International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 709-714

Received: 08-03-2018
Accepted: 10-04-2018

Deepika Chandravanshi
Department of Horticulture (COA) Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Pravin kumar Sharma
Department of Horticulture (COA) Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

HG Sharma
Department of Horticulture (COA) Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Okesh Chandrakar
Department of Horticulture (COA) Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Correspondence
Deepika Chandravanshi
Department of Horticulture (COA) Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Genetic divergence and cluster analysis in chaulai (*Amaranthus viridis* L.)

Deepika Chandravanshi, Pravin kumar Sharma, HG Sharma and Okesh Chandrakar

Abstract
The present investigation entitled "Evaluation and characterization of leafy vegetables (*Amaranthus spp.*) grown in Chhattisgarh." was conducted during the year 2014-15 and 2015-16 at Research and Instructional Farm, Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experiment I was conducted during *Rabi* Season and experiment II was conducted during *Kharif* Season. The experiment was comprised of twenty three genotypes of chaulai (*Amaranthus viridis* L.). laid out in Randomized Block Design (RBD) with three replications. The data were analyzed to work out the genetic variability, correlation coefficient, path analysis and genetic divergence for the character *viz.*, plant height, number of leaves per plant, leaf length, leaf breadth, petiole length, number of branch per plant, stem girth, fresh leaf weight, dry matter percentage of plant, harvest index %, test weight, yield kg per plot, yield tonne ha^{-1}, seed yield tonne ha^{-1}, duration of crop and fibre content %. The distributing pattern indicated that the maximum number of genotypes (7) was included in cluster (I) followed by cluster II, cluster III contains (6) genotypes, while cluster IV contains minimum (4) genotypes. The pooled analysis of data shows that the maximum number of genotypes were grouped into cluster II (IGCB-2014-31, IGCB-2014-32, IGCB-2014-33, IGCB-2014-34, IGCB-2014-35, IGCB-2014-36 and IGCB-2014-37) included seven genotypes, were highly divergent from all other genotypes and may be used as parents in transgenic breeding programme and may directly be used as a pure line variety for yield and it's component characters in chaulai for Chhattisgarh plain condition. Hence, germplasm/genotypes collected from different districts of Chhattisgarh were evaluated in two consecutive years

Keywords: Genetic divergence, cluster analysis, chaulai (*Amaranthus viridis* L.)

Introduction

Chaulai (*Amaranrhus viridis* L.) are leafy vegetable locally known as *chaulai bhaji* (*lal & green*) belongs to the family Amranthaceae. The green Amaranthus consist of approximately 60 species out of which about 18 species are occurring in India. There are three major producing Amaranthus species, *A. caudatus, A. cruentus* and *A. hypochondriacus*, all believed to originate from Central and South America; and three major leafy vegetable species, *A. tricolor*, *A. dubius* and *A. blitum* (*A. lividus*), of which *A. tricolor* is thought to originate from India or Southern China, *A. blitum* from Central Europe and *A. dubius* from Central America (Yadav *et al.*, 2014) [20]. The plant height varies from 0.3 m to 5m among various species. Leaves are oblong to elliptical with color ranged from light to dark green with some expressing red pigment throughout the genus.

India is the largest producer of vegetable crops next to China. Leafy vegetables are cultivated in an area of 9205 thousand hectare with an annual production of 162187 thousand MT (Anon., 2013) [3]. In Chhattisgarh, vegetables occupied an area of 377.21 thousand hectare with an average production of 4965.33 thousand MT out of these, leafy vegetables are cultivated in an area of 7688 hectare with an average production of 72902 MT (Anon., 2014) [3]. Despite such a huge production in the country, less than the appropriate requirement of balanced diet is provided to every individual.

