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Evaluation of Thirty Amaranthus Genotypes (*Amaranthus tricolor* L.) for Different Biometric Characters

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A B S T R A C T

The present study entitled "Evaluation of thirty amaranthus genotypes (*Amaranthus tricolor* L.) for different biometric characters" was carried out in the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during 2016-2018, with an objective to evaluate the amaranthus genotypes in terms of yield and other yield attributing characters and to assess the variability. The study was conducted with thirty genotypes and evaluated for thirteen characters. The genotype Madhur local (A22) recorded highest yield plant^{-1}(125.926g) and least incidence of leaf blight. The genotypes showed varied responds towards different characters studied which concluded the presence of high variability exists in the germplasm of amaranthus, which could be exploited through selection and further breeding programme.

Introduction

Amaranthus (*Amaranthus tricolor* L.) is a popular leafy vegetable commonly consumed in Kerala. It is the important crop within Kerala farmers as sole crop or intercrop. Amaranthus belongs to the family *Amaranthaceae*, consists of diverse species as leafy amaranth, grain amaranth and ornamental amaranth. It is rich in terms of nutrients like protein, vitamin A, fibre content and ascorbic acid. Variability present in the collection of germplasm is pre requisite for crop improvement. Exploitation of variability present in the germplasm enhances the crop improvement. The amaranthus crop is variable in terms of colour, plant morphology, inflorescence pattern and crop duration. The plant breeder can exploit the existing variability from the amaranthus germplasm and can improve the objectives accordingly. The present study was aimed at identifying and evaluating the amaranthus genotypes for the variability and further exploitation through selection.

Hamid *et al.,* (1989) revealed that height and stem girth are positively correlated with yield in amaranthus, from the study of performance of some local and exotic germplasm of amaranthus. Twenty three amaranthus genotypes were evaluated and the variability in stem diameter was ranged from 0.30 to 0.40 cm with mean of 0.35 cm. The genotype AMAR-23 recorded highest stem girth of 0.40 cm and AMAR- 04 showed the lowest of 0.30 cm in stem diameter (Jangde, 2016).

Variability in length of leaf lamina was observed by Celine *et al.,* (2007) in a study of eighty nine accessions of amaranthus. The accessions Am 67 and Am 24 were had the maximum (21.1 cm) and the minimum (7.4 cm) length of leaf lamina accordingly. The genotype CO5 had reported the maximum petiole length (11 cm), followed by A40 (7.5 cm) and CO4 had minimum (3.38 cm) at 30 DAS (Selvaraj, 2004). Joshi *et al.,* (2011) reported a wide range of variability in leaf width (5.2 to 12.7 cm) indicated the possible exploitation of variation for amaranthus improvement.

Eight red amaranthus were studied by Mohideen *et al*., (1983) and revealed that types A. 144, A. 145 and local 1 were having tall growth habit and long duration with a few or no branches. Yield plant^{-1} in amaranthus varied from 1.18 to 3.29 kg with an average of 2.25 kg (Shukla and Singh, 2000). Shukla *et al.,* (2004) reported that the amaranthus strain AV-41 showed highest foliage yield (5.99 kg plot^{-1}) and the heritability estimates were high for all the traits except number of branches plant^{-1} and moisture content. Various workers reported the yield of amaranthus ranged from 4.0 to 16.5 t ha^{-1} (Campbell and Abbott, 1982) and from 9.90 to 18.30 t ha^{-1} (Makus, 1984). Among the nineteen *Amaranthus spp.* Sirohi and Sivakami (1995) reported PusaKirti (*A. tricolor*) and PusaKiran (*A tricolor* × *A. tristis*) recorded high yield of 50 to 55 t ha^{-1} and 35 t ha^{-1} respectively. Priya (1998) conducted experiment in various genotypes of amaranthus and obtained the highest yield for Amt 193 (304.5 g plant^{-1}) and the genotype A 24 from *A. tricolor* showed the highest leaf to stem ratio of 1.57. Selvaraj (2004) revealed that optimum stage of harvest for yield and stem yield was between 30-40 DAS. Varalakshmi and Reddy (1994) studied 25 different lines of vegetable amaranthus and obtained mean values of 35.65 cm, 7.35 cm and 10.58 cm for plant height, leaf breadth and length respectively. Celine *et al.,* (2007) screened eighty nine diverse accessions of amaranthus for resistance to leaf blight caused by *Rhizoctonia solani*. *A. dubius* and *A. hypochondriacus* were found free from incidence of leaf blight, *A. tricolor* showed varied levels of susceptibility.

