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Comparative growth performance of vegetable amaranth (*Amaranthus* spp.) genotypes under Northern Dry Zone of Karnataka

Basavaraj Shellikeri*, T.B. Allolli, Lakshmidevamma, T.N., Satish D., Gollagi, S.G., Shashikant Evoor, Prabhudeva Ajjapplavara and Abdul Kareem

Department of Vegetable Science
Kittur Rani Channamma College of Horticulture, Arabhavi,
University of Horticultural Sciences, Bagalkot (Karnataka), India.

(Corresponding author: Basavaraj Shellikeri)*
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ABSTRACT: Amaranth is a quick growing nutritionally potential leafy vegetable crop with a high yield potential in a short period of time. In many regions of India, it is grown as a traditional leafy vegetable, using local cultivars. Concentrated research towards varietal development is very limited. The systematic assessment of foliage yield and yield attributing traits is necessary for the creation of new varieties. In the present investigation a set of 52 genotypes of vegetable amaranthus were characterized during *kharif* 2019 for yield and its attributing traits. Further, 35 promising genotypes were forwarded and evaluated across seasons (*rabi* 2019-20, summer 2020 and *kharif* 2020) to assess the yield potentiality of the genotypes.

The genotypes exhibited highly significant variation for herbage yield and yield attributing traits. The variation studied indicated that the genotype KVA-28 (multicut type) was better performing for the traits leaf length (12.19cm), leaf width (8.16cm), leaf area (64.63cm^2) and fresh leaf weight plant^{-1} (11.55g) during the *kharif* 2019. Similarly, in pooled analysis maximum leaf length was observed in KVA-24 (8.96cm) followed by Konkan Durangi, Renushree and KVA-28; Highest leaf width was counted in a check variety CO-1 (6.56cm); maximum leaf area was recorded in genotype KVA-28 (37.55cm^2) followed by KVA-17, CO-1 (Check var). The genotypes *viz*., CO-1, Nisco Red, Arka Suguna, KVA-34, Arun found to be most promising for leaf: stem ratio during *kharif* 2019 and pooled analysis. The genotypes *viz*., CO-1, Arka Suguna, KVA-18, Nisco Red, Pusa Kiran, Pusa Lal Chauli, KVA-34 and KVA-1 found to be the best for herbage yield during *kharif* (2019 and 2020) and summer (2020) season compared to *rabi* (2019-20) season. Hence, these genotypes were used as potential sources in breeding programme for multi-trait improvement.

Keywords: Genotypes, Vegetable amaranth, Herbage yield and Growth parameters.

INTRODUCTION

In India, leafy vegetables play a prominent role in attaining nutritional security of the local and indigenous people. These leafy vegetables have formed an integral part of the culture and tradition of many indigenous communities across the country. Amaranthus (*Amaranthus* spp.) is one among the popular leafy vegetables commonly known as Chauli (in Hindi), Danteen soppu or Rajgiri soppu (in Kannada) and belongs to the family Amaranthaceae. South East Asia, particularly India (Rai and Yadav 2015) is the probable native place of vegetable type of amaranthus.

In developing countries, vegetable type of amaranth serves as an alternative source of nutrition as it is a rich and cheap source of protein, calcium, vitamins and dietary fibre (Prakash and Pal 1991; Shukla and Singh 2003 and Garcia *et al*., 2018). Apart from the immense nutritional significance, it is extremely adaptable to adverse growing conditions, resists heat and drought, has no major disease problem and is among the easiest plants to grow. They can be grown under varying soil and agro-climatic conditions all year round but summer and rainy are main growing seasons. Unlike other leafy vegetables, it is grown during hot summer months when no other green vegetables are available in the market (Singh and Whitehead 1996). Amaranthus is definitely a special crop in terms of crop production, as every aspect of production from planting to harvesting and storage, needs special attention and consideration. The

development of the amaranthus in the present context is drastically different from that early of civilizations, or even from today's primitive agricultural systems. It is one of the most suitable crops for kitchen gardening and can be grown in different crop rotations because it produces high edible matter per unit area and time.

Amaranthus, exhibits wide genetic variability, thus offering a substantial scope to identify suitable genotype for any specific region. Collection, evaluation and characterization of germplasm is the basic requirement to initiate any crop improvement programme (Mandal *et al.,* 2010). This study was conducted to evaluate the performance of vegetable amaranthus genotypes for yield and yield attributing characters during different seasons.

MATERIALS AND METHODS

The investigation for the evaluation of 52 vegetable amaranth genotypes was carried out at Kittur Rani Channamma College of Horticulture, Arabhavi, Belagavi district (Karnataka) during *kharif* 2019 to assess the performance for yield and yield attributing traits. Further, 35 promising genotypes were forwarded and evaluated across seasons *viz., rabi* 2019-20, summer 2020 and *kharif* 2020. The experimental plots were laid out in RCBD design with two replications. The crop was raised as per the package of practices of University of Horticultural Sciences, Bagalkot (Anon., 2015). The experimental plot was ploughed repeatedly and land was brought to fine tilth. The plot size was 1.8 m × 1.2m. The seed drilling was done between rows about 30cm apart and seeds were sown continuously in the rows. Seedlings were thinned maintaining a spacing of 30cm x 10cm after 15 days of sowing to avoid the damping off disease. Five randomly chosen plants in each replication of each entry were labeled and used for recording the observations. The mean of five plants were considered for analysis using Indostat programme at the Department of Crop improvement and Biotechnology at College of Horticulture, Bengaluru.