In Chhattisgarh, the life and economy of the tribal and local people are intimately connected with the natural vegetation. Leafy vegetables play a major role in the nutritional requirement of the tribal and local population in remote parts of the Chhattisgarh. The use of leafy vegetables as food has been formed an integral part of the culture and tradition of many indigenous communities of the world. It constitutes an essential component in the diet and particularly people living around the forest fringe. It is estimated that in India about 800 species are consumed as wild edible plants over the country (Singh and Arora, 1978). Wild edible plants are not only providing food in sufficient quantity but also makes significant contribution to the population nutrition throughout the year (Grivetti and Ogle Britta, 2000; Ogle Britta *et al.,* 2003) [9, 12]. Fifty one such leafy vegetables are available in this region that are eaten by the tribal and local people of Chhattisgarh. Wild plants such as, *Amaranthus species*, *Borhaavia diffusa*, *Basell rubra*, *Cleome gynandra*, *Chenopodium species Corchorus* species, *Leucas cephalotes*, *Hibiscus cannabinus*, and *Trianthema portulacastrum* are very popular and still are widely available in the communities. Looking to the various types of leafy vegetables grown in Chhattisgarh *i.e.* Amari Bhaji, Tinpania Bhaji, Bathua Bhaji, Chaulai Bhaji, Chech Bhaji, Chunchunia Bhaji, Karmota Bhaji, Lal Bhaji, Methi Bhaji, Palak, Patawa Bhaji, Patharri Bhaji, Poi Bhaji, Sarson Bhaji, Jadi Bhaji, Bohar Bhaji and rapid urbanization of developing country like India, food security is a major concern (Chauhan *et al*., 2014) [8]. In Chhattisgarh state, leafy vegetables are found naturally in both cultivated and non-cultivated lands and there are major dietary component of tribal as well as rural people of the state.

Vegetable amaranth serves as an alternative source of nutrition for people in developing countries since it is a rich and inexpensive source of carotenoid, protein, vitamins and dietary fibre (Prakash and Pal, 1991; Shukla *et al*., 2003) [13, 16]. It has been rated equal or superior in taste to spinach and is considerably higher in protein (14 - 30% on dry weight basis), minerals (Fe, Mn and Zn), and antioxidants like beta-carotenoid (90 - 200 mg kg^{-1}) and ascorbic acid (about 28 mg/100 g) compared to any other leafy vegetables. Amaranth vegetables contribute greatly to the nutritional well-being of rural people by providing the essential nutrients required for body growth and development and for prevention of diseases associated with nutritional deficiencies such as blindness due to vitamin A deficiency (Varalakshmi, 2011) [19]. Amaranthus species are being cultivated since centuries as a leafy vegetable; it is characterized by a high degree of diversity and a wide spectrum of adaptability to different agro ecological conditions (Snezana *et al*. 2012; Katiyar *et al*. 2000; Shukla and Singh 2000) [18, 10, 15]. Looking to the wide genetic variability of these vegetables available in the local land races of the Chhattisgarh state, there is an urgent need to develop or identify high yielding varieties with high nutritional value, foreign exchange earner varieties and leafy vegetables with quality sustainable productivity. There is no systematic work has been done so far on evaluation and exploitation of *Amaranthus* germplasm in Chhattisgarh till date.

Materials and Methods

This chapter deals with a concise description of the material used and the technique adopted during the course of investigation. The present investigation entitled "Evaluation and Characterization of Leafy Vegetables (*Amaranthus spp*.) grown in Chhattisgarh" was conducted at Research and Instructional Farm, Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the experiment 1 conducted during rabi season of 2014-2015 and 2015-16 while experiment 2 was conducted during *kharif* season of the both year. Raipur district is situated in the central part of Chhattisgarh, agroclimatologically known as Chhattisgarh plains and lies between 21o 16' N latitude and 81o 36' E longitude with an altitude of 289.56 meters above the mean sea level. Twenty three indigenous genotypes of Chaulai (*Amaranthus viridis L*.) and twenty five indigenous genotypes of Khedha (Amaranthus dubius Mart.) where collected from different place of Chhattisgarh during May to June 2014. The observations on different growth parameters and leaf yield attributes were recorded on ten randomly selected competitive plants from each plot of all replications. The Mahalanobis (1936) D^2 statistic was used to measure the genetic divergence between the populations. The D^2 value was estimated on the basis of "P" character by the formula:

P P
D^2P = Σ = Σ = (ʎ ij) ʎiʎj
i = 1 j = 1

Where,
(i, j) is the reciprocal or (i, j), the pooled common dispersion matrix (i.e. Error matrix)
i = the difference in the mean value for the ith character
j = the difference in the mean value for the jth character
calculating the D^2 values, the variance and covariance were calculated. The genotypes were grouped into different clusters by Tocher's method. The population was arranged in order of their relative distances from each other. For including a particular population in the clusters, a level of D^2 was fixed by taking the maximum D^2 values between any two populations in the first row of the table where D^2 values were arranged in increasing order of magnitude.

