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Assessment of genetic diversity in grain amaranth (*Amaranthus hypochondriacus* L.)

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Abstract
The current study used 40 accessions of grain amaranth, including four check varieties, BGA-2, GA-2, BGA-7, and C.G. Rajgira 1, during rabi 2021–22 and 2022–23 at the experimental area of the Department of Genetics and Plant Breeding at Research and Instructional Farm, IGKV, Raipur, Chhattisgarh. A quantitative assessment of genetic divergence for 15 characters using Mahalonobis D^2 statistics revealed the presence of considerable genetic diversity. The 40 accessions were grouped into 6 distinct non overlapping clusters with variable number of accessions. The clustering pattern revealed highest number of accessions 24 appeared in cluster-I followed by 8 accessions in cluster-II and 5 accessions in cluster-III. The intra and inter-cluster distances ranged from 0.00 (cluster-IV, V and VI) to 6251.57 (cluster-III) and 5938.46 (cluster-V) to 32862.0 (cluster-VI) respectively. Cluster- III showed the highest intra-cluster distance followed by cluster-II and cluster-I. The maximum inter cluster distance 32862.0 between cluster-VI and cluster-I was observed, indicating presence of high divergence among the accessions. The accessions in cluster-I IC-95302, IC-95333, IC-95308, IC-95299, IC-41768, IC-42427, IC-42281, IC-95321, IC-93962, SKGPA-174 IC-41769, IC-38501, IC-95593, IC-41766, IC-42008, IC-95291, IC-41765, IC-95288, IC-38542, IC-38483, IC-95580, IC-46789, SKGPA-177 and IC-95298 are desirable accessions for days to 50% flowering, days to 80% maturity, plant height, inflorescence length, grain weight/panicle, dry weight of plant and harvest index, cluster-II IC-37156, SKGPA-179, RMA-7 check, BGA-2 check, SKGPA-173, SKGPA-175, SKGPA-172 and SKGPA-178 are desirable accessions for leaf length, petiole length and 10ml vol. seed weight, cluster-IV IC-42265 accessions desirable for number of leaves/plant and lateral spikelets length and cluster-V SKGPA-176 are desirable accessions for number of inflorescence/plant. The accessions IC-42277, SKGPA-182, C.G. Rajgira 1 check, SKGPA-181 and GA-2 check from cluster-III are desirable for seed yield/plant. Therefore, it would be logical to incorporate accessions from these cluster in further breeding programme.

Keywords: Accessions, cluster, checks, genetic diversity, grain amaranth, variation

Introduction

Grain amaranth is a fast growing, dicotyledonous, self-pollinated crop (2 n = 32) that belongs to the amaranthaceace family and is widely grown in India, particularly in the sub-Himalayan ranges and the Nilgiri Hills of South India. It is also known as Ramdana, Rajgira or Pigweed. The amaranth grain are rich in protein (14-18 %), lysine (5.5-6 %), carbohydrates (48–69%) and 6-10 % oil. Amaranth grain is a good source of iron which is required by a number of enzymes for oxygen metabolism. Grain amaranth, like other cereals, contains high levels of calcium, iron, magnesium, phosphorus, copper, manganese, cobalt, chromium, iodine, selenium, zinc, molybdenum, and sodium in addition to proteins, carbohydrates, dietary fiber, and lipids (Becker *et al.*, 1981) [1]. These nutrients are also needed by the body in very small amounts (typically less than 100 micrograms/day). Unused crops like amaranth have recently attracted attention on a global scale in this regard since they are a rich source of all the essential elements for healthy human growth.

In India, precise data on area and production is limited. However, as a grain crop, it is predicted that 40-50 thousand hectares are produced with 12q/ha productivity in India (Dua *et al.*, 2009) [2] and 20 q/ha productivity in the plain zone of Chhattisgarh (Yadav, 2016) [10]. The grain amaranth offers a wide range of varieties that can be easily crossed. Therefore, it is crucial to understand genetic divergence (Shukla *et al.*, 2010, Gurkoki *et al.*, 2013) [9, 3]. According to studies on diabetic rats, consumption of grain amaranth enhances lipid and glucose metabolism, making it advantageous for diabetic patients.

The examination of genetic diversity makes it simple to separate the various genotypes into segregating populations with the highest level of variability, allowing for the selection and transfer of desirable genes from germplasm lines. The D^2 statistic is a valuable tool for determining genetic divergence between populations. It also provides a quantitative estimate of geographical and genetic divergence based on generalized distance (Mahalanobis, 1928) [5]. The analysis and utilization of available genetic diversity is a short-term strategy for generating improved cultivars to meet the current needs of farmers and end users. The D^2 statistic groups a set of potential parents based on genetic divergence with the assumption that the best parent may be those showing genetic divergence (Yadav, 2021) [11].

