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Research Article

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Genetic variability of *Amaranthus hybridus* in tropical plains of West Bengal

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ABSTRACT

The modern agriculture science is in a position to solve the immediate problems for quantity as well as quality crop production. The seeds of Amaranthus hybridus was procured from the National Bureau of Plant Genetic Resources (NBPGR) to explore the possibilities of its agronomic potentiality in this tropical plains of West Bengal. Though a few leafy amaranths are being cultivated since a long time, but the amaranths can meet up the demand of cereal as well as leafy vegetables. Six accessions namely (i) IC 95609 ,(ii) IC 35482, (iii) IC 120617, (iv) IC 35626, (v) IC 9559 & (vi)IC 95589 were selected out of fifteen accessions. All these six accessions were grown in the research field of the Crop Research Farm [CRF] following uniform agronomic measures. The phenotypic variations were observed and exhibited in this context following proper statistical model. The aims and objects of this experimentation was to highlight the phenotypic as well as genotypic significance, component of variances ,heritability (in broad sense), genetic advance of each accession over this particular location.

Keywords: *Amaranthus hybridus, leafy Amaranth, heritability, genetic advance*

INTRODUCTION

Amaranthus hybridus is one of the leafy amaranth. It is used in native cultures as human consumption, medicine and ceremonial aspects in different parts of Africa and other countries[1,2]. In comparison to different cereal crops, Amaranth contain high nutrition value[3,4]. Vegetable amaranth has less attention than grain amaranth. Many authors referred it as 'neglected crops[5,6]. However, species of vegetable amaranthus contain higher minerals[7] and carotenoids[8] than most vegetables. Researcher of Plant breeding can only achieve success in any crop improvement programme with the knowledge of the extent of genetic variability that exists among accessions of a species[9, 10, 11]. So, a number of amaranth genotypes have been introduced and acclimatized in respective environment, but the systematic evaluation for these genotypes has not been conducted. Improvement of vegetable Amaranth requires in depth knowledge of the magnitude of variation present in the available germplasms and the relative degree by which a character is transmitted from parent to offspring. The main objective of present study was to estimate component of variance, heritability and genetic advances regarding yield and yield contributing traits using six genotypes of *Amaranthus hybridus.*

MATERIALS AND METHOD

Six genotypes viz. IC 95609, IC 35482, IC 120617, IC 35626, IC 95595, & IC 95589 of *Amaranthus hybridus* were procured from National Bureau Of Plant Genetic Resources (NBPGR) , New-Delhi, in the month of February, 2011 for their locational trial performance in this area.

These seeds were sown in the research field of the Crop Research Farm (CRF) under Department of Botany , The University of Burdwan , following Randamized Block Design (RBD) lay out having four replications. The experiment was carried out in the month of March – June in two consecutive years 2011 and 2012. Uniform agronomic measures were provided for their proper growth and development. Various metrical characters viz (i) Days to seed germination, (ii) Plant height in 50% flowering state (cm), (iii) Number of leaves plant^{-1} in 50% flowering state, (iv) Leaf length in 50% flowering state (cm), (v) Leaf width in 50% flowering state (cm), (vi) Length of petiole in 50% flowering state (cm), (vii) Basal diameter plant^{-1} in 50% flowering state, (viii) Days to emergence of inflorescence (days), (ix) Inflorescence plant^{-1} (number) in 50% flowering state, (x)Length of Inflorescence in 50% flowering state (xi) Seed weight plant $^{-1}$ (g), (xii) Vegetative Yield plant^{-1} and (xiii) Branch plant $^{-1}$ (number) were observed and recorded for its further computations to observe in yield attributes on fleshy healthy leaves of those genotypes in this particular location.

Statistical analysis were performed to estimate variability among the genotypes viz. Components of variance, $\sigma^2 g$ = genotypic variance, $\sigma^2 p$ = phenotypic variance and $\sigma^2 e$ = error variance were estimated using the following formula of Singh and Chaudhary[12].

$\sigma^2 g = MSG - MSE / r$

$\sigma^2 p = \sigma^2 g + \sigma^2 e$

Where as, $\sigma^2 e = MSE$

Where MSG, MSE and *r* are the mean squares of genotypes, mean squares of error and number of replication, respectively. Phenotypic (PCV) and genotypic (GCV) coefficients of variation and heritability were calculated as the following Singh and Chaudhary[12].