Scoring was done on 0 to 4 scales from which the highest incidence was obtained in Am1 (2.6). Celine *et al.,* (2011) observed that superior high yielding amaranthus accessions like AD-30, AD-23, and AD-22 were field resistant to leaf blight. Leaf webber (*Hymenia recurvalis*) was noticed as major pest in amaranthus (*A.tricolor* L.) field whereas red spider mite was found to be the minor pest (Muralikrishna, 2015).

Materials and Methods

Present study was conducted at Department of Plant Breeding and Genetics, College of Agriculture, Vellayani, with thirty genotypes of amaranthus evaluated in a Randomized Block Design (RBD) with three replications during 2016-2017. The amaranthus seedlings were transplanted to main field 21 DAS with a spacing of 30x20 cm. A total of twenty plants were maintained in each plot, each genotype was considered as each treatment. The observations on biometric characters were taken 30 days after transplanting. The main observations were taken on following characters,

Stem girth (cm)

The main stem girth at the collar region was taken by using a twine. Mean girth was measured and expressed in centimetres.

Length of leaf lamina (cm)

Length was recorded from the fifth leaf from top of the selected plants. Mean length was measured and expressed in centimetres.

Petiole length (cm)

The petiole length of the same plant which was used for recording length was measured and the mean expressed in centimetres.

Leaf width (cm)

The width of the same leaf of the plant which was used for recording length was measured and the mean expressed in centimetres.

Internodal Length (cm)

Internodal length of the same leaf of the plant which was used for recording length was measured and the mean expressed in centimetres.

Number of branches

The total branches of the each observational plant were counted and average was worked out.

Yield plant^{-1}(g)

Three cuttings were taken from each plant. The first cutting was taken at 30 days after transplanting and the subsequent two cuttings were taken at intervals of two weeks. The yield obtained cutting^{-1} was recorded and expressed in grams plant^{-1}.

Yield plot^{-1}(kg)

Yield from the twenty plants were taken for each cuttings, total yield was expressed in kilogram plot^{-1}.

Leaf to stem ratio

Leaf to stem ratio was taken by dividing the weight of leaves with weight of stem. The leaf to stem ratio was worked out for the total of three cuttings.

Days to 50% bolting

Days to 50% bolting was recorded from the plants left unharvested.

Plant height (cm)

Plant height was recorded from each observational plant by measuring the length of main stem from ground level to the top leaf bud of plants. Mean length was measured and expressed in centimetres.

Incidence of leaf blight

The genotypes were monitored for the incidence and intensity of leaf blight and scoring was done on a 0-4 scale (Celine *et al*., 2013).

0- No incidence
1- Up to 25% leaf area infected
2- Up to 50% leaf area infected
3- Up to 75% leaf area infected
4- Up to 100% leaf area infected

Scoring was done at biweekly intervals after transplanting and average score worked out.

Incidence of leaf webber

Incidence and intensity of leaf webber attack was observed and scored by using the following score chart (Sathy, 2006)

0- No incidence
1- Mild (25%)
2- Medium (50%)
3- Severe (75%)
4- Very severe (100%)

Scoring was done three times at fortnightly intervals after transplanting and average score was recorded.

Results and Discussion

Thirty genotypes of amaranthus were evaluated, performance of each genotype shown significant difference for the characters under study. The results are presented in the table 1.

Stem girth was noticed to be the maximum for the genotype A9 (3.745 cm. The minimum stem girth was noticed for the genotype A25 (1.759 cm) Length of leaf lamina varied from 12.780 cm to 8.687 cm. The maximum was observed for A28 genotype (12.870 cm). The minimum length of leaf lamina was observed for the genotype A26 (8.687 cm). The maximum petiole length was observed for the genotype A9 (5.175 cm), the least petiole length was noticed for the genotype A11 (2.873 cm).