Materials and Methods

During Rabi- 2021-22 and 2022-23, 40 accessions of grain amaranth were grown in a randomized complete block design with three replications at the Research Cum Instructional Farm, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India. Each accessions was grown in a plot size 3.0 m × 1.0 m keeping 45×15cm (R×P) spacing for each plot in each replication. During the crop growing phase, all standard prescribed agronomic methods, irrigation, and plant protection measures were used. Data were recorded on 15 characters *viz.* days to 50% flowering, days to maturity, plant height, leaf length, leaf width, petiole length, number of leaves /plant, inflorescence length, lateral spikelet length, number of inflorescence/plant, grain weight/panicle, dry weight of plant, harvest index, 10ml vol. seed weight and seed yield/ plant. The existence of genetic divergence among 40 grain amaranth accessions was examined using Mahalanobis D^2 statistics. It estimate the degree of diversity at the intra- and inter-cluster levels and determines the relative contribution of each component trait to the total genetic divergence. The accessions were grouped into a several clusters.

Table 1: List of experimental materials and their sources

S.No.	Name of accessions	Source	S.No	Name of accessions	Source
1.	IC-95302	NBPGR-Bhowali centre	21.	IC-41769	NBPGR-Bhowali centre
2.	IC-95308	NBPGR-Bhowali centre	22.	IC-42008	NBPGR-Bhowali centre
3.	IC-95321	NBPGR-Bhowali centre	23.	IC-42281	NBPGR-Bhowali centre
4.	IC-95333	NBPGR-Bhowali centre	24.	IC-42265	NBPGR-Bhowali centre
5.	IC-95580	NBPGR-Bhowali centre	25.	SKGPA-179	S.K. Nagar, Gujrat
6.	IC-95288	NBPGR-Bhowali centre	26.	SKGPA-178	S.K. Nagar, Gujrat
7.	IC-42427	NBPGR-Bhowali centre	27.	SKGPA-172	S.K. Nagar, Gujrat
8.	IC-93962	NBPGR-Bhowali centre	28.	SKGPA-182	S.K. Nagar, Gujrat
9.	IC-95593	NBPGR-Bhowali centre	29.	SKGPA-181	S.K. Nagar, Gujrat
10.	IC-95291	NBPGR-Bhowali centre	30.	SKGPA-176	S.K. Nagar, Gujrat
11.	IC-95298	NBPGR-Bhowali centre	31.	SKGPA-175	S.K. Nagar, Gujrat
12.	IC-95299	NBPGR-Bhowali centre	32.	SKGPA-173	S.K. Nagar, Gujrat
13.	IC-37156	NBPGR-Bhowali centre	33.	SKGPA-177	S.K. Nagar, Gujrat
14.	IC-42277	NBPGR-Bhowali centre	34.	SKGPA-174	S.K. Nagar, Gujrat
15.	IC-38483	NBPGR-Bhowali centre	35.	IC-46789	Shimla
16.	IC-38501	NBPGR-Bhowali centre	36.	IC-15660	Shimla
17.	IC-38542	NBPGR-Bhowali centre	37.	BGA-2 (C)	OUAT, Bhubaneswar
18.	IC-41765	NBPGR-Bhowali centre	38.	GA-2 (C)	S.K. Nagar, Gujrat
19.	IC-41766	NBPGR-Bhowali centre	39.	RMA-7 (C)	Mandor, Rajasthan
20.	IC-41768	NBPGR-Bhowali centre	40.	C.G.Rajgira1(C)	IGKV, Raipur

Result and Discussion

For all 15 characters, the analysis of variance revealed significant differences among 40 accessions. This indicated the existence of significant amount of diversity presence among the 40 accessions for the studied characters.

Genetic diversity

The clustering pattern of 40 grain amaranth accessions on the basis of D^2 analysis is presented in Table 2. All forty accessions significant differences for 15 quantitative characters. The accessions were grouped into 6 distinct non overlapping clusters pooled over two environments. The number of accessions per cluster varied from 1 (cluster-IV, V and VI) to 24 (cluster I) in pooled data. The highest number of accessions 24 appeared in cluster-I followed by 8 accessions in cluster-II and 5 accessions in cluster-III in pooled over two environments. The accessions constituting of pooled analysis, cluster-I are IC-95302, IC-95333, IC-95308, IC-95299, IC-41768, IC-42427, IC-42281, IC-95321, IC-93962, SKGPA-174 IC-41769, IC-38501, IC-95593, IC-41766, IC-42008, IC-95291, IC-41765, IC-95288, IC-38542, IC-38483, IC-95580, IC-46789, SKGPA-177 and IC-95298, cluster-II are IC-37156, SKGPA-179, SKGPA-173, SKGPA-175, SKGPA-172, SKGPA-178, RMA-7 check and BGA-2 check, cluster-III are IC-42277, SKGPA-182, SKGPA-181, GA-2 check and C.G. Rajgira 1 check, cluster-IV, V and VI having only one accessions are IC-42265, SKGPA-176 and IC-15660 respectively.