RESULTS AND DISCUSSION

The mean values of genotypes varied greatly for several traits, indicating the higher magnitude of variability. The range in the values reflects the amount of phenotypic variability. Wide range of variability was observed in both *kharif* 2019 and pooled over different seasons for yield and its related traits. Hence, this indicated ample scope for exploitation of these traits.

Significant variation was observed for fresh green yield per plant among different vegetable amaranthus genotypes studied. During *kharif* (2019) and pooled across the seasons, fresh green yield per plant was ranged from 7.18 g -24.63 g and 11.65 g - 22.58 g with an average yield of 13.80 g and 16.34 g respectively. Among all the genotypes, KVA-11 (24.63 g) recorded maximum fresh green yield plant^{-1} followed by KVA-28 (24.03g) and lowest fresh green yield per plant was recorded in KVA-23 (7.18g) during *kharif* (2019). However, in pooled analysis genotype KVA-29 (22.58g) had maximum fresh green yield per plant followed by CO-1 (20.36 g) and lowest fresh green yield per plant was recorded in the Pusa Lal Chauli. Variation among amaranth genotypes has also been documented for green yield by Varalakshmi and Pratap (1994); Rani and Veeraragavathatham (2003); Ahammed *et al*. (2012); Mandal *et al.* (2013); Sarker *et al*. (2018).

Genotype Arun (32.56 cm) recorded highest average plant height followed by Konkan Durangi (32.26 cm) and KVA-2 (16.66 cm) recorded lowest average plant height during *kharif* 2019. Likewise, in pooled analysis the highest plant height (Table 3) was recorded in genotype Konkan Durangi (31.56 cm) followed by KVA-31 (30.96 cm) and KVA-5 (17.52 cm) recorded lowest plant height. These findings were line with Diwan *et al*. (2017); Tejashwini *et al*. (2017); Jangde *et al*. (2018); Sarker *et al*. (2018); Rashad and Sarkar (2020). The average diameter of the stem varied significantly from one genotype to another during *kharif* 2019 and pooled across the season. Genotype KVA-18 had the average stem diameter of 8.76 mm which was the highest among all genotypes during *kharif* (2019) followed by KVA-30 (7.60mm). Similarly, in pooled analysis KVA-1 (7.98 mm) recorded highest stem diameter followed by KVA-18 (7.73 mm). The lowest average stem diameter was recorded in genotype KVA-23 (3.24 mm and 4.78 mm) during *kharif* (2019) and pooled analysis respectively. The mean stem diameters of 3.00 mm to 4.00 mm and 5.00 mm to 18 mm have been reported by Sarker *et al*. (2016), Jangde *et al*. (2018) and Malaghan *et al*. (2018) respectively which was more or less similar to the obtained results. Significant variation in number of leaves per plant was also recorded among different amaranthus genotypes. In *kharif* 2019, maximum number of leaves per plant was recorded in genotype KVA-5 (12.10) followed by KVA-7 and KVA-11 (11.60). Similarly, in pooled analysis more number of leaves per plant was recorded in Arka Suguna (13.17) followed by Pusa Lal Chauli (12.39). Earlier reports by Dhangrah *et al*. (2015); Sarker *et al*. (2015) and Rashad and Sarkar (2020) have also justified that the leaves per plant ranged from 4.50 to 12.40, 4.30-20.52 and 6.17 - 13.65 repsectively which was accoradance with the present reusults.

Petiole length ranged from 1.88 cm to 6.05 cm and 3.61 cm to 6.11 cm with an overall mean of 4.27 cm and 4.54 cm during *kharif* (2019) and pooled across the seasons respectively. The highest petiole length of 6.05 cm was recorded in check variety CO-1 whereas, genotype KVA-29 (6.11 cm) recorded maximum petiole length followed by KVA-15 (5.71 cm) during pooled analysis. These findings are in close proximity with the results of Jangde *et al*. (2018) and Sarker *et al*. (2018).

Among the genotypes, KVA-28 (multicut type) had maximum leaf length (12.19 cm), leaf width (8.16 cm), leaf area (64.63 cm^2) and fresh leaf weight per plant (11.55g) during *kharif* 2019 (Table 1 and 2) followed by KVA-24, KVA-22, KVA-21 and KVA-5 for leaf length; KVA-19-2, KVA-27, KVA-16-2 and KVA-30 for leaf width; KVA-16-2, KVA-5, KVA-24 and KVA-21 for leaf area; CO-1 (Check var), KVA-11, KVA-24 and KVA-5 for fresh leaf weight $plant^{-1}$ respectively. These similar findings are corroborated with the results of Oduwaye *et al*. (2017) and Jangde *et al*. (2018). In pooled analysis (Table 3 Fig. 1) maximum leaf length was recorded in KVA-24 (8.96cm) followed by Konkan Durangi, Renushree, KVA-28 and KVA-17; Highest leaf width was reported in check variety CO-1 (6.56 cm) followed by KVA-17, KVA-28, Rajgiri Red and Arka Suguna; maximum leaf area was recorded in genotype KVA-28 (37.55cm^2) followed by KVA-17, CO-1 (Check var), Renushree and KVA-15. These findings are in close proximity with the results of Oduwaye *et al*. (2017); Jangde *et al*. (2018); Table 4, Fig. 2 depicts the superior performance of genotypes for yield parameters where, CO-1 as a check variety (11.45g) exhibited maximum fresh leaf weight $plant^{-1}$ followed by Renushree, KVA-28, KVA-29, KVA-1, Arka Suguna, Pusa Kiran and KVA-18.

