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Genetic variability, heritability and genetic advance in grain amaranth (*Amaranthus* spp.)

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One hundred germplasm accessions of grain amaranth were evaluated during *Kharif*-2011 for assessing the genetic variability present in the material for grain yield and yield related traits. Analysis of variance revealed significant differences among the genotypes for all the characters studied. High PCV and GCV was observed for stem girth, plant height, panicle length and grain yield per plant. On the other hand, low PCV and GCV were observed fordays to maturity and grain protein content. All the traits studied exhibited high heritability. High genetic advance as per cent of mean was observed for days to 50 per cent flowering, stem girth, number of leaves per plant, plant height, panicle length, panicle width and grain yield per plant indicating scope for improvement of the traits of interest through hybridization and selection.

Key words : Heritability, Variability, Genetic advance

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INTRODUCTION

Grain amaranth is a protein rich pseudo-cereal belongs to family Amaranthaceae. The genus *Amaranthus* contains more than 60 species, of which there are four cultivated species, *Amaranthus* are native to new world and it is widely distributed throughout the old and new world. In India, these are cultivated both in hills as well as plains covering states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Chattisgarh, Maharastra, Gujarat, Orissa, Karnataka, Kerala and Tamil Nadu. It is a potential nutritional crop as the grain contains 14-16 per cent protein which other commonly used cereals like rice, wheat and maize do not contain this much of protein (Sauer, 1967). The protein is of higher quality due to the presence of higher lysine content (5.0 to 6.0 %) and also rich in the sulphur-containing amino acids which confirms its high potential for use in both human and animal nutrition and also shows high promise for supplementing nutritive food and amelioration of protein deficiency strictly in the vegetarian diet people (Downton, 1973; Senft, 1980; Vietmeyer, 1980; Bressani *et al*., 1987a; Bressani *et al*.,1987b; Andrasofszky *et al*., 1998). The genetic parameters like co-efficient of variation, heritability and genetic advance as per cent of mean provide a clear insight into the extent of variability and a relative measure of the efficiency of selection of genotypes based on phenotype, in a highly variable population. Hence, the present study was carried out to find the genetic parameters for yield and its component traits in grain amaranth.

RESEARCH METHODOLOGY

Field experiment for the present study on grain amaranth was conducted at the field unit of All India Coordinated Research Network on Underutilized Crops, Main Research Station, Hebbal, University of Agricultural Sciences Bangalore during *Kharif* 2011-12 under protective irrigation. The experimental material used in the present study comprised of hundred genotypes of grain amaranth of which fifty germplasm lines were obtained from Sardar Krushinagar Dantiwada Agricultural University, Gujarat and fifty from National Bureau of Plant genetic Resources (NBPGR) Regional Station, Akola, (Maharastra). Three varieties *viz.*, Suvarna, BGA-2 and GA-2 were used as check varieties.

The experiment was laid out in an Augmented design with 10 compact blocks. Each block was comprised of 10 genotypes and three checks. All the checks were repeated in all the blocks, while the genotypes were unreplicated. Each genotype was sown in two rows of three meters length, each with a spacing of 45 centimeters between the rows. Thinning of seedlings was done after 25-30 days after sowing and plant to plant distance of 15 centimeters was maintained. All the normal recommended agronomic practices and plant protection measures were followed for raising a good and healthy crop. Five plants were randomly selected and the observations were recorded in respect of various characters in each genotype. The average values of observations on these five plants were used as treatment mean in all statistical analysis. The observations included days to 50 per cent flowering, days to maturity, stem girth (cm), number of leaves per plant, plant height (cm), panicle length (cm), panicle width (cm), seed weight (g/10 ml), grain protein content (%) and grain yield per plant (g). Estimates of phenotypic, genotypic and environmental co-efficients of variation, heritability, and genetic advance were computed according Burton and Devane (1953) and Johnson *et al.* (1955), respectively.

RESEARCH FINDINGS AND ANALYSIS

The statistical analysis showed highly significant differences among the genotypes for all the characters studied, indicating considerable amount of genetic variation in the material. The mean, range, variance, co-efficient of variation, heritability and genetic advance for 10 traits including grain yield are presented in the Table 1.

