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Adaptability Under Predictable Environments in Grain Amaranthus [*Amaranthus hypochondrious* (L.)]

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ABSTRACT

Nine genotypes of Amaranthus were evaluated for their adaptability in respect of grain yield and other yield components by growing over four predictable environments. Significant differences among genotypes and environments suggested the presence of diversity in genotypes and environment. Based upon stability parameters, the genotypes IC-35642, IC-42256 and AG-114 exhibited wider adaptation and stability for grain yield, Annapurana (ch), IC-35711, IC-32186 and genotypes IC-95342, IC-41997 and IC-42256 exhibited wider adaptability for late and early flowering, respectively. Genotype, 41997 exhibited stability for plant height, genotypes, IC-35642, IC-42256 and AG-114 for number of spikeletes/plant; IC-42256, AG-114 and IC-32186 for length of inflorescence, IC-42256, AG-114 and IC-32186 for girth of inflorescence and IC-95342, IC-32186 and GA-1 wider adaptability for grain protein content. Sowing in 1st week of Oct., with 80 : 40 : 20 : kg NPK/ha provided most suitable environment for yield and its components.

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INTRODUCTION

Amaranthus (*Amaranthus hypochondriacus* L.) plant has multipurpose uses Medicinal, Nutritional, Dye,Ornamental, Vegetable, and Food grains to human-beings. Also,used to feed Pig and Poultry birds and dried stalks can be used for roof construction (Gopalan *et al.* 1971). Amaranthus is grown widely in India, along Himalayas from Kashmir to Bhutan, and South Indian hills, Tamil Nadu etc. (Harbhajan Singh,1961 and Sauer 1967).

The relative performance of different genotypes varies both environment and there exists a genotype x environment interaction.The occurrence of genotype x environment interaction has long provided a major challenge to obtaining fuller understanding of the genetic control of variability. The study of genotype x environment interaction is thus important not only from the genetical and evolutionary point of view, but also is very relevant to production problems of agriculture in general and to Plant Breeding in particular (Breese,1969).

The present study was conducted with a view to assess the elite genotypes of Amaranthus for their wider/general adaptability by growing in different environments.

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TABLE 1

Analysis of variance for stability for different characters in Amaranthus.

Sr. No.	Source	d.f.	Days to 50% flowering	Plant height	No. of branches/ plant	No. of spikelets/ plants	Length of inflorescences (cm)	Girth of inflorescences (cm)	Leaf area/at flowering/plant (cm^2)	Days to maturity	Grain yield/ plant (g)	Grain protein content (%)
1.	Genotypes	8	28.61‡‡	81.89‡‡	26.36‡‡	119.21‡‡	174.38‡‡	20.87‡‡	261831.54‡‡	30.58‡‡	103.03‡‡	7.9‡‡
2.	ENV.	3	0.292	338.75**	1.341**	1370.37**	277.03**	101.832**	385410.98**	0.436	151.749**	298.9**
3.	G X E	24	0.226**	3.402**	0.068	0.894**	1.125**	2.254**	118.51**	0.260	1.556**	0.163**
4.	E + (G x E)	27	0.233	40.66	0.210	153.06	31.78	13.32	42928.78	0.280	18.245	3.466
5.	ENV (L)	1	0.8734	1016.28‡‡	4.025‡‡	4111.10‡‡	831.09‡‡	35.5‡‡	1156227.7‡‡	1.294‡	455.248‡‡	89.672‡‡
6.	G x E (L)	8	0.108	3.310	0.151‡‡	2.003‡‡	0.816	0.331	151.507	0.124	3.918‡‡	0.364‡‡
7.	Pooled deviation	18	00.254**	3.066**	0.024	0.302	1.136**	2.858**	90.964**	0.293	0.334**	0.056
8.	Pooled Error	64	0.104	0.225	0.160	0.306	0.303	0.147	1.007	0.255	0.133	0.022

** indicates 1 per cent level of significance when tested against G x E.
‡, ‡‡ indicates 5 per cent level of significance when tested against pooled deviation.
++ indicates 1 per cent level of significance when tested against pooled error.

TABLE 2

Estimation of stability parameters for different characters of Amaranthus by (Eberhart and Russell, 1966 Model).