Result and Discussion

Divergence analysis of chaulai (*Amaranthus viridis* L)

The concept of D^2 statistics was originally developed by Mahalonobis (1936). Then Rao (1952) suggested the application of this technique for the arrangement of genetic diversity in plant breeding. Now, this technique is being extensively used in vegetable breeding also to study the selection of different parents. Genetic variability and selection of parents from diverse breeding material including germplasm and there diverse parents, can be used for the development of variety in chaulai.

On the basis of D^2 analysis, twenty three genotypes were grouped into four clusters [Table 4.6 A (I)]. During 2014-15 maximum number of genotypes was grouped into cluster I (IGCB-2014-31, IGCB-2014-33, IGCB-2014-34, IGCB-2014-35, IGCB-2014-36, IGCB-2014-39 and IGCB-2014-42) and cluster IV (IGCB-2014-41, IGCB-2014-43, IGCB-2014-44, IGCB-2014-45, IGCB-2014-48, IGCB-2014-49 and IGCB-2014-52) included seven genotypes. Whereas, cluster III (IGCB-2014-32, IGCB-2014-37, IGCB-2014-38, IGCB-2014-40 and IGCB-2014-46) included five genotypes, cluster II (IGCB-2014-47, IGCB-2014-53, IGCB-2014-54 and IGCB-2014-55) included four genotypes in cluster.

During the year 2015-16 [Table 4.6 B (I)] eight of genotypes were grouped into cluster IV (IGCB-2014-39, IGCB-2014-41, IGCB-2014-43, IGCB-2014-47, IGCB-2014-52, IGCB-2014-53, IGCB-2014-54 and IGCB-2014-55) whereas, cluster I (IGCB-2014-31, IGCB-2014-32, IGCB-2014-33, IGCB-2014-34, IGCB-2014-35 and IGCB-2014-36) included six genotypes, cluster III (IGCB-2014-37, IGCB-2014-38, IGCB-2014-40, IGCB-2014-42 and IGCB-2014-46) included only five genotype and cluster III (IGCB-2014-44, IGCB-2014-45, IGCB-2014-48 and IGCB-2014-49) included four genotypes, in cluster.

As regards pooled analysis [Table 4.6 C (I)] seven of genotypes were grouped into cluster II (IGCB-2014-31,

IGCB-2014-32, IGCB-2014-33, IGCB-2014-34, IGCB-2014-35, IGCB-2014-36, IGCB-2014-37) whereas, cluster II (IGCB-2014-39, IGCB-2014-41, IGCB-2014-43, IGCB-2014-48, IGCB-2014-49 and IGCB-2014-50) and cluster III (IGCB-2014-38, IGCB-2014-40, IGCB-2014-42, IGCB-2014-44, IGCB-2014-45, IGCB-2014-46) included six genotypes, each followed by cluster IV (IGCB-2014-47, IGCB-2014-51, IGCB-2014-52, IGCB-2014-53) included four genotype in cluster

Table 1: Composition of clusters of chaulai: year 2014-15

Cluster Number	Number of genotypes included	Name of genotypes
I	7	IGCB-2014-31, IGCB-2014-33, IGCB-2014-34, IGCB-2014-35, IGCB-2014-36, IGCB-2014-39, IGCB-2014-42
II	4	IGCB-2014-47, IGCB-2014-53, IGCB-2014-54, IGCB-2014-55
III	5	IGCB-2014-32, IGCB-2014-37, IGCB-2014-38, IGCB-2014-40, IGCB-2014-46
IV	7	IGCB-2014-41, IGCB-2014-43, IGCB-2014-44, IGCB-2014-45, IGCB-2014-48, IGCB-2014-49, IGCB-2014-52

Table 2: Intra (bold) and Inter cluster distance values in chaulai: year 2014-15

Cluster Number	I	II	III	IV
I	3.031			
II	4.836	2.063		
III	2.780	4.768	2.709	
IV	3.706	3.072	3.486	2.638

Table 3: Composition of clusters in chaulai: Year 2015-16

Cluster Number	Number of genotypes included	Name of genotypes
I	6	IGCB-2014-31, IGCB-2014-32, IGCB-2014-33, IGCB-2014-34, IGCB-2014-35, IGCB-2014-36
II	5	IGCB-2014-37, IGCB-2014-38, IGCB-2014-40, IGCB-2014-42, IGCB-2014-46
III	4	IGCB-2014-44, IGCB-2014-45, IGCB-2014-48, IGCB-2014-49
IV	8	IGCB-2014-39, IGCB-2014-41, IGCB-2014-43, IGCB-2014-47, IGCB-2014-52, IGCB-2014-53, IGCB-2014-54, IGCB-2014-55