Table 2: Pooled clustering pattern of 40 accessions of grain amaranth under overall environments

Cluster Number	Number of accessions	Name of accessions
I	24	IC-95302, IC-95333, IC-95308, IC-95299, IC-41768, IC-42427, IC-42281, IC-95321, IC-93962, SKGPA-174 IC-41769, IC-38501, IC-95593, IC-41766, IC-42008, IC-95291, IC-41765, IC-95288, IC-38542, IC-38483, IC-95580, IC-46789, SKGPA-177, IC-95298
II	8	IC-37156, SKGPA-179, RMA-7(C), BGA-2 (C), SKGPA-173, SKGPA-175, SKGPA-172, SKGPA-178
III	5	IC-42277, SKGPA-182, C.G. Rajgira 1 (C), SKGPA-181, GA-2(C)
IV	1	IC-42265
V	1	SKGPA-176
VI	1	IC-15660

The intra (bold) and inter-cluster values for yield and its contributing traits in grain amaranth during 2021-22 and 2022-23

The result of intra and inter distance of 6 clusters are presented in Table-3. Furthermore, the cluster diagram (Fig. 1) depicts the interrelationship between clusters. When accessions are classified using D2 statistics, a set of groups can be selected from which to select desirable parents for further breeding programs with respect to yield and its contributing traits in grain amaranth during 2021-22 and 2022-23. The intra and inter-cluster distances ranged from 0.00 (cluster-IV, V and VI) to 6251.57 (cluster-III) and 32862.0 between cluster-VI and cluster-I respectively in pooled over two environments. Cluster- III showed the highest intra-cluster distance followed by cluster-II and cluster-I in pooled data. The maximum inter cluster distance 32862.0 between cluster-VI and cluster-I in pooled was observed. It showed diverse much each other. Therefore, it would be logical to incorporate accessions from these cluster in further breeding programme.

Table 3: The intra (bold) and inter-cluster values for yield and its contributing traits in grain amaranth during 2021-22 and 2022-23

Cluster number	I	II	III	IV	V	VI
I	4659.4996	15182.58	21508.56	27295.84	25557.31	32862.00
II		5016.6995	11854.16	15285.14	9781.49	21125.24
III			6251.5795	31942.25	5938.46	9098.32
IV				0	30924.33	32817.67
V					0	10881.48
VI						0

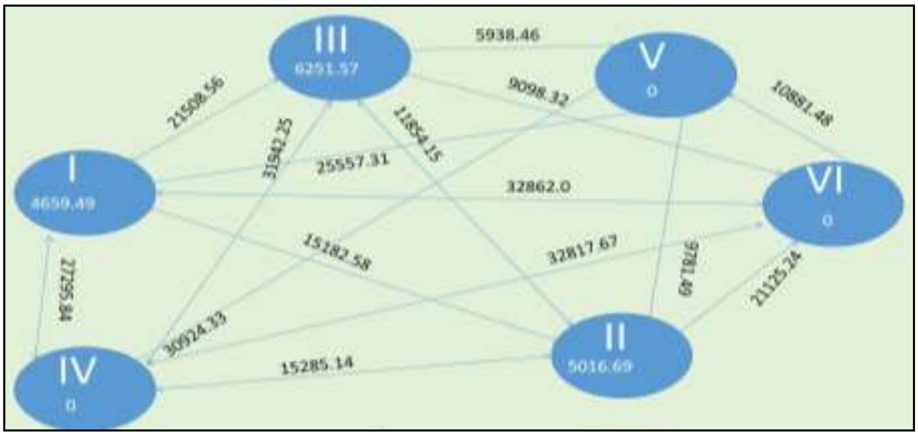

Fig 1: The intra and inter-cluster values (D_2 statistics) among 40 accessions of grain amaranth

Cluster mean of 6 clusters for 40 accessions of grain amaranth during 2021-22 and 2022-23

