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Short communication

GENETIC VARIATION AND CHARACTER ASSOCIATION IN VEGETABLE AMARANTH (*AMARANTHUS TRICOLOR* L.)

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Amaranth is one of the most important leafy vegetables of tropical and sub-tropical parts of the world. The leaves and stems provide cheap but rich source of vitamins A and C and elements like N, P, K, Ca, Mg, Fe, Na and Zn. Among the species of vegetable amaranth, *Amaranthus tricolor* L. is the most commonly grown and shows appreciable variation for different characters. However, no systematic work has been done for improvement of this important species particularly in Jharkhand where it is grown successfully almost round the year. The estimates of heritability and genetic advance are useful in determining the influence of environment in expression of the characters and the extent to which improvement is possible after selection (Robinson *et al.*, 1949). Correlation between yield and its components and their relative contribution to yield will be of great value in improving the efficiency of selection. Hence, the present investigation was aimed at assessing the genetic variability, association of different characters and path analysis for improvement of vegetative yield in *A. tricolor*.

The experimental material consisted of 24 indigenously collected germplasm of *A. tricolor* including two released varieties. These were evaluated during summer of 2008 in RBD with three replications at Farm-I of Horticulture and Agro-forestry Research Programme, Ranchi. In each replication, each entry was grown in two rows at 30 cm apart with row length of 1.5 m. Thus, the plot size for each entry was 0.9 m^2. Observations were recorded on nine important quantitative traits namely, days to 1st clipping, girth of stem, length of internode, length of leaf, width of leaf, leaf-stem ratio, number of clipping, duration of harvest and total yield of greens per plot. Ten randomly selected leafy shoots were used for recording data on girth of stem, length of internode, length and width of leaf. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were estimated as per Burton (1952). Heritability in a broad sense and genetic advance were computed according to Johnson *et al.* (1955). The correlation was worked out as per Al-Jibouri *et al.* (1958). Path coefficient analysis was estimated as described by Dewey and Lu (1959).

Highly significant differences were observed among the 24 indigenously collected germplasm lines of vegetable amaranth (*A. tricolor*) for all the nine quantitative characters (Table 1 & 2). The maximum extent of genetic variability was exhibited by leaf-stem ratio followed by total yield of greens/plot, girth of stem and length of leaf. The high GCV values for girth of stem and width of leaf were obtained by Pan *et al.* (1991), for green yield and leaf-stem ratio by Varalakshmi and Reddy (1994) and for green yield by Rani and Veeraragavathatham (2003) in vegetable amaranth. These characters having high GCV values have a better scope of improvement through selection.

The broad sense heritability was high for leaf-stem ratio, width of leaf, length of leaf, days to 1st clipping, number of clipping, girth of stem and total yield of greens per plot which suggest the effectiveness of selection on phenotypic performance would be more effective for these characters. High heritability along with high genetic advance was observed for leaf-stem ratio, width of leaf, total yield of greens/plot and length of leaf. These results are in consonance of the earlier findings of Varalakshmi and Reddy (1994), Shukla *et al.* (2000) and Rani and Veeraragavathatham (2003). These characters also recorded moderate to high values of GCV and PCV which indicated that improvement in these characters could be more effective through selection.