Sr.	*Genotype*	*Days to 50% flowering*			*Plant height at flowering*			*No. of spikelets per plant*			*Length of inflorescence*		
No.		*Mean*	*bi*	*δ di*	*Mean*	*bi*	*δ di*	*Mean*	*bi*	*δ di*	*Mean*	*bi*	*δ di*
1.	IC-95342	41.50	0.5724	-0.0640	113.012	0.8279	10.4537**	58.25	0.9592	-0.1745	55.30	1.0311	0.8630
2.	IC-41997	45.33	0.00	-0.1038	121.86	1.1661	0.2429	61.75	0.9324	0.1632	61.55	0.8896	2.1947**
3.	IC-35711	48.42	-.3498	-0.0677	118.93	1.0000	-0.1496	57.08	0.9049	0.5097	53.77	0.9125	1.8340**
4.	IC-35642	46.25	1.7491	0.1223	122.96	1.2201	7.0612**	70.25	1.0013	-0.2767	69.35	1.1153	1.3596*
5.	IC-42256	44.83	1.8445	0.0094	116.08	1.0886	1.0738*	65.83	1.005	-0.3038	64.33	0.9677	-0.2307
6.	AG-114	42.92	2.3851	0.9952**	114.49	0.770	1.3622**	68.00	1.0046	-0.17	67.47	1.0078	0.6143
7.	IC-32186	47.17	2.0990	0.1824	127.41	1.1862	2.4176**	73.67	1.1286*	0.7546	73.33	1.0247	-0.1581
8.	Annapurna (check)	49.75	0.9222	-0.1031	119.02	0.8645	00.3295	64.00	0.9908	-0.2994	62.73	0.8961	0.7413
9.	GA-1	48.08	-0.2226	0.3801*	121.57	0.8771	2.7818**	62.17	1.0322	-0.239	57.20	1.1552	0.2764
	$\bar{X}$	46.03			119.48			64.54			62.78		
	S. Em. ±	0.291			1.022			0.3171			0.6153		

Sr. No.	Genotype	Girth of inflorescence			Leaf area at flowering			Grain yield per plant			Protein content		
		Mean	bi	$\delta^2 di$	Mean	bi	$\delta^2 di$	Mean	bi	$\delta^2 di$	Mean	bi	$\delta^2 di$
1.	IC-95342	17.57	0.9606	0.8161**	914.19	1.00	77.54**	12.568	0.8106	-0.0783	17.72	1.08	0.04
2.	IC-41997	18.86	1.0592	-0.0694	1010.96	1.00	1.56	15.127	0.7315	-0.1069	16.77	0.98	0.09
3.	IC-35711	18.04	0.7773	10.2943**	811.08	1.01	2.30	11.504	0.7810	0.0775	14.31	1.11	-0.02
4.	IC-35642	21.72	1.1004	12.8225**	1457.06	1.01	5.14**	22.368	1.1903	0.1871	18.76	0.57*	0.01
5.	IC-42256	20.93	1.0782	0.3461	1292.00	1.06	337.66**	18.700	1.0968	0.0462	15.29	1.14	-0.02
6.	AG-114	22.23	1.0454	0.1111	1390.71	0.99	43.30**	20.558	1.1386	0.1475	16.17	1.17	0.00
7.	IC-32186	24.47	0.9443	0.1689	1501.41	0.92	305.61**	27.068	1.5823*	1.3746**	17.00	1.14	-0.02
8.	Annapurna (check)	19.95	1.0442	-0.1255	1155.10	1.00	41.91**	16.38	0.8850	0.1408	17.08	0.91	0.24**
9.	GA-1	18.43	0.9904	0.0388	950.24	1.01	0.63	13.90	0.7839	0.0237	18.28	0.88	-0.01
	$\bar{X}$	20.24			1164.75			17.54			16.82		
	S. Em. ±	0.976			5.507			0.334			0.137		

bi = regression co-efficient., $\delta^2 di$ = deviation from regression. *, ** = Significant at 5% and 1% level.

MATERIALS AND METHODS

The field experiment comprising of nine genotypes of grain Amaranthus (*Amaranthus hypochondriacus* L.) was sown in R.B.D.with three replications during rabi 1993 in four predictable environments as under :

E_1 — Sowing 1st October, with 20 + 40 + 20 kg NPK/ha.