Fresh stem weight per plant was noticed to be highest in KVA-11 (11.66 g) followed by KVA-9 (11.12 g) in *kharif* 2019 analysis.. However, in pooled analysis genotype KVA-9 (12.15 g) showed maximum fresh stem weight per plant followed by KVA-29 (10.86 g). In the same way, high range of variation for leaf and stem fresh weight was also reported by Campbell and Abbott (1982); Rani and Veeraragavathatham (2003); Kumar (2015).

Highest leaf: stem ratio was recorded in KVA-5 (1.83) followed by KVA-7 (1.82), Arun (1.80), CO-1 (1.72), Nisco Red (1.71), Arka Suguna (1.58) and KVA-34 (1.37) during *kharif* 2019. The genotype CO-1 (2.37) as a check variety exhibited the highest leaf: stem ratio followed by Arka Suguna (2.35), Pusa Kiran (1.97), KVA-34 (1.66), Arun (1.61) and Nisco Red (1.55) in pooled analysis which is in accordance with the findings of Chattopadhyay *et al*. (2013); Dhangrah *et al*. (2015); Tejashwini *et al*. (2017) who expressed similar views on the edible part partitioned into leaf and stem components, which helps to understand the relative contribution of different plant parts (*i.e.* leaf and stem) towards yield. Leaf: stem ratio is also a good indicator of leafiness of a genotype. High leaf and stem ratio indicated that the leaf portion contributed to the yield more than the stem portion.

The number of days to first harvest obtained varied significantly and the genotypes KVA-3 and KVA-20 took least number of days (27.00 days) followed by KVA-11 (29.00), whereas, KVA-12 took maximum number of days (43.00 days) followed by Rajgiri Red, Suchino Red and KVA-25 (39.50 days) during *kharif* 2019 (Table 1). Likewise in pooled analysis (Table 4), Arka Samraksha (29.34 days) took minimum number of days followed by KVA-11 (29.67 days) and KVA-34 taken maximum number of days to first harvest (40.67days) followed by KVA-31 (36.84 days). Generally vegetable amaranthus is harvested at 20 to 30 days after sowing to consume as tender greens. Consumption of plants within 15 to 20 days as well as at the mature stages of 35 to 40 days after sowing is also not uncommon in all seasons. Dhangrah *et al*. (2015) also reported similar range of marketable maturity in vegetable amaranthus *i.e.* 23.00 days to 35.30 days; Kader (1978) reported that the optimum stage of harvest in amaranthus could be fixed at 25th day after sowing, as at this stage the performance was found to be superior with enhanced leaf weight, stem weight, leaf length, leaf breadth, stem diameter and plant height; According to Vijayakumar (1980), the optimum stage of harvest in most of the types of amaranthus could be fixed between 25-30 days after sowing to get the highest yield as well as nutritious and palatable greens. Similarly, days to 50 % flowering also varied significantly and a KVA-29 taken more number of days for 50% flowering (74.50 days and 72.33 days respectively) followed by KVA-24 (72.00 days) and KVA-28 (70.50) during *kharif* (2019) and pooled across the seasons respectively. While the least number of days for 50% flowering was observed in Arka Varna (50.50 days) and Pusa Lal Chauli (51.00 days) during *kharif* (2019) and pooled across the seasons respectively as seen in Table 1 and 4. These genotypes produced prolonged vegetative growth which could help in higher herbage yield. Hence, selection in these late flowering types of genotypes can be suitable for homestead cultivation to harvest multiple times to provide the nutritional requirement.

Thirty five genotypes of vegetable amaranthus (includes both pulling and multicut types) evaluated across the seasons (*rabi* 2019-20, summer 2020 and *kharif* 2020) for total herbage yield per hectare. Based on the mean performance (Table 5 and Fig. 3) it is revealed that the maximum total herbage yield per hectare was recorded during summer 2020 followed by *kharif* 2020 and *rabi* (2019-20) season. Among all the genotypes, Arka Suguna (25.38 t ha^{-1}, 22.16 t ha^{-1} respectively) recorded maximum total herbage yield during both summer (2020) and *kharif* (2020) seasons followed by check variety CO-1 (23.70 t ha^{-1}, 19.89 t ha^{-1} respectively), KVA-18 (21.98 t ha^{-1}, 19.38 t ha^{-1} respectively), Nisco Red (21.03 t ha^{-1}, 18.12 t ha^{-1} respectively), Pusa Lal Chauli (18.43 t ha^{-1}, 11.71 t ha^{-1} respectively) and Pusa Kiran (17.67 t ha^{-1}, 15.80 t ha^{-1} respectively). However, minimum total herbage yield was recorded in pulling type of genotype KVA-19-1 (4.45 t ha^{-1}) followed by KVA-24, KVA-20 and KVA-5 during summer (2020); in pulling types *viz*., KVA-23 (4.04 t ha^{-1}) followed by Suchino Red and KVA-20 in *kharif* (2020). During *rabi* (2019-20) check variety

