Genetic Variability, Correlation and Path Analysis in Grain Amaranth

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The present study on grain amaranth revealed presence of genetic variability in seed yield and harvest index. Genetic index and flowering time showed high heritability while genetic advance was high for plant height. Harvest index, plant height, inflorescence length, maturity period, flowering time and test weight had significant positive correlation with seed yield. Path analysis revealed highest positive direct effect of harvest index followed by maturity period, basal girth and plant height. Plant height, inflorescence length and flowering time had substantial indirect contribution through harvest index.

Key Words: Genetic Variation, Grain Amarnath, Heritability, Path Analysis

Grain amaranth is a widely adapted under-utilized crop plant having immense potential for scientific exploitation. This C_4 plant species can be grown in varying agroclimatic conditions ranging from the high altitude temperate Himalayas to the desert plains of Gujarat. In the Himalayan region, it is grown as a *kharif* cash crop in high altitude areas while in the plains it is cultivated in the *rabi* season. For achieving increased production in grain amaranth it is essential to evolve high yielding varieties as very few improved varieties have been evolved in this crop. Planning of any breeding programme requires information on the amount of genetic variability available among the breeding genotypes. The nature of association among easily measurable characters influencing yield determines the success of selection programmes. Current knowledge on genetic variability and character association in grain amaranth genotypes is meagre. The present study was, therefore, undertaken to assess the genetic variation, heritability, correlation and direct and indirect contributions of some quantitative characters on seed yield in a set of diverse grain amaranth genotypes.

Materials and Method

Twenty-two widely adapted grain amaranth genotypes belonging to *Amaranthus hypochondriacus* species received from different regions of the country, were raised at Plant Breeding Research Block, Hill Campus (2100 m asl) of GB Pant University of Agriculture and Technology during 1991-92. The genotypes tested were IC 38269, IC 38280, IC 38658, IC 42255-5, IC 42290-17, IC 42316-1, IC 42374, VHC 7502, VHC 7519, VL 21, VL 33, VL 35, VL 36, VL 38, VL 44, PRA 8701, PRA 8801, PRA 8901, Annapurna, Suvarna, Ranichauri Local and Saonli Local. The experiments were laid out in a randomized block design with three replications. Plot size was 5 rows each of 2.5 m long. Row to row distance was 50 cm while plants within a row were spaced at 15 cm. Recommended agronomic practices were followed with a fertilizer dose of 20:40:0 NPK kg/ha, but no plant protection measures were undertaken since no insect and disease problems were encountered.

Observations were recorded on 10 randomly selected representative plants/plot. Data on flowering time (days taken for 50% head emergence), maturity period (days), plant height (cm), inflorescence length (cm), basal girth of stem at collar region (cm), height: girth ratio, test weight (weight of 10 ml seed in g), seed yield (q/ha) and harvest index (%) were recorded. Analysis of variance were done from the mean data obtained for each character. The phenotypic (PCV) and genotypic (GCV) coefficients of variation, heritability in broad sense, genetic advance were calculated following Johnson *et al.*, (1955) and path coefficient analysis following Dewey and Lu (1959).

Results and Discussion

Significant differences were observed among the genotypes for all the characters studied indicating presence of adequate variability. Low estimates of phenotypic and genotypic coefficients of variations revealed in general (Table 1), but grain yield and harvest index showed maximum coefficients of variation. Heritability was high for harvest index and flowering time while genetic advance was high for harvest index and flowering time while genetic advance was high only for plant height (Table 1). The absence of any character combining high heritability as well as high genetic advance in this study suggests that non-additive gene actions are predominantly operating for the characters studied (Liang and Walter, 1968). Lohithaswa *et al.* (1996) in a study in the plains of southern India reported

Table 1. Estimates of genetic variability in grain amaranth

Character	Mean	PCV (%)	GCV (%)	Genetic advance	Heritability (%)
Flowering time	69.3	6.1	5.3	6.7	77.4
Maturity period	131.7	2.8	2.2	4.5	58.7
Plant height	227.5	10.4	7.3	23.9	49.3
Inflorescence length	77.9	14.0	7.1	5.8	25.6
Basal girth	7.9	11.8	6.2	5.3	27.7
Height:girth ratio	3.5	12.1	9.0	0.5	55.2
Test weight	8.6	2.9	1.9	0.2	44.4
Harvest index	16.2	18.0	16.5	5.0	83.6
Seed yield	12.9	27.6	18.2	3.2	43.2

high heritiability but moderate genetic advance for plant height and days taken to 50% flowering only.