E_2 — Sowing 1st October, with 80 + 40 + 20 kg NPK/ha.

E_3 — Sowing 1st November, with 20 + 40 + 20 kg NPK/ha.

E_4 — Sowing 1st November, with 80 + 40 + 20 kg NPK/ha.

Observations were recorded on ten characters viz., days for 50% flowering, plant height at flowering (cm), number of branches/ plant, number of spikelets/plant, length of inflorescence (cm), girth of inflorescence (cm), leaf-area/plant at flowering (cm^2), days to maturity, grain yield/plant (g) and grain protein content (%). Pooled analysis of variance over four environments and stability parameters [mean (μ), regression co-efficient (bi) and deviation from regression (δdi)] and environmental indices (Ij) were estimated as per the model suggested by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Pooled analysis of variance over four environments showed that genotypic and environmental differences when tested against G x E, were significant for all the characters under study (Table 1) indicating the presence of genetic variability among the genotypes and environments. Genotype x environment interaction was significant when tested against pooled error for all characters except number of branches/plant and days to maturity. Indicating that major portion of interaction was linear in nature and prediction over environments was possible. Significant pooled deviation was observed for most of the characters including grain yield per plant which suggested that the genotypes differed considerably for various economic characters and grain yield.

According to Eberhart and Russell (1966) the ideal genotype would be the one which has high mean, regression coefficient equal to unity (bi = 1 and low deviation mean square $\delta^2di = 0$. In the present study linear regression (bi) is treated as measure of response of a particular genotype whereas deviation from the regression line (δ^2di) is considered as a measure of stability. Therefore, genotype with lowest or non significant deviation being most stable and vice versa. The estimates of stability parameters i.e. mean (m), regression coefficient (bi) and deviation from regression (δ^2di) for different characters are presented in Table 2. From the table it is obvious that the three genotypes IC-35642, IC-42456 and AG-114 exhibited wider adaptability for grain yield as they have mean greater than average. Regression co-efficient (bi.>1) and deviation from regression (δ^2di) was also low indicating that these genotypes respond to changing environments and give high yield in favourable environments. The genotypes, Annapurana (ch), IC-35711, IC-32186 and genotypes IC-95342, IC-41997 and IC-42256 exhibited wider adaptability for late and early flowering respectively, IC-41997 exhibited stability for plant height, IC-42256 and AG-114 for number of spikelets/plant, IC-42256, AG-114 and IC-32186 for length and girth of inflorescence, IC-95342, IC-32186 and GA-1 exhibited wider adaptability for grain protein content, while the IC-35186 and IC-35642 were having specific adaptability for number of spikelets/plant and grain protein content respectively.

Estimation of environmental indices (Ij) suggested E_2 environment (sowing on 1st October with 80 + 40 + 20 kg NPK/ha) was most favourable for the characters early

TABLE 3

Estimates of environmental indices (Ij) for different characters in Amaranthus.

ENV. No.	Days to 50% flowering	Plant height at flowering	No. of branches/ plant	No. of spikelets per plant	Length of inflorescence	Girth of inflorescence	Leaf area at flowering plant	Days to maturity	Grain yield per plant (g)	Protein content (%)
E_1	-0.10133	-4.95	-0.29	-4.45	-5.32	-1.21	-49.22	-0.08	-3.03	-1.7
E_2	-0.10244	4.91	0.34	14.44	0.14	3.6	248.23	-0.12	4.57	1.36
E_3	-0.06467	-5.65	0.37	-14.45	-2.26	-4.05	-248.88	-0.16	-3.87	-2.6
E_4	+0.2680	+5.69	0.34	+4.44	−7.4	+1.66	+49.87	+0.33	+2.34	+2.94

flowering, number of spikelets/plant, girth of inflorescence, leaf area at flowering, days to maturity and grain yield. The environment E_4 (Sowing on 1st November, with 80 + 40 + 20 kg NPK/ha) was most favourable for plant height, length of inflorercence, grain protein content and number of branches/plant. Estimates of environmental indices (*Ij*) are presented in Table 3.

The genotypes IC-32642, IC-42256 and AG-114 were high yielders with wider adaptability. They can be used as a parents in breeding programmes. This is first report on stability analysis in Amaranthus.

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