Table 4: Intra (bold) and Inter cluster distance values in chaulai: Year 2015-16

Cluster Number	I	II	III	IV
I	2.801			
II	3.030	2.507		
III	4.190	3.383	2.574	
IV	3.836	3.402	3.104	3.093

Table 5: Composition of clusters in chaulai: Pooled Analysis

Cluster Number	Number of genotypes included	Name of genotypes
I	7	IGCB-2014-31, IGCB-2014-32, IGCB-2014-33, IGCB-2014-34, IGCB-2014-35, IGCB-2014-36, IGCB-2014-37
II	6	IGCB-2014-39, IGCB-2014-41, IGCB-2014-43, IGCB-2014-48, IGCB-2014-49, IGCB-2014-52
III	6	IGCB-2014-38, IGCB-2014-40, IGCB-2014-42, IGCB-2014-44, IGCB-2014-45, IGCB-2014-46
IV	4	IGCB-2014-47, IGCB-2014-53, IGCB-2014-54, IGCB-2014-55

Table 6: Intra (bold) and Inter cluster distance values in chaulai: Pooled Analysis

Cluster Number	I	II	III	IV
I	2.872			
II	3.971	2.858		
III	3.327	3.274	2.466	
IV	4.887	3.686	3.804	2.156

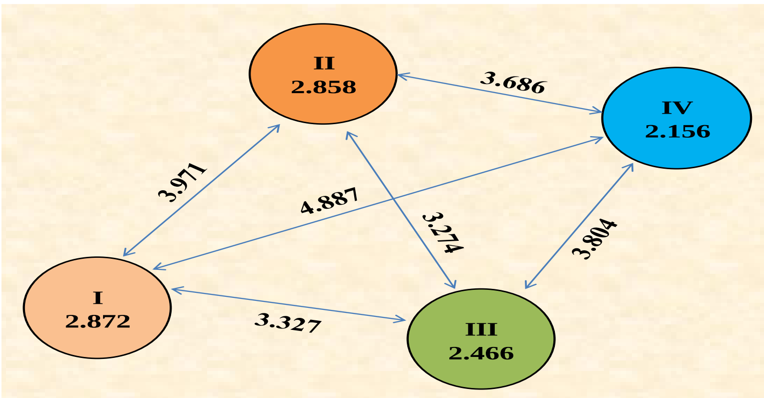

Fig 4.5 (1): Diagrammatic representation of different intra and inter cluster distance of chaulai (*Amaranthus viridis* L.) (Values inside circle is intra-cluster distance)

These results are in general agreement with the findings of Anuja *et al*., (2007), Anuja (2011) for number of leaves plant^{-1}. Similar result shows Ahammed *et al.* (2013) and Akther *et al.* (2013).

In the year of 2014-15 [Table 4.7 A (I)] data shows that the intra-cluster distance varied from 2.063 to 3.031. The maximum intra cluster distance was shown by cluster I (3.031) followed by cluster III (2.709), cluster IV (2.638) and cluster II (2.063), which indicates distance within the cluster.

In the year of 2015-16 [Table 4.7 B (I)] data shows that the intra-cluster distance varied from 2.507 to 3.093. The maximum intra cluster distance was shown by cluster IV (3.093) followed by cluster I (2.801), cluster III (2.574) and cluster II (2.507) which indicates distance within the cluster. In the pooled analysis [Table 4.7 C (I)] intra-cluster distance varied from 2.156 to 2.872. The maximum intra cluster distance was shown by cluster I (2.872) followed by cluster II (2.858), cluster III (2.466) and cluster IV (2.156), which indicates distance within the cluster. The intra and inter-cluster distance among 23 genotypes revealed that Cluster I showed the maximum inter-cluster value (2.872) in pooled analysis, which is in confirmation to the finding of Chattopadhyay *et al*. (2013), Kallow (1980), Akther *et al*. (2013).