Table 1. Average performance of 24 amaranth genotypes for 9 traits

Genotypes	Days to 1st clipping	Girth of stem (cm)	Length of internode (cm)	Length of leaf (cm)	Width of leaf (cm)	Leaf-stem ratio	Number of clipping	Duration of harvest (days)	Total yield of greens/ plot (kg)
HAAMTH-3	50.00	0.40	3.39	7.02	3.42	0.55	3.33	27.00	2.38
HAAMTH-5	51.00	0.50	3.20	9.52	4.53	1.23	3.00	23.00	1.82
HAAMTH-6	50.00	0.54	3.97	8.46	3.80	0.37	3.00	23.66	2.35
HAAMTH-9	50.00	0.64	3.29	10.51	4.84	0.63	3.66	27.00	2.33
HAAMTH-13	50.33	0.56	3.39	8.84	4.04	0.71	3.66	29.66	2.65
HAAMTH-15	50.33	0.73	3.72	12.35	7.37	1.10	3.33	26.66	1.95
HAAMTH-16	50.33	0.65	3.55	12.09	7.30	2.01	3.00	23.66	1.73
HAAMTH-17	50.33	0.64	4.78	11.28	5.34	1.00	3.00	23.66	2.97
HAAMTH-21	48.00	0.57	3.65	10.35	5.02	1.06	3.00	28.33	3.11
HAAMTH-24	51.00	0.78	3.38	9.82	5.35	0.78	3.00	26.00	1.21
HAAMTH-25	50.00	0.62	4.31	10.26	6.29	1.39	4.00	33.00	2.96
HAAMTH-26	50.00	0.44	3.59	7.49	3.99	0.44	3.00	24.00	2.23
HAAMTH-28	47.00	0.55	3.37	11.50	4.38	0.60	3.00	26.00	1.36
HAAMTH-29	47.00	0.62	4.37	9.33	4.53	0.40	4.00	27.00	3.00
HAAMTH-31	49.66	0.61	3.30	8.76	4.04	0.64	3.00	23.33	2.45
HAAMTH-33	44.33	0.45	3.42	7.89	3.87	0.69	4.00	24.33	2.28
HAAMTH-37	44.66	0.80	5.04	11.91	5.02	0.63	3.00	26.00	1.38
HAAMTH-38	49.33	0.62	5.58	12.66	4.64	0.59	3.00	24.00	2.18
HAAMTH-39	50.00	0.43	4.28	8.28	3.84	0.51	3.00	24.00	2.06
HAAMTH-42	47.66	0.69	4.15	9.33	3.72	0.88	4.00	32.00	2.40
HAAMTH-43	49.33	0.48	3.53	9.09	3.79	0.52	3.00	24.00	2.28
HAAMTH-48	41.00	0.60	3.94	11.03	4.94	0.27	3.00	33.00	3.15
Pusa Lal Chaulai	48.00	0.41	3.93	9.39	4.02	0.46	3.00	26.00	2.05
Pusa Kirti	48.00	0.59	4.29	10.47	4.82	0.58	3.00	26.00	2.28
General mean	48.63	0.58	3.89	9.90	4.70	0.75	3.25	26.30	2.27
SEM±	0.99	0.05	0.32	0.49	0.32	0.07	0.17	2.06	0.27
CV (%)	3.53	15.81	14.34	8.60	12.03	16.75	9.44	13.56	20.65
CD (at 5%)	2.82	0.15	0.91	1.40	0.93	0.20	0.50	5.87	0.77
CD (at 1%)	3.78	0.20	1.23	1.87	1.24	0.27	0.67	7.85	1.03

In general, the genotypic correlation coefficients were higher in magnitude than the phenotypic correlation coefficients (Table 3) which suggests strong inherent relationship between the traits. The results are in agreement with those of Pan and Sirohi (1992) who also obtained similar relation in most of variable pairs in vegetable amaranth. The results are discussed in term of genotypic correlation coefficients. The total yield of greens/plot was found to be positively and significantly correlated with duration of harvest. The result is in agreement with that obtained by Pan and Sirohi (1992) in vegetable amaranth. Thus, selection for duration of harvest in positive direction could result in substantial improvement in total yield of greens in vegetable amaranth. Path coefficient analysis of different characters contributing towards total yield of greens (Table 4) revealed that duration of harvest had maximum positive direct effect on total yield. The indirect effect of duration of harvest via number of clippings was maximum and positive. The path coefficient analysis thus shows that duration of harvest and number of clippings exert a higher direct influence on total yield of greens which is supported by the earlier findings of Pan and Sirohi (1992) in vegetable amaranth.