Mean cluster value for seed yield and its component in grain amaranth accessions given in Table 4. Mean cluster value of pooled analysis over all two environments in cluster-I showed high cluster mean for days to 80% maturity (122.86) followed by plant height (66.37), number of leaves/plant (44.34), and days to 50% flowering (44.17), cluster-II showed high cluster mean values for days to 80% maturity (128.343) followed by plant height (115.91), dry weight of plant (79.26) and days to 50% flowering (58.58), cluster-III showed high cluster mean for days to 80% maturity (128.55) followed by plant height (116.03), number of leaves/plant (82.82) and dry weight of plant (66.41), cluster-IV showed a high mean value for days to 80% maturity (124.92) followed by plant height (106.82), number of inflorescence/plant (74.56) and dry weight of plant (64.32), cluster-V showed a high mean value for plant height (140.54) followed by days to 80% maturity (128.75), number of leaves/plant (81.97) and dry weight of plant (76.80) and cluster-VI showed a high mean value for days to 80% maturity (127.50) followed by plant height (123.14), number of leaves/plant (110.0) and dry weight of plant (74.61) in pooled over all environments. The above grouping indicates of wide genetic divergence among constituent accessions. Such degree of divergence was found by Yadav (2021) [11], Raut *et al.*, (2020) [8], Kumar *et al.*, (2019) [4], Pandey and Singh (2011) [6] and Rajesab *et al.*, (2007) [7]. Hence, on the basis of divergence analysis the accessions to be selected for hybridization programme.

Table 4: Cluster mean of 6 clusters for 40 accessions of grain amaranth during 2021-22 and 2022-23

Cluster number	I	II	III	IV	V	VI
Days to 50% flowering	44.17	58.58	58.43	58.5	60.5	54.17
Days to 80% maturity	122.86	128.34	128.55	124.92	128.75	127.5
Plant height (cm)	66.37	115.91	116.03	106.82	140.54	123.14
Leaf length (cm)	8.65	12.8	13.19	11.64	11.15	12.92
Leaf width (cm)	4.4	6.44	6.18	6.54	6.46	5.71
Petiole length (cm)	5.49	7.64	8.19	6.83	7.58	6.64
Number of leaves/plant	44.34	50.32	82.82	29.54	81.97	110
Inflorescence length (cm)	26.35	20.81	23.41	9.46	24.1	17.93
Lateral spikelet length (cm)	18.52	13.59	15.05	9.01	17.8	9.74
Number of inflorescence/plant	22.29	43.54	47.2	74.56	48.39	63.39
Grain weight /panicle (g)	0.46	0.26	0.34	0.14	0.18	0.23
Dry weight of plant (g)	38.61	79.26	69.54	64.32	76.8	74.61
Harvest index (%)	25.61	13.66	18.73	12.48	10.74	16.3
10 ml vol. seed weight(g)	7.38	7.71	7.26	6.35	7.13	6.9
Seed yield /plant (g)	8.86	10.7	12.84	7.87	7.52	12.41

References

1. Becker RE, Wheeler L, Lorenz K, Stafford AE, Grosjean OK, Betschart AA, *et al*. A Compositional Study of Amaranth Grain. Journal of Food Science. 1981;46:1175-1180.
2. Dua RP, Raiger HL, Phogat BS, Sharma SK. Underutilized crop improved varieties and cultivation practices. Technical Bulletin, NBPGR, New Delhi. 2019, p. 73.
3. Gurkoki T, Kaymak E, Boztepe G, Koyuncu M, Parmaksiz I. Molecular characterization of the genus Papaver section Oxytona using ISSR markers. Turkish Journal of Botany. 2013;37:644-650.
4. Kumar Y, Prasad R, Chameli. Genetic divergence analysis in amaranthus (*Amaranthus* spp.) genotypes for yield and its component characters. The Pharma Innovation Journal. 2019;8(12):41-45.
5. Mahalanobis PC. On generalized distance in statistics. Nat. Inst. Sci. 1928;2:49-55.
6. Pandey RM, Singh R. Genetic divergence in grain amaranth (*Amaranthus hypochondriacus* L.). Genetika. 2011;43(1):41-49.
7. Rajesab SRG, Muniraj C, Raju C, Chikkadevaiah. Genetic divergence studies in grain amaranth (*Amaranthus* spp. L.). Gregor Mendel Foundation Proceedings, 2007, 27-32.
8. Raut VA, Dodake SS, Magar NM. Genetic diversity in future important under utilized crop grain amaranth (*Amaranthus hypochondriacus* L.) Genotypes based on cluster. Int. J Curr. Microbiol. App. Sci. 2020;9(12):1987-1996.
9. Shukla S, Bhargava A, Chatterjee A, Pandey AC, Kumar ARA. Genetic Interrelationship among Nutritional and Quantitative Traits in The Vegetable Amaranth, Crop Breeding and Applied Biotechnology. 2010;10:16-22.
10. Yadav RK. Proceeding of Chhattisgarh State Seed Sub-Committee, Director of Research Services, I.G.K.V., Raipur, 2016, p. 3.
11. Yadav RK. Genetic diversity of quantitative traits in grain amaranth (*Amaranthus hypochondriacus* L.). Int. J Farm Sci. 2021;12(3):131-133.