The genotype A9 registered highest leaf width (8.268 cm). The internodal length ranged from 4.640 cm (A21) to 1.643 cm (A14). The number of branches ranged from 11.467 (genotype A21) to 0.000 (genotype A7 and A15).

The genotype A22 registered high yield plant^{-1} (125.926 g) and high yield plot^{-1} (2.513 kg) and the lowest yield plant^{-1} was reported for the genotype A18 (64.163 g) with 1.436 kg (lowest) yield plot^{-1}. Significant variation was observed for the character leaf to stem ratio. It was ranged from 1.678 (A15) to 0.491 (A7). Days to 50% bolting was found to be highest for the genotype A21 (49.667) and the lowest for the genotype A16 (30. 667). The maximum plant height was recorded for the genotype A7 (72.500 cm). The minimum plant height was recorded for the genotype A16 (17.840 cm).

Incidence of leaf blight was scored according to 0-4 scale, the highest score was reported for the genotype A6 (1.990) and the lowest score 0 were reported for the genotypes A1, A2, A8, A11, A13, A15, A21, A22, A24, A26, A27 and A28.

Scoring for the incidence leaf webber were done with 0-4 scale, maximum score was recorded for the genotype A17 (3.260) which was on par with A14 (3.080). The score 0 was reported for genotypes A9, A20, A21, A23 and A26.

A wide range of observations were reported for different genotypes in terms of biometric characters which indicate the extent of variability present in the germplasm. In the present study, under first experiment thirteen biometric characters were studied for thirty genotypes and all the characters showed considerable variation among the genotypes evaluated.

Analysis of variance showed significant differences for all the 13 traits of 30 genotypes indicating the significant variability for all the characters of amaranthus under study which could be exploited through selection. Similar results were noticed in amaranthus by Selvaraj (2004), Shukla *et al.*, (2005), Pan *et al.*, (2008), Diwan (2015) and Jangde (2016) (Table 2).

Table.1 List of Amaranthus (*Amaranthus tricolor* L.) genotypes used in the study

Genotypes No.	Name of the genotypes	Sources
A1	Elamad local	Kollam district
A2	Palakkadu local	Palakkad district
A3	Ayira local	Thiruvananthapuram district
A4	Kalliyoor local	Thiruvananthapuram district
A5	Thrissur local	Thrissur district
A6	Anachal local	Idukki district
A7	Haripad local	Alappuzha district
A8	Manacaud local	Thiruvananthapuram district
A9	Kazhakkuttom local	Thiruvananthapuram district
A10	Kannur local	Kannur district
A11	Chettikulangara local	Alappuzha district
A12	Kottembram local	Kozhikode district
A13	Thiruthi local	Kozhikode district
A14	Adoor local	Pathanamthitta district
A15	Karnataka local	Kasaragode district
A16	Kollamcode local	Kanyakumari district
A17	Trivandrum local	Thiruvananthapuram district
A18	Kumily local	Idukki district
A19	Nilamel local	Kollam district
A20	Poonkulam local	Thiruvananthapuram district
A21	Aryanadu local	Thiruvananthapuram district
A22	Madhur local	Kasaragod district
A23	Alathur local	Palakkad district
A24	Maranalloor local	Thiruvananthapuram district
A25	Nellad local	Ernakulam district
A26	Aleppy local	Alappuzha district
A27	Cherthala local	Alappuzha district
A28	Ayyanthole local	Thrissur district
A29	Kannara local	Thrissur district
A30	Kilimanur local	Thiruvananthapuram district

Table.2 Mean performance of 13 biometric characters of 30 genotypes of Amaranthus under field condition

