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Genetic analysis and inter-relationship of yield attributing traits in Amaranthus germplasm

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Abstract
In the present investigation 67 germplasms including four checks of *amaranthus spp.* maintained in research plot of Department of Plant Breeding and Genetics at Birsa Agricultural University, Kanke to collect information on the extant of variability, degree of association of different yield components, their direct and indirect effect on seed yield and extant of genetic diversity among the genotypes. The experiment was conducted in the research plot of Ranchi Agriculture College farm during rabi 2013. *Amaranthus* are summer annual weeds and are commonly referred to as pigweed. Catkin-like cymes of densely packed flowers grow in summer or autumn. The analysis of variance revealed highly significant differences among germplasm for eleven characters and significant for remaining two characters studied. This indicated the inherent genetic differences among the genotypes for all the fourteen quantitative characters and thirteen qualitative characters under the present study. A wide range of phenotypic variability observed for plant height, seed yield per plant, insect infestation, days to maturity and days to 50% flowering. The genotypic & phenotypic coefficient of variance was highest in number of branches per plant among all other quantitative traits followed by plant height and petiole length respectively. Genetic Advance were being observed by plant height followed by days to 50% flowering at 5%.

Keywords: Genetic advance, Heritability, Genotypic and Phenotypic coefficient of variation (GCV and PCV)

Introduction
Amaranthus, collectively known as amaranth is a cosmopolitan genus of annual or short-lived perennial plants. Some amaranth species are cultivated as leaf vegetables, pseudo-cereals, and ornamental plants. Most of the species from *Amaranthus* are summer annual weeds and are commonly referred to as pigweed. Amaranth originated in America and is one of the oldest food crops in the world, with evidence of its cultivation reaching back as far as 6700 BC. The nutritive value as per 100 gram of grain amaranth is energy-1,554 kJ (371 kcal), carbohydrates-65.25 g, fat-7.02g saturated fat-1.459g, protein-13.56g. Amaranth is not usually planted in South Africa but occurs as a volunteer crop after the first rains; it is harvested from the wild. Genetic divergence study helps to develop cultivars with increased yield, wider adaptation, desirable qualities, pest and disease resistance. Contribution of component traits to yield either through their direct effects or indirect effects cannot be differentiated from more correlation studies. Manggoel *et al.*, (2012) suggested that path coefficient analysis would be of great importance to a plant breeder as a flexible means of relating the correlations coefficients between variables in a multiple system to the functional relation among them.

Materials and Methods
The present investigation was carried out in the experimental area of Department of Plant Breeding & Genetics, Birsa Agricultural University, Ranchi. Sixty seven germplasm of grain amaranth were taken from Underutilized Crops research scheme of Plant Breeding and Genetics department along with seven check varieties in the present experiment. The parental material for the present study comprised of 60 germplasm along with seven checks varieties. The data on twelve quantitative characters were recorded on randomly in each selected plant for characters like Plant Height (cm), Inflorescence length (cm), Leaf length (cm), Leaf width (cm), Petiole Length (cm), Days to 50% flowering, Number of branches per plant, Days to

80% Maturity, Seed weight (g/10 ml), Seed yield per plant (g), Oil Content (%), Protein Content (%). The mean value is used for statistical analysis. Analysis of variation was done for partitioning the total variation into variation due to treatments and replications. Heritability in broad sense was calculated by the formulae given by Lush (1949) and Johnson (1955). The genetic advance was obtained by the formulae given by Johnson (1955).

Results and Discussion

The analysis of variation was carried out among 67 genotypes including seven checks (GA-1, GA2, VL-44, Suvarna, GA-3, BGA-2, RMA-7), out of 12 character studied the analysis of variance revealed highly significant difference among the genotypes for the all the yield attributing traits which is shown in Table 1. The phenotypic co-efficient of variation (PCV) is higher than that of genotypic coefficient of variation (GCV) for all the characters except leaf length and leaf width. Highest value of genotypic co-efficient of variation was observed for number of branches per plant (40.54) followed by plant height (40.10).

Heritability and Genetic advance are important selection parameters. Heritability estimates along with genetic advance are normally more helpful in predicting the gain selection than heritability estimates alone. Hence knowledge about genetic advance coupled with heritability is most useful. high magnitude of heritability was recorded for protein content (99.9%) followed by oil content (99.3%), plant height (99%), seed yield per plant (98%), number of branches per plant (97.5%), petiole length (97), inflorescence length (96.5), days to 50% flowering (95.5%), leaf length (95.4%) and leaf width(93.9%). Similar results were obtained by Varalakshmi and Reddy (1997) [11], Revenappa *et al*.,(1998) [8], Shukla *et al*., (2006), Anuja and Mohideen (2007) [1], Pan *et al.,* (2008) [4]. and Pan *et al.* (2013) [5].