$PCV = \sigma p / X \times 100$

$GCV = \sigma g / X \times 100$, Where, σg,, σp and X are the phenotypic, genotypic standard deviation and grand mean of the traits respectively. Heritability in the broad sense (h^2) was determines as , $h2 = \sigma^2 g / \sigma^2 p$

Expected genetic advance (GA) and percentage of GA calculated[13] and expected genetic advance (GA) = i. $\sigma p. h^2$ (where i = selection intensity at 5%)

GA (%) = GA x 100/X

RESULT AND DISCUSSION

Thirteen metrical characters for phenotypic expression of the crop were measured and tabulated in two-way table for calculating analysis of variance for both the years (2011 and 2012).Combined ANOVA for different metrical traits of Amaranth cultivars for the years 2011 and 2012 have been exhibited in table 1 and table 2 respectively. In all the cases df of replications and variety were 5 and 3 respectively. All the six Amaranth accessions exhibited significant differences for all characters studied in both the years and the extent of variability and its critical differences at 1% level of probability were presented in table 1 and Table2. Other components of variances viz. σ^2g, σ^2p, GCV, PCV, h^2 and genetic Advance (%) also presented in table 3 and Table 4 for two consecutive years.

Highest GCV was found in seed wt/ plant in both the years (26.408 and 26.485 in 2011 and 2012 respectively). In the same way, highest PCV was found in seed wt/ plant in both the years (26.599 and 26.586 in 2011 and 2012 respectively). Close resemblance between PCV and GCV suggest that environment plays very minimal role in expression of different traits. High estimate of GCV indicates that these characters showed high range of genetic variation and therefore it helps in selection for crop improvement. GCV alone did not determine the amount of variation. But GCV along with h^2 give clear indication of improvement (Johnson et al, 1955). So, heritability is an important component for selection because high heritability indicates superiority of genotypes[14]. In this experiment, heritability ranges from 0.844 – 0.998 (2011) and 0.840-0.997 (2012). Highest heritability was in the character vegetative yield/ plant. The value of genetic advance percentage ranges 11.565-55.806 (Table 3) and 10.993-56.175 in 2012 (Table-4).

In present investigation, the traits that contain higher GCV, heritability and genetic advance are seed weight plant^{-1}, branch plant$^{-1,}$, leaf length, leaf width and leaf petiole.

So these metrical traits can be used in plant breeding programme of *Amaranthus hybridus* in summer season. Akaneme and Ani (2013) works on Morphological Assessment of Genetic Variability among Accessions of *Amaranthus hybridus* in Nigeria[15]. Hasan et al determined the genetic variability, degree of association between yield and its component characters in case of Stem Amaranth[16].

Table1: ANOVA at a glance for different metrical traits in amaranth cultivars (Year -2011)

S.No.	Characters	Source of variation	df	SS	MS	F	CD at 5%	CD at 1%
1.	Seed germination (Days)	V	5	6.050	1.210	151.250**	__	0.011
		R	3	0.025	0.008	1.000^{ns}		
		E	15	0.125	0.008			
2	Plant height (cm) in 50% flowering state	V	5	2646.842	529.368	1054.519**	__	1.473
		R	3	2.838	0.946	1.884^{ns}		
		E	15	7.540	0.502			
3	Leaf plant^{-1} in 50% flowering state (number)	V	5	2006.653	401.330	1031.696**	__	1.299
		R	3	1.070	0.356	0.915^{ns}		
		E	15	5.846	0.389			
4	Leaf length in 50% flowering state (cm)	V	5	149.749	29.949	179.335**	__	0.848
		R	3	0.597	0.199	1.191^{ns}		
		E	15	3.527	0.167			
5	Leaf width in 50% flowering state (cm)	V	5	43.542	8.708	161.259**	__	0.484
		R	3	0.665	0.221	4.092*		
		E	15	0.813	0.054			
6	Length of petiole(cm) in 50% flowering state	V	5	30.324	6.064	252.667**	__	0.321
		R	3	0.282	0.094	3.916*		
		E	15	0.371	0.024			
7	Emergence of inflorescence(days)	V	5	165.175	33.035	250.265**	__	0.754
		R	3	0.085	0.028	0.212^{ns}		
		E	15	1.985	0.132			
8	Inflorescence / plant (number) in 50% flowering state	V	5	78.224	15.644	162.958**	__	0.645
		R	3	0.165	0.055	0.572^{ns}		
		E	15	1.448	0.096			
9	Basal diameter in 50% flowering state (cm)	V	5	0.747	0.149	24.900**	__	0.159
		R	3	0.011	0.003	0.500^{ns}		
		E	15	0.091	0.006			
10	Seed weight /plant(g)	V	5	392.374	78.475	316.431**	__	1.108
		R	3	0.015	0.005	0.017^{ns}		
		E	15	4.269	0.284			
11	Vegetative yield plant $^{-1}$ in 50% flowering state	V	5	14451.458	2890.291	3537.687**	__	1.883
		R	3	1.409	0.469	0.574^{ns}		
		E	15	12.265	0.817			
12	Branch plant $^{-1}$ (number) in 50% flowering state	V	5	57.854	11.570	22.686**	__	1.485
		R	3	1.152	0.384	0.752^{ns}		
		E	15	7.661	0.510			
13	Length of inflorescence (cm) in 50% flowering state	V	5	387.447	77.489	301.513**	__	1.055
		R	3	0.745	0.248	0.964^{ns}		
		E	15	3.868	0.257			