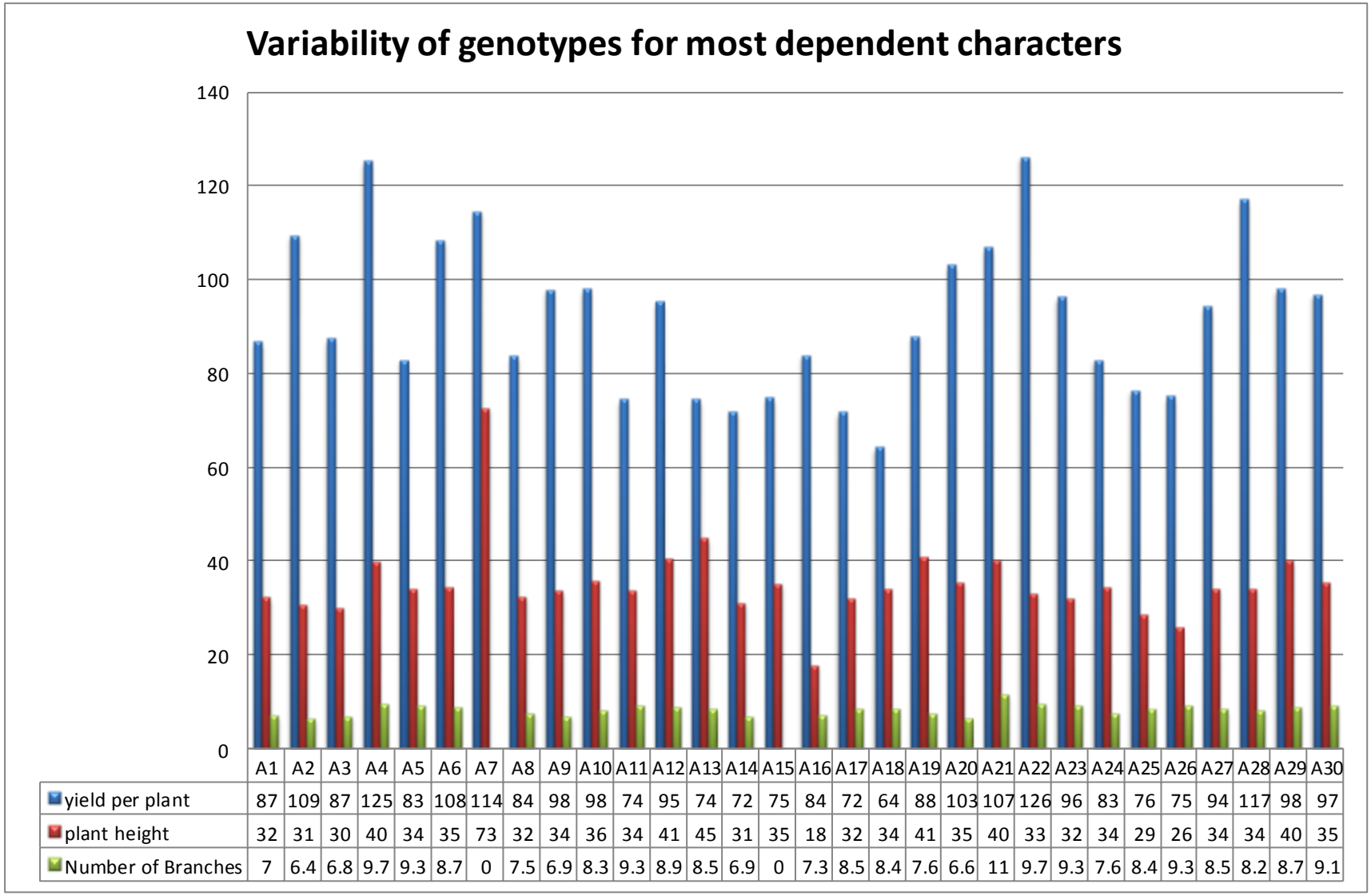
SI No.	Genotypes	X 1	X2	X3	X 4	X5	X 6	X 7	X 8	X9	X 10	X 11	X 12	X13
1	A1	2.880	12.291	4.472	7.930	2.642	7.033	86.680	1.730	0.951	35.333	32.187	0.000	2.170
2	A2	2.657	12.098	4.353	7.778	2.673	6.400	109.26	2.295	1.577	31.333	30.780	0.000	0.320
3	A3	2.700	10.325	3.347	6.283	3.183	6.817	87.323	1.746	1.249	43.333	30.033	1.716	0.730
4	A4	3.200	9.1800	3.027	5.653	3.850	9.667	125.22	2.153	0.707	47.000	39.867	0.830	0.473
5	A5	3.037	10.692	3.683	6.358	3.633	9.283	82.837	1.656	0.906	39.000	33.890	1.246	2.073
6	A6	3.288	11.580	3.493	6.768	2.957	8.733	108.27	2.154	0.713	43.667	34.520	1.990	0.356
7	A7	3.033	11.000	3.700	6.320	4.267	0.000	114.42	2.278	0.491	48.333	72.500	0.846	0.340
8	A8	2.977	10.650	3.773	5.307	2.358	7.520	83.690	1.655	0.719	39.000	32.370	0.000	2.860
9	A9	2.893	12.445	5.175	8.268	2.733	6.933	97.696	1.962	1.428	39.667	33.675	0.283	0.000
10	A10	3.745	12.767	3.717	8.265	4.080	8.267	97.993	1.943	0.916	31.667	35.750	0.603	2.393
11	A11	2.953	9.9800	2.873	6.668	3.927	9.333	74.466	1.486	0.660	48.000	33.833	0.000	1.373
12	A12	3.113	10.690	3.333	6.767	2.767	8.867	95.185	1.903	0.857	44.000	40.580	0.770	1.956
13	A13	3.327	10.713	3.733	6.380	4.133	8.467	74.387	1.486	0.691	38.000	44.900	0.000	0.660
14	A14	1.780	10.653	3.433	6.433	1.643	6.933	71.873	1.437	1.224	36.000	31.087	0.280	3.080
15	A15	2.075	10.873	3.320	6.107	3.213	0.000	74.823	1.496	1.678	48.667	35.100	0.000	2.496