The phenotypic and genotypic correlation coefficients are presented in Table 2. Harvest index, plant height, inflorescence length, maturity period, flowering time and test weight had significant positive associations with grain yield. Plant height had significant positive association with all the characters except height:girth ratio. Thus, selection for this characters may result in correlated response in other character including seed yield. The significant positive correlation of test weight, inflorescence length and flowering time with plant height suggests that tall and late flowering plants having longer inflorescence and larger seed size would produce high seed yield. Tall and late maturing genotypes were found to be higher yielders among the Himalayan collections by Joshi and Rana (1991, 1995) also. But, these unfavourable associations may pose difficulty in breeding early maturing genotypes having high seed yield which are of prime importance in the hill farming system where crop growing period is extremely short because of the limitations imposed by cold climatic conditions. The significant positive association of harvest index with seed yield indicates high partitioning ability of the high yielders. Genotypic correlations showed almost similar trend as that of phenotypic correlations but had larger values. Inflorescence length had maximum genotypic correlation with seed yield.

Path coefficient analysis was carried out using phenotypic correlations to estimate the direct and indirect contribution of individual characters on grain yield. Harvest index had the highest positive direct effect on grain yield followed by maturity period, basal diameter, plant height and inflorescence length (Table 3). Height: girth ratio and flowering time had direct negative effects on seed yield. Test weight had negligible direct contribution indicating its minimum influence on seed yield. The indirect effect of harvest index through flowering time was negative but it was positive through other characters. Plant height, inflorescence length and flowering time all had positive indirect contributions through harvest index. Pandey (1981) observed that plant

Table 2. Phenotypic (upper) and genotypic (lower) correlations in grain amaranth

	Maturity period	Plant height	Inflorescence length	Basal diameter	Height: diameter	Test weight	Harvest index	Seed yield
Flowering time	0.535** 0.734	0.377** 0.860	0.394** 0.957	0.228 0.694	-0.162 -0.321	0.246 0.460	0.390** 0.436	0.284* 0.727
Maturity period	–	0.179 0.425	0.150 0.826	0.134 0.368	-0.052 -0.139	0.445** 0.646	0.207 0.233	0.314* 0.430
Plant height	–	–	0.613** 1.215	0.454** 0.134	-0.474** -0.790	0.910** 0.263	0.399** 0.661	0.476** 0.893
Inflorescence length	–	–	–	0.424** 0.696	-0.139 -0.660	0.181 0.657	0.370** 0.916	0.385** 1.098
Basal girth	–	–	–	–	0.555** 0.504	0.142 0.324	0.257 0.485	0.240 0.716
Height:diameter	–	–	–	–	–	0.011 -0.030	-0.164 -0.287	-0.233 -0.336
Test weight	–	–	–	–	–	–	0.180 0.247	0.288* 0.302
Harvest index	–	–	–	–	–	–	–	0.536** 0.965

*, ** Significant at 0.05 and 0.01 probability levels, respectively

Table 3. The direct (bold) and indirect effects of different characters on seed yield in grain amaranth

	Flowering time	Maturity period	Plant height	Panicle length	Basal diameter	Height: diameter	Test weight	Harvest index	Phenotypic correlation with seed yield
Flowering time	**-0.1474**	0.1319	0.0440	0.0412	0.0323	0.0289	0.0002	0.1529	0.284*
Maturity period	-0.0790	**0.2465**	0.0209	0.0157	0.0189	0.0093	0.0004	0.0810	0.314*
Plant height	-0.0556	0.0442	**0.1167**	0.0642	0.0643	0.0848	0.0009	0.1561	0.476**
Inflorescence Length	-0.0580	0.0370	0.0716	**0.1047**	0.0600	0.0249	0.0002	0.1448	0.385**
Basal girth	-0.0337	0.0329	0.0529	0.0443	**0.1417**	-0.0993	0.0001	0.1007	0.240
Height:diameter	0.0239	-0.0128	-0.0554	-0.0145	0.0787	**-0.1789**	0.0001	-0.0640	-0.223
Test weight	-0.0363	0.1098	0.1062	0.0189	0.0201	-0.0020	**0.0010**	0.0706	0.288*
Harvest index	-0.0576	0.0509	0.0465	0.0387	0.0365	0.0293	0.0002	**0.3916**	0.536**

Residual effect = 0.584

height had the greatest direct effect on the number of panicles which is an important yield contributory character.

Thus, in view of the above, it appears that selection of late maturing but early flowering and tall plants having higher partitioning efficiency would result in increased seed yield in grain amaranth. But, this may result into reduced cropping intensity and increased lodging susceptibility. However, the linkage of these unfavourable associations with seed yield could be broken through intensive recombination breeding. The high residual effect suggests that the present set of characters alone were not sufficient in explaining the variability in seed yield and hence more yield contributing characters need to be included in future studies.

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