* indicates the "F" value significant at 5% level of probability. **indicates the "F" value significant at 1% level of probability.CD= Critical difference

Table2: ANOVA at a glance for different metrical traits in amaranth cultivars (Year -2012)

S.No.	Characters	Source of variation	df	SS	MS	F	CD at 5%	CD at 1%
1.	Seed germination (Days)	V	5	6.140	1.228	175.428**	—	0.174
		R	3	0.075	0.025	3.570*		
		E	15	0.110	0.007			
2	Plant height (cm) in in 50% flowering state	V	5	2764.434	552.886	973.390**	—	1.567
		R	3	0.752	0.250	0.440 ns		
		E	15	8.520	0.568			
3	Leaf plant^{-1} in in 50% flowering state (number)	V	5	1946.744	389.348	433.090**	—	1.975
		R	3	1.958	0.652	0.725 ns		
		E	15	13.494	0.899			
4	Leaf length in in 50% flowering state (cm)	V	5	137.452	27.490	130.904**	—	0.954
		R	3	1.138	0.379	10804		
		E	15	3.161	0.210			
5	Leaf width in in 50% flowering state (cm)	V	5	43.239	8.648	154.429**	—	0.492
		R	3	0.166	0.055	0.982 ns		
		E	15	0.834	0.056			
6	Length of petiole(cm) in 50% flowering state	V	5	29.079	5.815	232.6**	—	0.329
		R	3	0.155	0.051	2.040 ns		
		E	15	0.381	0.025			
7	Emergence of inflorescence(days)	V	5	150.195	30.039	417.208**	—	0.557
		R	3	0.333	0.111	1.541 ns		
		E	15	1.091	0.072			
8	Inflorescence / plant (number) in 50% flowering state	V	5	39.375	7.875	140.625**	—	0.492
		R	3	0.268	0.089	1.589 ns		
		E	15	0.842	0.056			
9	Basal diameter in 50% flowering state	V	5	0.774	0.155	22.142**	—	0.173
		R	3	0.032	0.010	1.428 ns		
		E	15	0.112	0.007			
10	Seed weight /plant(g)	V	5	356.974	71.395	545.00**	—	0.754
		R	3	1.584	0.528	4.030*		
		E	15	1.975	0.131			
11	Vegetative yield plant^{-1} in 50% flowering state	V	5	14294.037	2858.807	1253.313**	—	3.147
		R	3	12.708	4.236	1.857 ns		
		E	15	34.224	2.281			
12	Branch plant^{-1} (number) in 50% flowering state	V	5	104.644	20.928	185.302**	—	0.698
		R	3	0.024	0.008	0.070 ns		
		E	15	1.706	0.113			
13	Length of inflorescence (cm) in 50% flowering state	V	5	341.109	68.221	248.981**	—	1.090
		R	3	2.155	0.718	2.620 ns		
		E	15	4.112	0.274			

* indicates the "F" value significant at 5% level of probability. **indicates the "F" value significant at 1% level of probability.CD= Critical difference