Mean performance of clusters of chaulai (*Amaranthus viridis* L)

The mean performance for different clusters of genotypes for yield and its components are presented in [Table 4.8 A (I) to 4.8 C (I)]. The data of cluster means for all the characters showed appreciable differences. During the year 2014-15 plant height showed the lowest mean performance for cluster I (41.79), which was followed by cluster III (45.54), cluster IV (51.09) and highest in cluster II (65.14). Number of leaves plant^{-1} exhibited the lowest mean performance for cluster I (22.33), followed by cluster III (24.73), cluster IV (34.05) and highest in cluster II (42.58). Number of branches plant^{-1} exhibited the lowest mean performance for cluster IV (3.86), followed by cluster II (4.08), cluster I (4.24) and highest in cluster III (4.53). Leaf length showed the lowest mean performance for cluster II (3.77) followed by cluster IV (4.16), cluster I (4.72) and highest in cluster III (5.72). Leaf breadth exhibited the lowest mean performance for cluster II (1.55) followed by cluster IV (1.79), cluster III (1.80) and highest in cluster I (2.37). Petiole length showed the lowest mean performance for cluster II (1.47), followed by cluster I (1.68), cluster IV (2.05) and highest in cluster III (2.18). Stem girth exhibited the lowest mean performance for cluster II (2.60), followed by cluster III (2.80), cluster IV (3.06) and highest in cluster I (3.29). Fresh leaf weight exhibited the lowest mean performance for cluster IV (167.90), followed by cluster I (172.18), cluster II (172.64) and highest in cluster III (180.28). Dry matter percent showed the lowest mean performance for cluster II (13.83), followed by cluster IV (15.66), cluster III (16.42) and highest in cluster I (17.59). Duration of crop showed the lowest mean performance for cluster III (30.67), followed by cluster IV (31.81), cluster I (37.10) and highest in cluster II (40.75). Harvest index showed the lowest mean performance for cluster IV (2.16), followed by cluster II (2.37), cluster III (3.12) and highest in cluster IV (3.43). Fiber content exhibited the lowest mean performance for cluster III (8.68) followed by cluster I (8.97), cluster IV (10.17) and highest in cluster II (12.10). Yield plot^{-1} exhibited the lowest mean performance for cluster I (5.11), followed by cluster III (5.85), cluster II (7.39) and highest in cluster IV (7.88).

During the year 2015-16 plant height showed the lowest mean performance for cluster II (47.57), which was followed by cluster I (48.05), cluster III (49.52) and highest in cluster IV (61.35). Number of leaves plant^{-1} exhibited the lowest mean performance for cluster I (23.16), followed by cluster II (25.75), cluster IV (35.45) and highest in cluster III (38.43). Number of branches plant^{-1} exhibited the lowest mean performance for cluster IV (3.92), followed by cluster II (4.80), cluster I (5.33) and highest in cluster III (5.67). Leaf length showed the lowest mean performance for cluster IV (4.18) followed by cluster III (4.41), cluster I (4.90) and highest in cluster II (5.51). Leaf breadth exhibited the lowest mean performance for cluster II (1.43) followed by cluster III (1.48), cluster IV (1.63) and highest in cluster I (2.20). Petiole length showed the lowest mean performance for cluster IV (1.71), followed by cluster II (1.95), cluster I (1.97) and highest in cluster III (2.10). Stem girth exhibited the lowest mean performance for cluster II (2.73), followed by cluster III (2.79), cluster IV (2.97) and highest in cluster I (3.29). Fresh leaf weight exhibited the lowest mean performance for cluster III (168.07), followed by cluster IV (170.68), cluster I (177.73) and highest in cluster II (181.42). Dry matter percent showed the lowest mean performance for cluster I (14.74), followed by cluster II (14.83), cluster IV (14.97) and highest in cluster III (18.38). Duration of crop showed the lowest mean performance for cluster III (31.42), followed by cluster II (31.60), cluster I (36.67) and highest in cluster IV (38.75). Harvest index showed the lowest mean performance for cluster II (2.99), followed by cluster III (3.55), cluster IV (3.58) and highest in cluster I (3.85). Fiber content exhibited the lowest mean performance for cluster I (7.46) followed by cluster II (9.63), cluster III (10.39) and highest in cluster IV (11.63). Yield plot^{-1} exhibited the lowest mean performance for cluster I (4.60), followed by cluster II (5.91), cluster IV (6.86) and highest in cluster III (7.69)

Table A (I): Mean performance of genotypes in individual cluster for yield and its components of chaulai: year 2014-15