(CO-1) exhibited highest total herbage yield (18.21 t ha^{-1}) followed by Arka Suguna (17.03 t ha^{-1}), KVA-34 (15.22 t ha^{-1}) and KVA-18 (14.47 t ha^{-1}). While, lower total herbage yield was obtained in pulling type KVA-21 (3.05 t ha^{-1}) followed by KVA-3 and KVA-24. From the present study it is clearly indicated that both summer (2020) and *kharif*-(2020) seasons would be the favourable seasons for amaranthus cultivation as the genotypes have showed maximum herbage yield over *rabi* (2019-20) season. Mbwambo *et al*. (2015) reported similar results of performance of genotypes during different seasons (Trial-1, Feb-May) and (Trial-2, May-Sept).

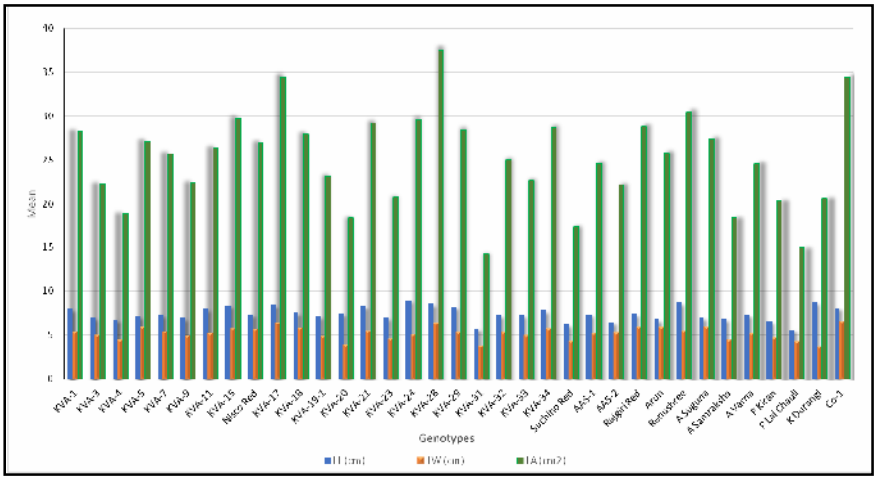

Fig. 1. *Per se* performance of genotypes of vegetable amaranthus for growth parameters across the seasons (Pooled analysis).

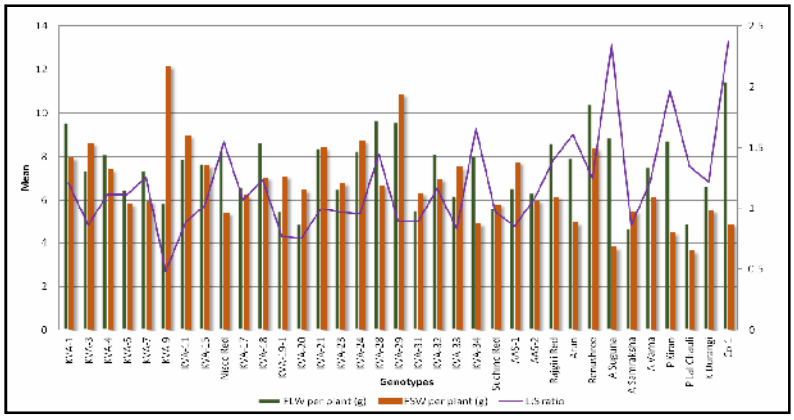

Fig. 2. *Per se* performance of genotypes of vegetable amaranthus for growth parameters across the seasons (Pooled analysis).

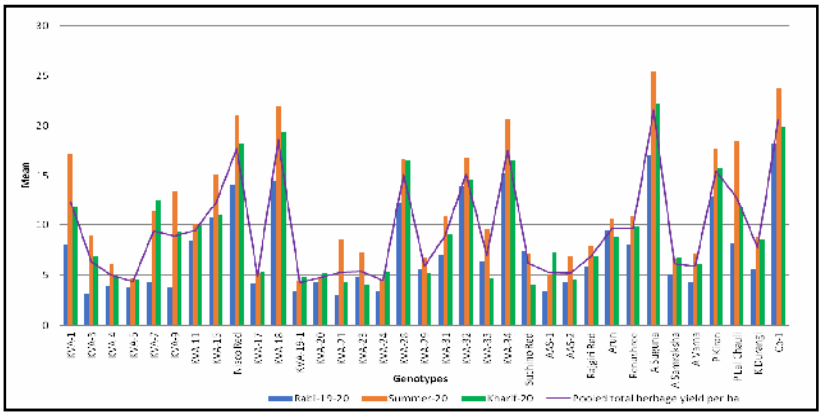

Fig. 3. Mean performance of genotypes of vegetable amaranths for total herbage yield per hectare across the seasons (Pooled analysis).

