	11 Harvest index %	12 Fiber content %	13 Yield plot^{-1} (kg)
1	G	1.000	-0.126	0.643**	-0.059	0.223	-0.071	0.130	-0.054	0.005	0.144	-0.177	0.241	0.519*
	P	1.000	-0.136	0.406*	-0.005	0.109	-0.078	0.095	-0.011	0.001	0.092	-0.065	0.161	0.568**
2	G		1.000	0.270	0.117	0.258	0.506**	0.373	0.492*	-0.241	-0.254	0.063	-0.064	0.593**
	P		1.000	0.252	0.070	0.226	0.406*	0.350	0.453*	-0.228	-0.234	0.081	-0.055	0.358
3	G			1.000	0.111	0.357	0.304	0.316	0.095	-0.065	0.033	0.066	-0.048	0.065
	P			1.000	0.144	0.242	0.286	0.264	0.111	-0.061	0.030	0.061	-0.035	0.077
4	G				1.000	0.742**	0.151	-0.020	0.237	-0.105	-0.343	0.066	0.242	-0.096
	P				1.000	0.625**	0.175	-0.018	0.211	-0.095	-0.286	0.040	0.197	-0.026
5	G					1.000	0.279	-0.142	0.448*	-0.002	-0.270	0.164	0.153	0.080
	P					1.000	0.177	-0.127	0.416*	-0.006	-0.257	0.141	0.142	0.049
6	G						1.000	0.560**	0.447*	-0.007	-0.300	0.166	0.018	0.305
	P						1.000	0.438*	0.344	0.011	-0.240	0.071	0.021	0.229
7	G							1.000	0.219	-0.002	0.070	-0.008	0.289	0.501**
	P							1.000	0.217	-0.005	0.069	-0.005	0.286	0.358
8	G								1.000	-0.167	-0.210	0.551**	0.236	0.427*
	P								1.000	-0.175	-0.209	-0.451*	0.235	0.312
9	G									1.000	0.157	-0.088	0.011	-0.173
	P									1.000	0.154	-0.088	0.013	-0.119
10	G										1.000	0.044	-0.211	-0.105
	P										1.000	0.037	-0.211	-0.078
11	G											1.000	-0.060	-0.387
	P											1.000	-0.034	-0.571**
12	G												1.000	0.340
	P												1.000	0.233

Table 4: Direct and indirect effect of component character on yield in *Amaranthus dubius* Mart.: Year-2014-15

Character	Plant height (cm)	No. of leaves plant^{-1}	No of branches plant^{-1}	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	Stem girth (mm)	Fresh leaf weight (g)	Dry matter %	Duration of crop	Harvest index %	Fibre content %
Plant height (cm)	0.196	-0.007	0.049	0.050	-0.114	0.068	-0.251	-0.121	-0.045	-0.009	0.126	0.054
No. of leaves plant^{-1}	0.005	-0.236	0.021	-0.018	-0.031	0.337	-0.117	0.116	-0.003	-0.021	-0.087	-0.041
No of branches plant^{-1}	0.043	-0.022	0.219	0.013	0.005	-0.070	-0.075	-0.048	-0.018	0.008	0.238	-0.019
Leaf length (cm)	0.096	0.041	0.029	0.102	-0.169	-0.114	0.005	-0.012	-0.022	-0.013	-0.000	0.209
Leaf breadth (cm)	0.070	-0.023	-0.003	0.053	-0.319	0.027	0.095	0.179	-0.008	-0.013	-0.179	0.145
Petiole length (cm)	0.018	-0.112	-0.021	-0.016	-0.012	0.713	-0.255	0.123	0.006	-0.028	-0.013	0.015
Stem girth (mm)	0.077	-0.043	0.025	-0.001	0.047	0.283	-0.644	0.031	-0.015	-0.002	-0.146	0.140
Fresh leaf weight (g)	-0.041	-0.047	-0.018	-0.002	-0.099	0.152	-0.035	0.581	0.024	-0.008	-0.467	0.099
Dry matter %	0.138	-0.009	0.061	0.036	-0.041	-0.064	-0.157	-0.221	-0.063	0.005	0.259	0.015
Duration of crop	-0.031	0.083	0.031	-0.022	0.069	-0.343	0.024	-0.077	-0.005	0.059	0.005	-0.136
Harvest index %	-0.035	-0.029	-0.075	0.000	-0.081	0.013	-0.134	0.388	0.023	-0.0004	-0.701	0.039
Fibre content %	0.022	0.020	-0.009	0.045	-0.096	0.022	-0.188	0.120	-0.007	-0.017	-0.058	0.479

and harvest % (year 2015-16). High heritability values in vegetable amaranthus have also been reported (Revanappa and Madalageri 1998; Shukla *et al.* 2006; Anuja 2012a). These heritability values were likely to be over estimated as in this calculation it was not possible to exclude variation due to different genetic components and their interactions. The heritability estimates were, therefore, to be considered with these limitations in view.