Table 2. Mean sum of squares, mean, parameters of variance, heritability and genetic advance for 9 characters in amaranth

Characters	Mean sum of squares	Mean	Coefficient of variation		Heritability (%)	Genetic advance (k = 2.06)	Genetic advance as % of mean
			Genotypic (%)	Phenotypic (%)			
Days to 1st clipping	17.73**	48.63	4.56	5.77	62.50	3.61	7.42
Girth of stem	0.03**	0.58	16.52	22.86	52.19	0.14	24.13
Length of internode	1.12**	3.89	13.37	19.61	46.50	0.73	18.76
Length of leaf	7.32**	9.90	14.97	17.26	75.19	2.65	26.76
Width of leaf	3.28**	4.70	21.12	24.31	75.48	1.78	37.87
Leaf-stem ratio	0.45**	0.75	50.54	53.25	90.09	0.74	98.66
Number of clipping	0.47**	3.25	10.90	14.42	57.14	0.55	16.92
Duration of harvest	26.78**	26.30	8.22	15.86	26.88	2.31	8.78
Total yield of greens /plot	0.86**	2.27	20.33	28.98	49.22	0.66	29.07

**Significant at 1% level

Table 3. Genotypic (G) and phenotypic (P) correlation coefficient between 9 characters of 24 genotypes of amaranth

Characters		X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
X_1 Days to 1st clipping	G	-0.07	-0.28	-0.18	0.17	0.41	-0.13	-0.54	-0.23
	P	-0.03	-0.10	-0.07	0.09	0.32	-0.08	-0.27	-0.12
X_2Girthof stem	G		0.26	0.74**	0.63	0.31	0.07	0.36	-0.20
	P		0.34	0.60	0.58	0.31	0.08	0.17	-0.17
X_3 Length of internode	G			0.48	0.04	-0.13	-0.06	0.14	0.22
	P			0.41	0.16	-0.09	-0.03	-0.02	0.05
X_4 Length of leaf	G				0.73**	0.40	-0.30	0.13	-0.21
	P				0.70**	0.38	-0.13	0.05	-0.14
X_5 Width of leaf	G					0.75**	-0.06	0.13	-0.12
	P					0.68**	0.01	0.12	-0.06
X_6 Leaf-stem ratio	G						0.09	0.02	-0.15
	P						0.06	-0.00	-0.05
X_7 Number of clipping	G							0.52	0.46
	P							0.53	0.25
X_8 Duration of harvest	G								0.67*
	P								0.30
X_9 Total yield of greens/ plot	G								
	P								

*Significant at 5% level; **Significant at 5% level

Table 4. Path coefficient analysis effects of 8 characters on the total yield of greens/plot in 24 genotypes of amaranth

Character	Effects via								
	Days to 1st clipping (X_1)	Girth of stem (X_2)	Length of internode (X_3)	Length of leaf (X_4)	Width of leaf (X_5)	Leaf-stem ratio (X_6)	Number of clipping (X_7)	Duration of harvest (X_8)	Genotypic correlation with yield
X_1	**0.71**	0.08	-0.05	-0.08	0.06	-0.25	-0.03	-0.65	-0.23
X_2	-0.05	**-1.07**	0.05	0.36	0.23	-0.19	0.01	0.44	-0.20
X_3	-0.19	-0.28	**0.21**	0.24	0.01	0.08	-0.01	0.16	0.22
X_4	-0.12	-0.79	0.10	**0.49**	0.27	-0.24	-0.07	0.15	-0.21
X_5	0.12	-0.68	0.01	0.36	**0.37**	-0.46	-0.01	0.15	-0.12
X_6	0.29	-0.34	-0.02	0.20	0.28	**-0.61**	0.02	0.03	-0.15
X_7	-0.09	-0.07	-0.01	-0.14	-0.02	-0.05	**0.25**	0.62	0.46
X_8	-0.38	-0.39	0.03	0.06	0.04	-0.01	0.13	**1.19**	0.67*

Residual effect = 0.1788, *Significant at 5% level

On the basis of yield performance (Table1), the red leaved line HAAMTH-48 (3.15 kg/plot; 35.0 t/ha) performed the best followed by the red leaved line HAAMTH-21 (3.11 kg/plot; 34.5 t/ha) and the green leaved line HAAMTH-29 (3.00 kg/plot; 33.3 t/ha). These lines also outyielded the released varieties of vegetable amaranth viz., Pusa Lal Chaulai and Pusa Kirti. These three lines could be considered suitable for cultivation of vegetable amaranth during summer in Chotanagpur plateau region of Jharkhand.

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