Table 1: *Per se* performance of vegetable amaranthus genotypes for growth and earliness parameters (*kharif* 2019).

Sr. No.	Genotypes	Plant height (cm)	Stem diameter (mm)	Number of leaves	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Petiole length (cm)	Days to first harvest	Days to 50% flowering
1.	KVA-1	23.29	7.20	9.20	7.84	4.50	22.97	4.18	32.00	63.00
2.	KVA-2	16.66	7.13	7.30	6.38	4.34	17.97	3.44	32.50	60.00
3.	KVA-3	20.64	4.76	9.80	6.56	5.24	22.09	4.40	27.00	61.50
4.	KVA-4	19.92	3.88	10.90	5.11	4.46	14.90	4.03	34.00	64.00
5.	KVA-5	19.22	4.54	12.10	9.70	6.68	42.09	3.86	32.50	57.00
6.	KVA-6	18.72	3.86	10.70	8.77	5.23	29.74	4.00	29.50	62.00
7.	KVA-7	19.57	6.23	11.60	9.40	5.73	35.00	4.58	31.00	61.00
8.	KVA-8	19.33	5.15	7.00	6.98	4.31	19.82	3.87	32.00	62.50
9.	KVA-9	19.43	5.38	8.60	7.20	4.22	19.81	4.12	37.50	55.50
10.	KVA-10	23.03	5.73	11.50	7.93	5.74	29.63	4.71	34.50	63.50
11.	KVA-11	19.66	5.28	11.60	8.90	6.15	35.57	4.98	29.00	57.50
12.	KVA-12	30.31	6.91	8.30	6.81	3.80	16.79	2.92	43.00	56.00
13.	KVA-13	19.75	5.89	7.10	6.85	4.54	20.15	3.91	37.00	56.50
14.	KVA-14	18.81	6.90	7.60	5.92	5.01	19.26	3.33	36.00	59.00
15.	KVA-15	19.08	6.86	7.90	7.28	5.25	24.91	4.92	31.00	56.50
16.	KVA-16-1	18.55	5.98	7.30	7.55	4.61	22.55	4.46	32.50	68.00
17.	KVA-16-2	17.13	6.82	8.90	8.98	7.23	42.13	4.62	36.50	56.50
18.	Nisco Red	28.47	6.74	11.10	8.12	6.08	32.04	4.68	36.00	57.50
19.	KVA-17	18.23	3.62	7.50	7.53	6.41	31.35	4.84	33.00	59.00
20.	KVA-18	29.15	8.76	6.80	7.61	5.74	28.20	5.15	32.00	55.50
21.	KVA-19-1	18.66	4.40	7.30	8.95	5.79	33.81	4.73	37.00	66.50
22.	KVA-19-2	20.12	4.92	6.90	7.91	7.70	39.66	3.77	34.00	57.50
23.	KVA-20	19.97	7.08	6.90	7.40	3.51	16.95	5.82	27.00	65.00
24.	KVA-21	20.77	5.91	9.80	10.06	6.07	39.75	4.49	34.00	70.50
25.	KVA-22	18.04	4.74	9.50	10.32	5.89	39.61	5.21	37.50	68.50
26.	KVA-23	20.64	3.24	8.90	7.92	4.84	24.95	3.97	31.50	56.00
27.	KVA-24	19.65	4.92	7.60	11.61	5.45	41.09	4.22	34.00	72.00
28.	KVA-25	17.46	6.82	6.60	6.54	4.15	17.58	3.94	39.50	58.50
29.	KVA-26	19.86	7.14	6.70	5.70	4.42	16.41	4.73	35.00	57.50
30.	KVA-27	19.00	5.30	7.90	6.49	7.33	30.85	4.14	31.50	65.50
31.	KVA-28	18.58	4.57	8.80	12.19	8.16	64.63	5.30	33.50	68.00
32.	KVA-29	18.64	3.87	6.90	8.08	5.28	27.67	5.62	37.00	74.50
33.	KVA-30	30.97	7.60	9.20	8.52	6.94	38.43	5.21	34.00	65.50
34.	KVA-31	25.68	6.22	8.00	7.11	3.94	18.39	3.22	36.00	68.00
35.	KVA-32	30.24	7.31	7.20	6.34	5.11	21.00	4.99	35.00	65.50
36.	KVA-33	21.59	7.11	8.40	5.86	5.24	19.80	3.52	36.00	69.00
37.	KVA-34	24.60	6.63	7.10	8.12	5.59	29.58	3.52	37.50	61.00
38.	Suchino Red	31.11	6.38	8.40	5.49	3.79	13.52	1.88	39.50	56.50
39.	AAS-1	24.35	6.74	7.90	6.11	5.14	20.24	2.92	37.00	68.50
40.	AAS-2	21.51	6.02	8.00	6.18	5.42	21.76	3.98	34.00	66.50
41.	AAS-3	18.84	5.56	7.00	5.62	4.16	15.25	3.12	36.50	57.00
42.	ASS-1	18.24	6.66	8.30	5.57	4.02	14.23	3.87	38.50	58.00
43.	Rajgiri Red	22.24	7.06	9.70	7.45	5.78	27.98	4.42	39.50	71.00
44.	Arun	32.56	7.37	10.10	7.30	5.61	26.57	3.63	37.00	62.00
45.	Renushree	28.88	6.93	8.50	8.06	5.49	28.78	5.41	34.00	58.50
46.	Arka Samaraksha	24.55	6.77	7.10	6.48	4.77	20.02	3.93	33.00	54.00
47.	Arka Varna	17.04	6.11	8.10	6.16	4.90	19.60	4.55	30.00	50.50
48.	Pusa Kiran	25.88	6.24	8.20	6.03	3.93	15.46	3.53	37.00	57.50
49.	Pusa Lal Chauli	25.22	4.51	7.70	5.92	4.55	14.23	4.10	34.50	55.50
50.	Konkan Durangi	32.26	7.38	10.00	9.16	4.37	25.66	5.67	31.00	60.50
51.	Arka Suguna	23.77	5.07	6.80	7.06	5.93	27.19	3.90	35.50	63.00
52.	CO-1 (Check var)	22.07	6.01	9.90	7.97	6.22	32.25	6.05	34.50	59.50
	Mean	**22.15**	**5.96**	**8.50**	**7.52**	**5.28**	**26.34**	**4.27**	**34.42**	**61.53**
	S.Em±	1.05	0.36	0.48	0.54	0.30	2.42	0.25	1.28	1.19
	CV (%)	6.70	8.44	7.98	10.16	8.09	13.01	8.21	5.28	2.73
	C.D. at 5%	2.98	1.01	1.36	1.53	0.86	6.88	0.70	3.65	3.37