Correlation and path analysis :

Mutual association of traits is often expressed by phenotypic, genotypic and environmental correlations (Akinyele and Osekita 2006). Phenotypic correlation is directly proportional to genotypic and environmental correlations. On the other hand, a positive genetic correlation between two desirable traits makes selection easy for improving both traits simultaneously while the reverse is the case for negative correlation. In the present study, genotypic correlation co-efficients were higher than corresponding phenotypic correlation co-efficients, indicating greater contribution of genotypic factor in the growth and development of these traits association (Table 2). Positive and significant (*P* d" 0.05) genotypic and phenotypic correlations were observed for plant height (r = 0.530, 0.597) and (r = 0.519, 0.568). Positive and significant (*P* d" 0.05) genotypic correlations were observed for number of leaves/plant (r = 0.475) and (r = 0.593), petiole length (r = 0.418) and (r = 0.501), stem girth (r = 0.397) and (r = 0.427) with green yield in the year of 2014-15 and 2015-16 observation. Significantly positive phenotypic correlation between plant height and foliage yield (Shukla *et al.* 2010; Anuja 2012 b) have been reported. On the other hand, negative correlations were exhibited for harvest % (r= -0.0.591, -0.615) and (r = -0.505, -0.514) with green yield. It could be implied that amaranthus genotypes having narrow leaves would produce more green yield.

Among the 13 yield component traits, petiole length followed by fresh leaf weight and fiber content (Year 2014-15 analysis) and plant height followed by fresh leaf weight and number of leaves per plant (Year 2015-16 analysis) showed substantial positive direct effect on green yield per plot (Table 4 and 5) which is in confirmation to the finding of Shukla and Singh (2003), Varalakshmi and Devaraju (2010). The direct selection for these three characters could be beneficial for green yield improvement of *Amaranthus dubius* Mart. since these characters also showed significant positive correlation with green yield per plot. Residual effect was very low (-0.18 and -0.08) suggesting inclusion of maximum green yield influencing characters of *Amaranthus dubius* Mart. in the present analysis.

Conclusion :

From the study, it can be concluded that attention should be paid on selection based on plant height, fresh leaf weight, number of leaves per plant and fiber content

Table 5: Direct and indirect effect of component character on yield in *Amaranthus dubius* Mart.: Year-2015-16

Character	Plant height (cm)	No. of leaves plant^{-1}	No of branches plant^{-1}	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	Stem girth (mm)	Fresh leaf weight (g)	Dry matter %	Duration of crop	Harvest index %	Fiber content %
Plant height (cm)	0.587	-0.057	-0.369	0.012	0.027	0.005	0.048	-0.029	-0.0004	0.001	0.102	-0.008
No. of leaves plant^{-1}	-0.073	0.456	-0.154	-0.025	0.032	-0.033	0.138	0.268	0.021	-0.001	-0.036	0.002
No of branches plant^{-1}	0.377	0.122	-0.573	-0.024	0.044	-0.019	0.117	0.02	0.006	0.0002	-0.038	0.002
Leaf length (cm)	-0.034	0.053	-0.063	-0.216	0.092	-0.009	-0.007	0.129	0.009	-0.002	-0.038	-0.008
Leaf breadth (cm)	0.130	0.118	-0.204	-0.160	0.124	-0.018	-0.052	0.244	0.0002	-0.002	-0.094	-0.005
Petiole length (cm)	-0.041	0.231	-0.174	-0.032	0.035	-0.065	0.207	0.243	0.0006	-0.002	-0.095	-0.0006
Stem girth (mm)	0.076	0.170	-0.181	0.004	-0.018	-0.036	0.371	0.119	0.0001	0.0004	0.005	-0.009
Fresh leaf weight (g)	-0.031	0.224	-0.054	-0.051	0.056	-0.029	0.081	0.544	0.014	-0.0012	-0.317	-0.008
Dry matter %	0.003	-0.109	0.037	0.022	-0.0003	0.0005	-0.0005	-0.091	-0.086	0.0009	0.051	-0.0004
Duration of crop	0.084	-0.115	-0.019	0.074	-0.034	0.019	0.026	-0.114	-0.014	0.006	-0.025	0.007
Harvest index %	-0.103	0.028	-0.037	-0.014	0.021	-0.011	-0.003	0.299	0.008	0.0003	-0.576	0.002
Fiber content %	0.141	-0.029	0.027	-0.052	0.019	-0.001	0.107	0.129	-0.0009	-0.001	0.035	-0.033

for green yield improvement of *Amaranthus dubius* Mart.

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