Cluster	Plant height (cm)	No. of leaves plant^{-1}	No of branches plant^{-1}	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	Stem girth (mm)	Fresh leaf weight (g)	Dry matter %	Duration of crop	Harvest index %	Fiber content %	Yield plot^{-1} (kg)
I	41.79	22.33	4.24	4.72	2.37	1.68	3.29	172.18	17.59	37.10	3.43	8.97	5.11
II	65.14	42.58	4.08	3.77	1.55	1.47	2.60	172.64	13.83	41.75	2.37	12.10	7.39
III	45.54	24.73	4.53	5.72	1.80	2.18	2.80	180.28	16.42	30.67	3.12	8.68	5.85
IV	51.09	34.05	3.86	4.16	1.79	2.05	3.06	167.90	15.66	31.81	2.16	10.17	7.88

Table B (I): Mean performance of genotypes in individual cluster for yield and its components in chaulai: Year 2015-16

Cluster	Plant height (cm)	No. of leaves plant^{-1}	No of branches plant^{-1}	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	Stem girth (mm)	Fresh leaf weight (g)	Dry matter %	Duration of crop	Harvest index %	Fiber content %	Yield plot^{-1} (kg)
I	48.05	23.16	5.33	4.90	2.20	1.97	3.29	177.73	14.74	36.67	3.85	7.46	4.60
II	47.57	25.75	4.80	5.51	1.43	1.95	2.73	181.42	14.83	31.60	2.99	9.63	5.91
III	49.52	38.43	5.67	4.41	1.48	2.10	2.79	168.07	18.38	31.42	3.55	10.39	7.69
IV	61.35	35.45	3.92	4.18	1.63	1.71	2.97	170.68	14.97	38.75	3.58	11.63	6.86

Table C (I): Mean performance of genotypes in individual cluster for yield and its components in Chaulai: Pooled Analysis

Cluster	**Plant height (cm)**	**No. of leaves plant^{-1}**	**No of branches plant^{-1}**	**Leaf length (cm)**	**Leaf breadth (cm)**	**Petiole length (cm)**	**Stem girth (mm)**	**Fresh leaf weight**	**Dry matter %**	**Duration of crop**	**Harvest index %**	**Fiber content %**	**Yield plot^{-1} (kg)**
I	45.86	22.93	4.52	5.15	2.10	2.01	3.37	175.66	15.06	35.10	3.66	7.57	4.82
II	52.60	33.03	3.81	4.17	1.80	2.05	3.34	167.14	16.73	32.31	2.61	11.14	7.08
III	45.45	27.61	5.08	5.02	1.65	1.82	2.43	178.14	16.43	33.28	3.03	9.70	6.85
IV	65.80	42.62	4.21	3.99	1.59	1.49	2.58	172.61	14.68	42.25	3.27	12.18	7.23

In the pooled analysis plant height showed the lowest mean performance for cluster III (45.45), which was followed by cluster I (45.86), cluster II (52.60) and highest in cluster IV (65.80). Number of leaves plant^{-1} exhibited the lowest mean performance for cluster I (22.93), followed by cluster III (27.61), cluster II (33.03) and highest in cluster IV (42.62). Number of branch plant^{-1} exhibited the lowest mean performance for cluster II (3.81), followed by cluster IV (4.21), cluster I (4.52) and highest in cluster III (5.08). Leaf length showed the lowest mean performance for cluster IV (3.99) followed by cluster II (4.17), cluster III (5.02) and highest in cluster I (5.15). Leaf breadth exhibited the lowest mean performance for cluster IV (1.59) followed by cluster III (1.65), cluster III (1.80) and highest in cluster I (2.10). Petiole length showed the lowest mean performance for cluster IV (1.49), followed by cluster III (1.82), cluster I (2.01) and highest in cluster II (2.05). Stem girth exhibited the lowest mean performance for cluster III (2.43), followed by cluster IV (2.58), cluster II (3.34) and highest in cluster I (3.37). Fresh leaf weight exhibited the lowest mean performance for cluster II (167.14), followed by cluster IV (172.61), cluster I (175.66) and highest in cluster III (178.14). Dry matter % showed the lowest mean performance for cluster IV (14.68), followed by cluster I (15.06), cluster III (16.43) and highest in cluster II (16.73). Duration of crop showed the lowest mean performance for cluster II (32.31), followed by cluster III (33.28), cluster I (35.10) and highest in cluster IV (42.25). Harvest index showed the lowest mean performance for cluster II (2.61), followed by cluster III (3.03), cluster IV (3.27) and highest in cluster I (3.66). Fibre content exhibited the lowest mean performance for cluster I (7.57) followed by cluster III (9.70), cluster II (11.14) and highest in cluster IV (12.18). Yield plot^{-1} exhibited the lowest mean performance for cluster I (4.82), followed by cluster III (6.85), cluster II (7.08) and highest in cluster IV (7.23).