Table 2: *Per se* performance of vegetable amaranthus genotypes for yield parameters (*kharif* 2019).

Sr. No.	Genotypes	Leaf: Stem ratio	Fresh leaf weight (g/plant)	Fresh stem weight (g/plant)	Fresh green yield (g/plant)	Total herbage yield (t/ha)
1.	KVA-1	0.75	5.13	6.94	13.61	11.41
2.	KVA-2	0.78	2.45	3.16	8.34	4.00
3.	KVA-3	1.15	7.93	7.01	16.87	6.99
4.	KVA-4	0.92	5.54	6.17	10.91	5.91
5.	KVA-5	1.83	8.73	4.79	12.80	3.90
6.	KVA-6	0.96	5.95	6.17	11.33	3.94
7.	KVA-7	1.82	7.58	4.16	14.07	14.18
8.	KVA-8	0.64	3.05	4.69	10.43	4.32
9.	KVA-9	0.52	5.74	11.12	18.75	9.56
10.	KVA-10	0.84	7.69	9.16	17.17	4.21
11.	KVA-11	0.92	10.66	11.66	24.63	13.91
12.	KVA-12	1.21	5.76	5.02	13.16	3.93
13.	KVA-13	0.85	4.00	4.79	12.17	4.31
14.	KVA-14	0.96	3.83	4.02	11.03	2.43
15.	KVA-15	0.88	5.47	6.31	11.23	10.43
16.	KVA-16-1	0.78	3.66	4.75	10.13	4.11
17.	KVA-16-2	0.75	3.59	4.81	11.14	7.66
18.	Nisco Red	1.71	6.01	3.99	12.66	14.69
19.	KVA-17	1.29	5.70	4.58	12.90	5.21
20.	KVA-18	0.80	7.63	9.61	18.64	20.20
21.	KVA-19-1	1.64	8.27	5.15	15.43	5.27
22.	KVA-19-2	1.21	6.59	5.48	15.24	3.19
23.	KVA-20	0.65	2.89	4.55	8.78	5.34
24.	KVA-21	1.71	7.88	4.62	17.76	4.74
25.	KVA-22	0.48	2.52	5.24	11.60	2.95
26.	KVA-23	0.94	7.36	7.89	7.18	3.53
27.	KVA-24	1.20	9.18	7.66	18.30	5.79
28.	KVA-25	0.89	5.05	5.68	13.31	2.95
29.	KVA-26	0.72	3.56	5.00	10.80	3.71
30.	KVA-27	0.71	3.74	5.32	12.29	2.82
31.	KVA-28	1.06	11.55	10.90	24.03	16.71
32.	KVA-29	0.88	7.17	8.17	16.41	4.71
33.	KVA-30	0.97	4.08	4.18	9.63	4.86
34.	KVA-31	0.95	2.84	3.17	8.58	10.91
35.	KVA-32	0.98	6.95	7.31	16.28	13.14
36.	KVA-33	0.77	6.09	7.99	16.76	4.54
37.	KVA-34	1.37	4.80	3.96	11.79	18.55
38.	Suchino Red	0.70	4.19	5.97	12.71	3.36
39.	AAS-1	0.60	5.31	9.26	16.72	6.60
40.	AAS-2	1.42	7.54	5.37	15.80	5.25
41.	AAS-3	1.05	6.63	6.36	16.05	2.45
42.	ASS-1	0.80	4.08	5.19	11.28	3.07
43.	Rajgiri Red	1.22	5.83	4.79	13.31	6.00
44.	Arun	1.80	7.38	4.11	13.70	7.97
45.	Renushree	1.16	6.94	6.04	15.84	13.92
46.	Arka Samraksha	0.85	4.69	5.65	13.33	5.79
47.	Arka Varna	0.78	4.10	5.81	12.41	5.85
48.	Pusa Kiran	0.78	2.80	3.60	9.31	12.38
49.	Psa Lal Chauli	0.73	3.10	4.25	10.44	10.57
50.	Konkan Durangi	0.79	5.73	7.25	15.59	5.75
51.	Arka Suguna	1.58	6.17	3.96	14.02	19.98
52.	CO-1 (Check var)	1.72	10.93	6.44	21.16	21.74
.	**Mean**	**1.03**	**5.81**	**5.94**	**13.80**	**7.68**
	S.Em±	0.17	0.65	0.81	1.42	1.04
	CV (%)	23.44	15.94	19.21	14.55	19.20
	C.D. at 5%	0.48	1.86	2.29	4.03	2.96