X1- Stem girth , X2- Length of leaf lamina, X3- Petiole length, X4- Leaf width, X5- Internodal length, X6- Number of branches, X7- Yield plant^{-1}, X8- Yield plot^{-1}, X9- Leaf to stem ratio, X10- Days to 50% bolting, X11- Plant height, X12- Incidence of leaf blight, X13- Incidence of leaf webber.

Table.2 Continued

SI No.	Genotypes	X 1	X2	X3	X 4	X5	X 6	X 7	X 8	X9	X 10	X 11	X 12	X13
16	A16	2.623	11.453	3.540	7.007	3.407	7.267	83.736	1.676	1.232	30.667	17.840	0.323	2.286
17	A17	2.900	10.653	2.927	6.480	2.380	8.533	71.796	1.436	1.281	48.333	32.113	0.630	3.260
18	A18	2.567	9.9000	3.100	6.133	2.617	8.400	64.163	1.466	0.724	47.667	33.867	0.556	2.923
19	A19	3.347	10.400	3.200	5.820	3.947	7.600	87.893	1.753	0.942	46.667	40.900	1.143	0.576
20	A20	2.707	11.747	3.813	7.587	3.000	6.600	103.09	2.063	1.530	35.000	35.300	0.890	0.000
21	A21	3.387	8.7230	3.000	5.350	4.640	11.46	106.71	2.136	0.955	49.667	40.167	0.000	0.000
22	A22	2.633	9.9700	3.007	5.627	2.513	9.667	125.92	2.513	0.620	48.000	33.033	0.000	0.253
23	A23	3.537	10.287	3.920	6.360	3.507	9.267	96.226	1.924	0.898	42.000	32.053	1.280	0.000
24	A24	3.395	10.853	4.447	6.590	3.280	7.600	82.826	1.656	1.012	42.000	34.453	0.000	2.720
25	A25	1.759	10.965	3.712	6.505	2.167	8.350	76.233	1.523	0.846	34.000	28.545	0.250	1.800
26	A26	2.487	8.6870	3.330	6.460	2.227	9.267	75.090	1.503	1.277	35.000	25.803	0.000	0.000
27	A27	2.980	8.9130	3.933	5.800	2.667	8.467	94.183	1.883	0.804	43.000	34.200	0.000	1.220
28	A28	3.037	12.780	4.373	6.813	2.820	8.200	116.98	2.339	0.607	40.000	34.133	0.000	1.720
29	A29	2.940	9.4670	3.387	5.653	3.003	8.733	97.923	1.956	0.852	42.333	40.133	1.170	0.726
30	A30	3.262	10.313	3.158	6.770	2.600	9.133	96.666	1.936	1.086	42.000	35.413	1.503	1.263
	S.E	**0.379**	**0.496**	**0.469**	**0.489**	**0.400**	**0.716**	**6.312**	**0.025**	**0.100**	**0.894**	**2.818**	**0.258**	**0.112**
	CD(0.05)	**0.760**	**0.994**	**0.940**	**0.981**	**0.803**	**1.433**	**12.638**	**0.143**	**0.227**	**2.345**	**5.643**	**0.122**	**0.201**