The genetic advance as percent of mean was observed high for the characters plant height (45.68%). When heritability and genetic advance as expressed in percent of mean were considered together, it was observed that most of the yield and yield contributing characters *viz*., plant height, days to maturity, days to 50% flowering, inflorescence have recorded high heritability coupled with high genetic advance. This indicated that the yield and quality contributing traits are mostly governed by additive gene effects and selection for these traits would be effective for yield as well as quality improvement, Anuja and Mohideen (2007) [1] reported high heritability coupled with high genetic advance for plant height, leaf length and leaf width. High heritability estimate have been found to be helpful in making selection of superior genotypes, on the basis of superior genotypic performance of economic trait. It has been realized that heritability estimates in broad sense along with the genetic advance is more useful in producing the resultant effect for selection of the best individuals as reported by Johnson *et al*., (1955). Heritability in broad sense include both positive and epistatic gene effect. High heritability associated with the high genetic advance is expected due to the additive gene action. This indicates the presence of additive gene effect and consequently a high genetic gain from phenotypic selection. Although, variability estimates provide information on the extent of improvement possible in different characters, but they do not explain about the extent and nature of relationship prevalent between these characters. This could be obtained from simple association analysis that determines the direction of action of different characters. Based on this analysis, the traits that can be selected for improving the desired variables can be ascertained. Yield, a complex character is dependent on various ancillary traits predominantly governed by a large number of genes and are greatly influenced by environmental fluctuations. These traits may vary in their relationship with yield in terms of their nature as well as magnitude. Therefore, selection based on yield alone is not effective. Therefore, selection based on yield alone is not effective. Therefore, the importance of quality as the character of prominent choice in plant breeding needs no comment. The value of studies on relationship between various quality characters in addition to yield components which influence quality is very great indeed, as it furnishes to the plant breeder with an easy and fairly reliable means of isolating high yielding with better quality genotypes from the breeding material. An improvement in yield and quality can be brought by effective indirect selection for yield and quality contributing components, whose heritability are high and show a strong positive association with yield which acts as an alternative mode of selection for yield improvement.

Wide range of means was observed for all the characters. Correlation revealed the significance of inflorescence length, leaf length, leaf width for selecting better yielding genotypes observed by Rana *et a*l., (2005) [7]. A positive correlation of seed yield per plant with inflorescence length, leaf length, leaf width, number of branches per plant, days to maturity and gram per ml seed weight was obtained. Similar results were found by Varalakshmi and Reddy (1994) [10] and Joshi and Rana (1995) [2]. Prajapati *et al*. (2005) [6] reported positive correlation with inflorescence length. Rana *et al*., (2005) [7] reported a positive correlation of seed yield with leaf width and inflorescence length. Kusuma *et al*., (2007) [3] reported a positive association of seed yield with inflorescence-length.

Table 1: Analysis of variance of different characters in grain amaranth

Sources of variation	df	Plant Height (cm)	Inflorscence length (cm)	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)	Days to 50% flowering	Number of branches/ plant	Days To maturity	Seed weight (g/10ml)	Seed yield/ plant (g)	Oil Content (%)	Protein content (%)
Treatment	66	1494.7**	116.6**	13.55**	3.861**	8.306**	209.60**	9.038**	253.68**	1.261*	93.622**	23.903**	31.349**
Replication	2	0.096	0.002	0.002	0.003	0.001	0.154	0.001	1.209	0.001	0.313	0.070	0.039
Error	132	9.571	4.070	0.617	0.236	0.248	9.442	0.227	27.294	0.408	93.622	0.163	0.034

*, ** Significant at 5% and 1% probability levels, respectively.

Table 2: Mean, range and variance for different characters in grain amaranth

Characters	Mean	Range	σ^2 Error	σ^2 phenotypic	σ^2 genotypic
Plant Height (cm)	55.48	98.3-19	3.19	498.25	495.06
Inflorescence Length (cm)	23.31	38-11.6	1.35	38.88	37.52

Leaf length (cm)	8.65	14-3.5	0.20	4.51	4.31
Leaf Width (cm)	4.65	7-3	0.07	1.28	1.20
Petiole length (cm)	5.62	9-2	0.08	2.76	2.68
Days to 50% flowering	77.25	93-61	3.14	69.86	66.72
Number of branches per plant	4.22	8-1.16	0.07	3.01	2.93
Days to 80% maturity	143.71	170-127	9.09	84.56	75.46
100 seed weight	9.70	10.8-6.1	0.13	0.42	0.28
Seed yield per plant (g)	21.84	34-9.8	0.63	31.20	30.57
Oil content	8.36	15-4.66	0.05	7.96	7.91
Protein content (%)	21.98	27-18.18	0.01	10.44	10.43