The highest value of phenotypic co-efficient of variation (PCV) and genotypic co-efficient of variation (GCV) were observed for grain yield per plant (63.08 and 55.96%, respectively) followed by stem girth (50.94 and 47.86 %), panicle length (37.57 and 31.67 %) and plant height (31.76 and 25.73 %). Higher values of PCV with corresponding higher values of GCV in these traits suggest that these characters are under the influence of genetic control. Hence, these characters can be relied up on and simple selection can be practiced for further improvement of these traits. Similar kind of results have been reported by Hiremath (2005), Yashwant Kumar (2009), Joshi (1986), Pandey (1982) and Vaidya (1984). The character which showed higher PCV but moderate GCV was number of leaves per plant. (21.42 and 17.75, respectively) Joshi and Mehra (1983), Vaidya (1984) and Hiremath (2005) reported similar observation for this trait. Inspite of the differences between PCV and GCV, considerable variability existed for these characters indicating that there is abundant scope for selection. Moderate phenotypic and genotypic co-efficients of variation were observed for days to 50 per cent flowering (11.27, 10.64), panicle width (18.75, 17.38) and seed weight (10.87, 10.18). Remaining characters *viz.*, days to maturity and grain protein content showed lower values of phenotypic and genotypic co-efficient of variation, which is in conformity with the findings of Lohitaswa (1992), Hiremath (2005), Maruthi (1987) and Kusuma *et al.* (2007). Low variability present in these characters suggests applying suitable selection procedures to improve the characters which have limited genetic variability. The differences were minimum between PCV and GCV for seven out of ten traits studied indicating less influence of environment in expression of these traits. In respect of number of leaves, plant height and grain yield per plant the differences between phenotypic co-efficient of variation (PCV) and genotypic co-efficient of variation (GCV) were higher indicating more influence of extraneous factors on the expression of these traits.

Effectiveness of selection depends not only on the nature of gene combination of individual genes; but also influenced

Table 1: Variability parameters for ten different characters in grain amaranth

Sr. No.	Characters	Mean ± SE	Range		Variance		Co-efficient of variability		h^2 (broad Sense) (%)	GA as per cent of mean
			Lowest	Highest	PV	GV	PCV (%)	GCV (%)		
1.	Days to 50% flowering	44.41±2.70	27.55	59.87	25.05	22.321	11.27	10.64	89.10	20.69
2.	Days to maturity	82.10±3.03	59.59	106.90	35.82	32.42	7.29	6.93	90.51	13.59
3.	Stem girth (cm)	2.98±0.85	1.02	3.99	2.30	2.03	50.94	47.86	88.27	92.62
4.	Number of leaves per plant	84.39±16.53	27.12	122.90	326.90	224.39	21.42	17.75	68.64	30.30
5.	Plant height (cm)	99.58±30.27	49.27	178.78	1000.24	656.60	31.76	25.73	65.64	42.95
6.	Panicle length (cm)	36.28±11.98	14.21	60.79	185.80	132.02	37.57	31.67	71.05	54.99
7.	Panicle width (cm)	10.78±1.24	6.43	17.89	4.09	3.51	18.75	17.38	85.87	33.12
8.	Seed weight (g/10 ml)	7.89±0.48	5.88	11.21	0.74	0.65	10.87	10.18	87.77	19.65
9.	Grain protein content (%)	12.91±0.74	7.89	16.75	0.82	0.80	7.01	6.92	97.56	14.10
10.	Grain yield per plant (g)	24.39±11.62	10.50	43.50	236.73	186.31	63.08	55.96	78.70	102.26

strongly by the degree to which phenotype can be modified by environment, selection acts on genetic differences and benefit from selection for a particular trait depends largely on its heritability (Allard, 1960). Thus it is evident that the co-efficient of variation alone may not reveal the actual situation of heritable nature of the trait. Hence, to obtain more information on heritable portion of the variability, it is essential to know the heritability estimates of different characters. In view of Burton (1952) GCV along with heritability would provide a precise idea to the amount of genetic gain to be expected from selection. High estimates of broad sense heritability were observed for all the characters studied, indicating less influence of environmental factors on expression of these characters. The results indicated the presence of high genotypic component of variability, which might be of much value in the selection programme. The result is in conformity with the reports of Pushpa Rekha (1986) and Yashwant Kumar (2009). High heritability (broad sense) does not always indicate better response to selection since it is inclusive of non-additive genetic variance also. Hence, for predicting the real resultant effect of selection, high heritability coupled with high genetic advance heritability estimates appear to be more meaningful when accompanied by estimates of genetic advance.

Genetic advance is a measure of improvement that can be achieved by practicing selection in a population. Genetic advance under selection depends mainly on the amount of genetic variability in the base population, intensity of the selection and magnitude of the masking effect of the environmental and interaction components of variability. In the current study, high genetic advance (as per cent of mean) was observed for days to 50 per cent flowering, stem girth, number of leaves per plant, plant height, panicle length, panicle width and grain yield per plant suggesting that these variables are not much influenced by environmental factors and substantial improvement for these characters could be achieved through direct selection and also these traits are considered to be governed by additive genes. These results are supported by findings of Yashwant Kumar (2009) and Das *et al*. (1991). Moderate genetic advance as per cent on mean was observed for days to maturity (13.59), seed weight (19.65) and grain protein content (14.10) indicating moderate response of these characters for selection and less influence of environment but found to be governed by both additive and non-additive gene action. Similar results were reported by Pushpa Rekha (1986), Maruthi (1987) and Lohitaswa (1992). Since genotypic co-efficient of variability, phenotypic co-efficient of variability and heritability estimates determine the component of heritable variation and genetic advance measures the extent of its suitability under selection, all these parameters should be considered simultaneously so as to bring effective improvement in yield and other characters of interest included in the present study.

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