Table 3: *Per se* performance of vegetable amaranth genotypes for growth parameters pooled across the seasons (*rabi* 2019-20, summer 2020 and *kharif* 2020).

Sr. No.	Genotypes	Plant height (cm)	Stem diameter (mm)	Number of leaves	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Petiole length (cm)
1.	KVA-1	25.14	7.98	11.41	7.98	5.32	28.26	4.31
2.	KVA-3	25.72	6.51	10.14	7.00	4.98	22.35	4.14
3.	KVA-4	19.02	5.71	10.99	6.78	4.45	18.98	4.07
4.	KVA-5	17.52	5.63	9.57	7.15	5.89	27.18	4.47
5.	KVA-7	19.54	6.12	9.15	7.29	5.41	25.75	4.90
6.	KVA-9	25.32	6.13	8.74	6.94	4.94	22.48	4.64
7.	KVA-11	20.84	5.72	10.02	7.98	5.17	26.39	4.66
8.	KVA-15	19.64	6.43	8.53	8.37	5.72	29.74	5.71
9.	Nisco Red	23.90	6.61	10.62	7.37	5.65	26.98	4.67
10.	KVA-17	23.72	5.70	8.17	8.44	6.42	34.47	5.41
11.	KVA-18	23.92	7.73	7.93	7.56	5.82	27.97	5.35
12.	KVA-19-1	26.07	5.28	8.00	7.14	4.86	23.22	4.01
13.	KVA-20	22.76	7.09	8.13	7.47	3.92	18.47	4.43
14.	KVA-21	21.55	6.76	9.15	8.30	5.47	29.26	4.29
15.	KVA-23	23.28	4.78	8.82	7.01	4.56	20.78	4.48
16.	KVA-24	24.38	5.43	8.57	8.96	5.05	29.67	4.22
17.	KVA-28	19.55	5.26	9.54	8.56	6.34	37.55	4.47
18.	KVA-29	19.81	5.24	8.47	8.23	5.33	28.50	6.11
19.	KVA-31	30.96	6.32	11.79	5.77	3.79	14.28	3.82
20.	KVA-32	26.25	7.45	9.93	7.26	5.32	25.04	5.20
21.	KVA-33	21.81	7.15	8.50	7.27	5.00	22.71	4.08
22.	KVA-34	20.56	6.65	8.37	7.81	5.75	28.71	4.43
23.	Suchino Red	24.78	6.95	7.93	6.22	4.31	17.44	3.61
24.	AAS-1	22.69	6.60	10.99	7.37	5.21	24.65	3.98
25.	AAS-2	23.04	5.96	7.99	6.48	5.27	22.21	3.62
26.	Rajgiri Red	22.07	6.19	10.00	7.41	5.96	28.84	4.50
27.	Arun	27.18	7.41	9.00	6.79	5.88	25.83	4.66
28.	Renushree	24.21	7.10	11.13	8.69	5.50	30.48	5.28
29.	Arka Samraksha	23.54	6.43	8.00	6.86	4.44	18.44	4.29
30.	Arka Varna	22.45	6.84	9.24	7.33	5.21	24.61	5.26
31.	Pusa Kiran	22.60	6.55	11.59	6.56	4.73	20.38	3.97
32.	Pusa Lal Chauli	22.94	5.09	12.93	5.61	4.22	14.94	3.91
33.	Konkan Durangi	31.56	6.34	11.04	8.74	3.74	20.64	4.06
34.	Arka Suguna	19.69	5.53	13.45	7.01	5.93	27.42	4.46
35.	CO-1 (Check var)	22.94	6.83	11.38	8.13	6.56	34.43	5.42
	Mean	**23.17**	**6.33**	**9.69**	**7.42**	**5.20**	**25.11**	**4.54**
	S.Em±	0.86	0.23	0.56	0.22	0.17	1.27	0.18
	CV (%)	5.25	5.05	8.21	4.28	4.54	7.17	5.59
	C.D. at 5%	2.47	0.65	1.62	0.65	0.48	3.66	0.52

Table 4: *Per se* performance of vegetable amaranth genotypes for yield parameters pooled across the seasons (*rabi* 2019-20, summer 2020 and *kharif* 2020).