Table 3: Estimation of variance components coefficients of variation, broad sense heritability(h^2) and genetic advance(GA) (%) for various metrical traits in amaranth cultivars (year 2011)

S. No	Characters	σ^2g	σ^2p	GCV	PCV	h^2	GA	GA (%)
1.	Seed germination (Days)	0.300	0.309	16.728	16.972	0.970	1.146	35.067
2	Plant height (cm) in 50% flowering state	132.216	132.718	12.313	12.336	0.996	24.439	26.172
3	Leaf plant^{-1} in 50% flowering state (number)	100.235	100.624	11.590	11.622	0.996	21.280	24.655
4	Leaf length in 50% flowering state (cm)	7.445	7.612	19.166	19.384	0.978	5.747	40.380
5	Leaf width in 50% flowering state (cm)	2.163	2.217	19.143	19.377	0.975	3.090	40.242
6	Length of petiole(cm) in 50% flowering state	1.510	1.534	16.456	16.456	0.984	4.213	56.463
7	emergence of inflorescence(days)	8.225	8.357	5.475	5.517	0.984	6.057	11.565
8	Inflorescence / plant (number) in 50% flowering state	3.887	3.983	25.069	25.375	0.975	4.143	52.697
9	Basal diameter in 50% flowering state (cm)	0.035	0.041	17.119	18.297	0.853	0.367	33.243
10	Seed weight /plant(g)	19.547	19.831	26.408	26.599	0.985	9.343	55.806
11	Vegetative yield plant $^{-1}$ in 50% flowering state	722.368	723.185	9.861	9.867	0.998	57.165	20.975
12	Branch plant $^{-1}$ (number) in 50% flowering state	2.765	3.275	15.689	17.086	0.844	3.252	30.718
13	Length of inflorescence (cm) in 50% flowering state	19.308	19.565	17.194	17.309	0.993	9.355	36.608

Table 4: Estimation of variance components coefficients of variation, broad sense heritability(h^2) and genetic advance(GA) (%) for various metrical traits in amaranth cultivars (year 2012)

S. No.	Characters	σ^2g	σ^2p	GCV	PCV	h^2	GA	GA (%)
1.	Seed germination (Days)	0.305	0.312	16.116	16.291	0.977	1.161	33.897
2	Plant height (cm) in in 50% flowering state	138.075	138.643	12.331	12.356	0.995	24.953	26.187
3	Leaf plant^{-1} in in 50% flowering state (number)	97.112	98.011	11.189	11.242	0.990	20.876	23.706
4	Leaf length in in 50% flowering state (cm)	6.820	7.030	17.558	17.827	0.970	5.477	36.834
5	Leaf width in in 50% flowering state (cm)	2.148	2.204	18.449	18.688	0.974	3.078	38.770
6	Length of petiole(cm) in 50% flowering state	1.447	1.472	15.700	15.831	0.983	2.539	33.147
7	Emergence of inflorescence(days)	7.491	7.563	5.188	5.213	0.990	5.798	10.993
8	Inflorescence / plant (number) in 50% flowering state	1.954	2.010	18.564	18.843	0.972	2.936	39.013

9	Basal diameter in 50% flowering state	0.037	0.044	15.471	16.841	0.840	0.373	30.132
10	Seed weight /plant(g)	17.816	17.947	26.485	26.586	0.992	8.950	56.175
11	Vegetative yield plant $^{-1}$ in 50% flowering state	714.131	716.412	9.668	9.683	0.997	56.838	20.564
12	Branch plant $^{-1}$ (number) in 50% flowering state	5.203	5.316	20.612	20.829	0.978	4.801	43.390
13	Length of inflorescence (cm) in 50% flowering state	16.986	17.260	16.778	16.912	0.984	8.706	35.446

CONCLUSION

High genetic advance and heritability in broad sense found in two consecutive years in 2011 and 2012. The value of GCV and PCV in both years found to be low variability. Therefore, the experience about the metrical characters were observed in both year 2011 and 2012 which are of great significant and the environment plays a little role over the population. Hence, the metrical characters viz. seed weight plant^{-1}, branch plant^{-1}, leaf length, leaf width and leaf petiole are considered as important yield components for the selected Amaranth cultivars which can be effectively used in a breeding programme.

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