The better genotypes can be selected for most of characters on the basis of mean performance in the cluster. The best genotypes which had chosen for different characters are presented in table 4.8 A (I) to 4.8 C (I).

References

1. Ahammed AU, Rahman MM, Mian MAK. Multivariate analysis in stem amaranth (*Amaranthus tricolor*). Bangladesh J Pl Bre and Gen. 2013; 26(1):11-17.
2. Akther CA, Hasan M, Raihan MS, Hossain MM, Mian MAK. Genetic Divergence in Stem Amaranth (*Amaranthus tricolor* L.) Genotypes for Yield and its Component Characters. The Agriculturists. 2013; 11(1):82-88.
3. Anonymous. Area, Production and Productivity. Directorate of Horticulture, Government of Chhattisgarh, Raipur (C.G.). (Chhattisgarh State Horticulture Department). 2013-14.
4. Anonymous. Area, Production and Productivity. Directorate of Horticulture, Government of Chhattisgarh, Raipur (C.G.). (Chhattisgarh State Horticulture Department). 2015-16a.
5. Anuja S, Mohideen MK. Variability, heritability and genetic advance studies in amaranthus (*Amaranthus spp.)*. The Asian Journal of Horticulture. 2007 a; 2(1):63.
6. Anuja S, Mohideen MK. Genetic diversity for green yield characteristics in vegetable amaranthus (*Amaranthus spp*.), The Asian Journal of Horticulture. 2007 b; 2(1):158-160.
7. Anuja S. D2 analysis in vegetable amaranthus. Asian Journal of Bio Science. 2011; 6(2):198-200.
8. Chauhan D, Shrivastava AK, Patra S. Diversity of leafy vegetables used by tribal peoples of Chhattisgarh India. Int. J Curr. Microbiol. App. Sci. 2014; 3(4):611-622.
9. Grivetti LE, Ogle Britta M. Value of traditional foods in meeting macro and micronutrient needs: the wild plant connection. Natl. Res. 2000; 13:31-46.
10. Katiyar RS, Shukla S, Rai S. Varietal performance of grain amaranth *(A. hypochondriacus)* on sodic soil. Proc Nat Acad Sci. (India). 2000; 70:185-187.
11. Mahalanobis PC. On the generalized distance in statistics. Proc. Nat. Inst. Sci., India, 1936; 21:49-55.
12. Ogle Britta M, Ho Thi Tuyet, Hoang Nghia Duyet, Nguyen Nhut Xuan Dung. Food, Feed or Medicine: The multiple functions of edible wild plants in Vietnam, Econ. Bot. 2003; 571:103-117.
13. Prakash D, M Pal. Nutritional and anti-nutritional composition of vegetable and grain amaranth leaves. J Sci. Food Agric. 1991; 57:573-583.
14. Rao CR. Advance Statistical Methods in Biometrics Research. Hofaer Pub. Darion. 1952, 371-378.
15. Shukla S, Singh SP. Studies on genetic parameters in vegetable Amaranth. J Genet. Breed. 2000; 54:133-135.
16. Shukla S, Singh SP. Correlation and path analysis in grain amaranth (*Amaranthus spp*.), Indian J of Genet. 2003; 63(2):163- 164.
17. Singh HB, Arora RK. Wild edible plants of India 1st ed. ICAR Publication, New Delhi. 1978; 88.

18. Snezana DM, Marija K, Danijela R, Milena S, Lidija S. Assessment of genetic relatedness of the two *Amaranthus retroflexus* population by protein and random amplified polymorphic DNA markers. Afri. J Biotech. 2012; 11(29):7331-7337.
19. Varalakshmi B, Devaraju. Genetic variability in Indian spinach (*Basella alba* L.). J Hort. Sci. 2011; 5:21-24.
20. Yadav R, Rana JC, Ranjan JK. Analysis of variability parameters for morphological and agronomic traits in grain amaranth (*Amaranthus sp*) genotypes, The Bioscan. 2014; 9(4):1661-1665.