X1- Stem girth , X2- Length of leaf lamina, X3- Petiole length, X4- Leaf width, X5- Internodal length, X6- Number of branches, X7- Yield plant^{-1}, X8- Yield plot^{-1}, X9- Leaf to stem ratio, X10- Days to 50% bolting, X11- Plant height, X12- Incidence of leaf blight, X13- Incidence of leaf webber.



	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30
yield per plant	87	109	87	125	83	108	114	84	98	98	74	95	74	72	75	84	72	64	88	103	107	126	96	83	76	75	94	117	98	97
plant height	32	31	30	40	34	35	73	32	34	36	34	41	45	31	35	18	32	34	41	35	40	33	32	34	29	26	34	34	40	35
Number of Branches	7	6.4	6.8	9.7	9.3	8.7	0	7.5	6.9	8.3	9.3	8.9	8.5	6.9	0	7.3	8.5	8.4	7.6	6.6	11	9.7	9.3	7.6	8.4	9.3	8.5	8.2	8.7	9.1

Plate.1 High yielding selected amaranthus genotypes (A) Madhur local, (B) Kalliyoor local, (C) Ayyanthole local and (D) Palakkadu local

(A) MADHUR LOCAL

(B) KALLIYOOR LOCAL

(C) AYYANTHOLE LOCAL

(D) PALAKKADU LOCAL

High amount of variability in amaranthus was recorded for the characters like plant height, yield per plant and weight of stem and leaves were in accordance with results of Panda *et al.,* (2017). High amount of heritability also noticed for the traits length of leaf lamina, plant height and yield per plant.

Contribution of different traits in amaranthus for the crop improvement was proven by Gerrano *et al.,* (2015), Praveen *et al.,* (2014) and Kumar *et al.,* (2018), which indicates that, the characters are taken in this study, can be considered as main yield contributing traits in amaranthus.

The greatest variability was recorded for yield plant^{-1} which could be used as selection criteria for crop improvement in *Amaranthus tricolor* L. Supporting evidences were given by Shukla*et al.,* (2005) and Celine *et al.,* (2007) in amaranthus.

The highest range of variation was recorded for number of branches, length of leaf lamina, yield plant^{-1}, days to 50% bolting, plant height, incidence of leaf webber in amaranthus. Supporting evidences were given by Sathy (2006) and Celine *et al.,* (2007) in amaranthus.

The genotype A22 (Madhur local) recorded the highest yield plant^{-1} followed by A4 (Klliyoor local), A28 (Ayyanthole local), A7 (Haripad local), A2 (Palakkadu local), A6 (Anachal local), A21 (Aryanadu local), A20 (Poonkulam local) A9 (Kazhakkuttom local) and A29 (Kannara local).

In conclusion, the present study was conducted to evaluate the variability present in the thirty amaranthus genotypes. *Amaranthus tricolor* L. showed tremendous variation in terms of different biometric characters including yield, which depicts the probability in amaranthus improvement in the field of breeding through exploitation of variability and further improvement. The amaranthus genotype Madhur local was identified as the best genotype under field condition, this genotype can be further screened for better genetic exploitation.

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