Table 3: Estimation of genetic parameter of 12 characters of amaranthus

Characters	Genotypic Coefficient of Variance	Phenotypic Coefficient of Variance	Environmental Coefficient of Variance	Heritability (%)	Genetic Advance	Genetic Advance as % of mean
Plant Height (cm)	40.10	40.23	5.57	99.0	45.68	105.52
Infloresence Length (cm)	26.27	26.74	8.65	96.5	12.39	68.13
Leaf Length (cm)	23.98	24.55	9.07	95.4	4.18	61.68
Leaf Width (cm)	23.60	24.36	10.43	93.9	2.19	60.37
Petiole Length (cm)	29.14	29.59	8.87	97.0	3.32	75.78
Days to 50% Flowering	10.57	10.81	3.97	95.5	16.44	27.27
No. of Branches/ Plant	40.54	41.06	11.27	97.5	3.48	105.69
Days To 80% Maturity	6.04	6.39	3.63	89.2	16.90	15.07
Seed Weight (g/10ml)	5.49	6.68	6.58	67.6	0.90	11.92
Seed Yield/Plant (g)	25.31	25.57	6.31	98.0	11.27	66.14
Oil Content (%)	33.63	33.74	4.83	99.3	5.77	88.48
Protein content (%)	14.69	14.70	0.83	99.9	6.65	38.78

Table 4: Estimation of genotypic (g) and phenotypic (p) correlation among different yield attributing traits

Characters		Inflorescence Length (cm)	Leaf Length (cm)	Leaf Width (cm)	Petiole Length (cm)	Days to 50% flowering	Number Of Branches/ Plant	Days To 80% Maturity	Seed weight (g/10ml)	Seed Yield/ Plant(g)	Oil Content (%)	Protein Content (%)
Plant Height (cm)	G	0.05	0.29**	0.28*	0.45**	0.43**	-0.40**	0.53**	-0.16	-0.12	0.18	-0.23*
	P	0.05	0.28*	0.27*	0.44**	0.42**	-0.39**	0.50**	-0.13	-0.12	0.18	-0.23*
Inflorescence Length (cm)	G		0.47**	0.36**	0.40**	-0.17	0.23*	-0.00	-0.05	0.03	-0.00	-0.13
	P		0.45**	0.34**	0.39**	-0.16	0.22*	-0.00	-0.05	0.03	-0.00	-0.13
Leaf Length (cm)	G			0.62**	0.68**	0.14	0.27*	0.14	-0.17	0.08	-0.08	-0.16
	P			0.59**	0.65**	0.14	0.26*	0.13	-0.12	0.08	-0.08	-0.15
Leaf Width (cm)	G				0.60**	0.07	0.06	0.01	0.03	0.09	0.16	-0.18
	P				0.57**	0.06	0.05	0.01	0.03	0.09	0.15	-0.17
Petiole Length (cm)	G					0.36**	0.20	0.32**	-0.33**	-0.00	-0.02	-0.30**
	P					0.35**	0.19	0.30**	-0.27*	-0.00	-0.02	-0.30**
Days To 50% Flowering	G						0.17	0.41**	-0.41**	-0.00	-0.04	-0.25*
	P						0.17	0.38**	-0.34**	-0.00	-0.04	-0.25*
Number of Branches/Plant	G							-0.13	-0.25*	0.15	-0.04	-0.03
	P							-0.12	-0.22*	0.15	-0.04	-0.03
Days To 80% Maturity	G								-0.60**	0.05	0.05	-0.19
	P								-0.47**	0.04	0.05	-0.18
g/10 ml Seed Weight	G									0.10	0.03	0.14
	P									0.08	0.02	0.12
Seed Yield Per Plant	G										0.15	0.17
	P										0.15	0.17
Oil Content (%)	G											0.20
	P											0.20

Conclusion

In the present study phenotypic coefficient of variations was higher in magnitude than the genotypic coefficient of variations in respect of all the characters. High to moderate phenotypic and genotypic co-efficient of variation (PCV & GCV) were recorded for plant height, Petiole Length (cm), Number of branches per plant, Inflorescence length (cm), Days to 50% flowering, Days to 80% maturity, Seed yield per plant (g), oil content (%) seed yield per plant (>20 means high and between 15-20 was moderate). Genotypic and phenotypic correlations between plant height and leaf length were positive and significant while correlation between plant heights and leaf width was positive and significant. A negative correlation was observed between plant height and number of branches per plant.

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