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Genetic Variability, Heritability and Genetic Advance in Grain Amaranth (*Amaranthus* spp.)

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A B S T R A C T

Forty four germplasm accessions of amaranth *spp* were evaluated during *rabi*-2016 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 number branches per plant, number of panicles per inflorescence, number of inflorescence per plant, panicle length (cm), panicle breadth (cm), thousand seed weight (mg), seed yield per plant (g), inflorescence length (cm), plant height at 90 das (cm) and stem diameter (cm). On the other hand, low PCV and GCV were observed for days to seed maturity. All the traits studied exhibited high heritability. High genetic advance as per cent of mean was observed for number branches per plant, number of inflorescence per plant, number of panicles per inflorescence, panicle length (cm), panicle breadth (cm) and thousand seed weight (mg) and seed yield (g) indicating predominance of additive genetic component in expression of these traits. Thus, there is scope for improvement of seed yield by adopting selection.

Introduction

Grain Amaranth is a very versatile pseudo-cereal crop and grown in a wide range of agro-climatic conditions (temperature 20-40ºC, elevation 500-2500 m from MSL and rainfall 800 mm to 1500 mm). The genus *Amaranthus* consists of approximately 60 species out of which about 18 species are occurring in India. There are three major grain producing *Amaranthus* species, *A. caudatus, A. cruentus and A. hypochondriacus*, all believed to originate from Central and South America (Sreelathakumary and Peter, 1993; Grubben, 1976). It is one of those rare plants whose leaves are eaten as a vegetable while the seeds are used as cereals. Besides, it is also used as fodder, ornamental, organic red dye and for industrial purposes.

The genus *Amaranthus* is receiving increasing attention because of the nutritional properties of the grain and leaves and can now be found throughout the world (Schulz- Schaeffer, 1993). It's high in protein, particularly in the amino acid Lysine, which is low in the other cereal grains. Amaranth is also rich in many vitamins and minerals. However, Amaranth does not contains gluten and because of this, it's not good for making yeast breads (O'Brien and Price, 1983). The wide geographical spread of the genus has resulted in the evolution of many landraces in widely separated areas forming a huge gene pool. In India, *Amaranthus* is mainly cultivated in the rural areas and is well adapted to diverse climatic conditions, highly resistance to stresses (including diseases and pests).

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.

Materials and Methods

Field experiment for the present study on grain amaranth was conducted at the research field unit of University of Horticultural Sciences, Bagalkot, Karnataka, during *rabi* 2015 – 16. The experimental material used in the present study comprised of forty four genotypes of amaranth *spp* of which thirty five germplasm lines were obtained from National Bureau of Plant Genetic Resources (NBPGR) Regional Station, Shimla, (Himachal Pradesh). Rest of nine used are varieties *viz.,* CO 1, CO 2, CO 3, CO 4, CO 5, Arka suguna, Arka samraksha, Arka arunima and Arka varna. The experiment was laid out in RBD with two replications. In each replication, each entry was grown in two rows at 30 cm apart with row length of 5 m. Thinning of seedlings was done after 15 days after sowing and plant to plant distance was maintained at 15 centimeters. A basal dose of 50 kg ha^{-1} each of P_2O_5 and K_2O along with nitrogen 100 kg ha^{-1} was applied through single super phosphate, muriate of potash and urea respectively. All recommended package and practices were followed to raise good 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 first flowering, days to 50% flowering, plant height at 90 DAS (cm), stem diameter (cm), number branches per plant, number of inflorescence per plant, inflorescence length (cm), number of panicles per inflorescence, panicle length (cm), panicle breadth (cm), days to seed maturity, thousand seed weight (mg), seed protein content (%), seed yield per plant (g). The protein content of seeds from each variety was estimated as per the Lowry's method and expressed in per cent (Lowry *et al.,* 1951). Estimates of phenotypic and genotypic co-efficients of variation, heritability, and genetic advance were computed according Burton and Devane (1953) and Johnson *et al.* (1955) respectively.

Results and Discussion

The statistical analysis showed highly significant differences among the genotypes for all the characters studied, indicating considerable amount of genetic variation in the material (Table 1). The mean, range, variance, co-efficient of variation, heritability and genetic advance for fourteen traits including grain yield are presented in the Table 2. The highest value of phenotypic co-efficient of variation (PCV) and genotypic co-efficient of variation (GCV) were observed for number branches per plant (90.64 and 93.96 %), followed by number of panicles per inflorescence (83.29 and 87.85%), number of inflorescence per plant (68.84 and 74.83 %), panicle length (cm) (64.28 and 68.29%), panicle breadth (cm) (40.68 and 43.50%), thousand seed weight (mg) (34.66 and 34.66%), seed yield per plant (g) (29.77 and 35.50%), stem diameter (cm) (29.85 and 31.57%), plant height at 90 DAS (cm) (28.37 and 29.64%), inflorescence length (cm) (27.73 and 32.09%), seed protein content (22.11 and 22.13 %) and days to first flowering (21.30 and 21.83 %). 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 Venkatesh *et al.*, (2014) for stem girth, number of leaves per plant, plant height, panicle length and seed yield per plant. Patial *et al.* (2014), Yadav *et al.* (2014), Akaneme and Ani, (2013), Selvan *et al.* (2013) and Sravanthi *et al.* (2012) for the seed yield. Moderate PCV and GCV are estimated for days to fifty per cent flowering, whereas days to seed maturity showed lower values of phenotypic and genotypic co-efficient of variation, which is in conformity with the findings of Venkatesh *et al.* (2014), Patial *et al.* (2014) and Rana *et al.* (2005). Thus, for improvement of these traits there is need for creating variability through introduction and hybridizing the diversified genotypes to generate transgressive segregant.

Phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the traits indicating that environmental factors were influencing their expression. Wide difference between phenotypic and genotypic coefficient of variations was observed for number of inflorescence per plant, inflorescence length (cm), number of panicles per inflorescence and seed yield per plant (g) indicated their sensitiveness to environmental fluctuations whereas rest of all traits showed narrow difference indicating less environmental interference on the expression of these traits.

Effectiveness of selection depends not only on the nature of gene combination of individual genes; but also influenced 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, but high heritability does not always indicate high genetic gain, heritability with genetic advance should be used in predicting selection of superior genotypes (Ali *et al.*, 2002). High estimate of heritability coupled with high genetic advances over mean were observed for the characters *viz.*, plant height at 90 DAS, stem diameter, number of branches per plant, number of inflorescence per plant, number of panicles per inflorescence, panicle length, panicle breadth, thousand seed weight and seed yield per plant. Similar observation were made by Venkatesh *et al.* (2014) for stem girth, panicle length, panicle width and seed yield per plant in *Amaranthus spp.*, similar observation also made by Sravanthi *et al.* (2012), Selvan *et al.* (2013), Yadav *et al.* (2014), Mobina and Jagatpati (2015) in amaranth for traits like plant height, stem diameter, number of branches per plant and seed yield. This indicated predominance of additive genetic component in expression of these traits.

Table.1 Analysis of variance (mean squares) for different growth and quality parameters for seed yield parameters in amaranth genotypes during *rabi* season

Sl No	Source of variation/characters	Replication	Treatment (Genotypes)	Error	C.D. (1%)	C.D. (5%)
	Degree of freedom	**1**	**43**	**43**		
1.	Days to first flowering	0.01	123.82	3.05	4.71	3.52
2.	Days to 50% flowering	1.37	125.85	2.44	4.21	3.15
3.	Plant height at 90 DAS (cm)	81.62	1018.95	44.57	17.99	13.46
4.	Stem diameter (cm)	0.02	0.19	0.010	0.27	0.20
5.	Number branches per plant	0.045	19.11	0.68	2.23	1.66
6.	Number of inflorescence per plant	0.12	19.61	1.63	3.44	2.57
7.	Inflorescence length (cm)	123.47	173.73	25.19	13.52	10.12
8.	Number of panicles per inflorescence	1.50	438.54	23.30	13.01	9.73
9.	Panicle length (cm)	19.56	159.07	9.61	8.35	6.25
10.	Panicle breadth (cm)	0.08	0.35	0.02	0.41	0.31
11.	Days to seed maturity	0.001	111.47	0.20	1.23	0.92
12.	Thousand seed weight (mg)	12.37	87680.97	11.00	8.93	6.68
13.	Seed protein content (%)	0.001	10.18	0.007	0.23	0.17
14.	Seed yield per plant (g)	1.44	30.93	5.38	6.25	4.68

All significant at 1% level

Table.2 Estimates of mean, range, components of variance, heritability and genetic advance for seed yield parameters in amaranth genotypes during *rabi* season

Sl. No.	Character	Mean ±S.Em	Range	GV	PV	GCV (%)	PCV (%)	h^2	GA	GAM (%)
1	Days to first flowering	36.49 ± 1.24	23.00 - 48.00	60.38	63.44	21.30	21.83	95.18	15.62	42.80
2	Days to 50% flowering	40.08 ± 1.11	25.50 - 52.50	61.71	64.15	19.60	19.98	96.18	15.87	39.60
3	Plant height at 90 DAS (cm)	77.79 ± 4.72	44.17 - 133.00	487.21	531.78	28.37	29.64	91.61	43.52	55.94
4	Stem diameter (cm)	1.00 ± 0.07	0.5 - 1.80	0.09	0.10	29.85	31.57	89.39	0.58	58.19
5	Number branches per plant	3.35 ± 0.59	0 - 11.34	9.21	9.90	90.64	93.96	93.06	6.03	180.17
6	Number of inflorescence per plant	4.36 ± 0.90	1.00 - 11.17	8.99	10.63	68.84	74.83	84.63	5.68	130.47
7	Inflorescence length (cm)	31.08 ± 3.55	14.33 - 52.17	74.27	99.46	27.73	32.09	74.67	15.34	49.36
8	Number of panicles per inflorescence	17.30 ± 3.41	1- 52.18	207.62	230.93	83.29	87.85	89.90	28.15	162.69
9	Panicle length (cm)	13.45 ± 2.19	1.16 - 38.50	74.74	84.35	64.28	68.29	88.60	16.76	124.64
10	Panicle breadth (cm)	1.01 ± 0.11	0.52 - 3.18	0.17	0.19	40.68	43.50	87.48	0.79	78.42
11	Days to seed maturity	92.14 ± 0.32	78.00 - 103.50	55.63	55.84	8.10	8.11	99.62	15.34	16.65
12	Thousand seed weight (mg)	604.13 ± 2.35	227.00 - 1325.50	43834.99	43845.99	34.66	34.66	99.97	431.24	71.38
13	Seed protein content (%)	10.20 ± 0.06	6.36 - 14.71	5.09	5.09	22.11	22.13	99.84	4.64	45.51
14	Seed yield per plant (g)	12.01 ± 1.64	6.70 - 23.56	12.77	18.16	29.77	35.50	70.33	6.18	51.44

GV – Genotypic variance; PV – Phenotypic variance
GCV – Genotypic coefficient of variance; PCV – Phenotypic coefficient of variance
GA – Genetic advance; h^2 – Heritability
GAM – Genetic advance over mean

Thus, there is scope for improvement of seed yield by adopting selection. Based on these traits, some of the promising genotypes in the genetic stock studied are G-4, G-20, G-27, G-32 and G-33 which have high seed yield per plant.

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