Sr. No.	Genotypes	Days to first harvest	Days to 50% flowering	Fresh leaf weight (g/plant)	Fresh stem weight (g/plant)	Fresh green yield (g/plant)	Leaf: Stem ratio	Total herbage yield (t /ha)
1	KVA-1	35.34	67.00	9.56	7.95	18.78	1.21	12.33
2	KVA-3	30.00	54.67	7.37	8.60	17.77	0.86	6.32
3	KVA-4	30.84	54.34	8.11	7.41	16.76	1.12	4.93
4	KVA-5	33.50	54.50	6.48	5.82	13.49	1.12	4.34
5	KVA-7	31.84	51.67	7.37	5.94	15.52	1.26	9.41
6	KVA-9	36.17	53.00	5.85	12.15	17.99	0.48	8.86
7	KVA-11	29.67	56.00	7.88	8.96	19.10	0.88	9.45
8	KVA-15	34.34	53.17	7.68	7.59	17.30	1.02	12.28
9	Nisco Red	34.50	55.50	8.29	5.38	15.92	1.55	17.72
10	KVA-17	31.17	56.17	6.61	6.23	14.84	1.07	4.89
11	KVA-18	34.67	53.33	8.66	7.03	17.86	1.24	18.59
12	KVA-19-1	34.00	56.33	5.45	7.10	13.96	0.77	4.25
13	KVA-20	30.50	65.83	4.86	6.47	14.09	0.75	4.73
14	KVA-21	34.67	57.33	8.39	8.41	16.36	1.00	5.29
15	KVA-23	33.17	58.00	6.54	6.78	14.67	0.97	5.36
16	KVA-24	34.84	59.34	8.28	8.72	20.29	0.95	4.43
17	KVA-28	36.17	70.50	9.69	6.68	17.47	1.45	15.12
18	KVA-29	36.00	72.33	9.59	10.86	22.58	0.89	5.88

19	KVA-31	36.84	54.67	5.51	6.32	14.73	0.89	8.96
20	KVA-32	34.34	57.67	8.12	6.97	17.47	1.17	15.10
21	KVA-33	36.17	59.50	6.20	7.52	15.65	0.83	6.87
22	KVA-34	40.67	56.84	8.03	4.88	15.22	1.66	17.49
23	Suchino Red	34.17	51.17	5.60	5.80	13.13	0.97	6.18
24	AAS-1	34.00	55.34	6.55	7.74	16.86	0.85	5.26
25	AAS-2	33.34	57.17	6.33	5.98	14.29	1.08	5.21
26	Rajgiri Red	35.50	68.00	8.60	6.15	17.00	1.41	6.91
27	Arun	35.17	57.50	7.93	4.92	15.00	1.61	9.64
28	Renushree	34.34	56.17	10.39	8.38	19.94	1.25	9.57
29	Arka Samraksha	29.34	53.67	4.67	5.45	12.00	0.86	6.14
30	ArkaVarna	30.50	51.67	7.51	6.12	16.96	1.23	5.88
31	Pusa Kiran	34.67	57.67	8.72	4.47	15.39	1.97	15.45
32	Pusa Lal Chauli	35.00	51.00	4.88	3.63	11.65	1.35	12.76
33	Konkan Durangi	32.67	54.00	6.64	5.49	14.39	1.22	7.69
34	Arka Suguna	32.83	59.17	8.87	3.80	17.07	2.35	21.52
35	CO-1 (Check var)	32.00	58.17	11.45	4.86	20.36	2.37	20.60
	Mean	33.80	57.38	7.50	6.76	16.34	1.19	9.58
	S.Em±	1.02	1.23	0.35	0.42	0.66	0.09	0.95
	CV (%)	4.27	3.03	6.68	8.80	5.72	10.16	14.00
	C.D. at 5%	2.94	3.53	1.02	1.21	1.90	0.25	2.73

Table 5: Mean performance of total herbage yield per hectare in 35 vegetable amaranth genotypes across the seasons.

Sr. No.	Genotypes	*Rabi* (2019-20)	Summer (2020)	*Kharif* (2020)	Pooled total herbage yield per ha
1.	KVA-1	7.97	17.14	11.90	**12.33**
2.	KVA-3	3.19	8.93	6.83	**6.31**
3.	KVA-4	3.88	6.12	4.79	**4.93**
4.	KVA-5	3.77	4.73	4.51	**4.34**
5.	KVA-7	4.28	11.42	12.52	**9.41**
6.	KVA-9	3.82	13.41	9.34	**8.86**
7.	KVA-11	8.32	10.09	9.94	**9.45**
8.	KVA-15	10.76	15.09	10.96	**12.27**
9.	Nisco Red	14.01	21.03	18.12	**17.72**
10.	KVA-17	4.21	5.20	5.26	**4.89**
11.	KVA-18	14.47	21.98	19.30	**18.58**
12.	KVA-19-1	3.46	4.45	4.83	**4.25**
13.	KVA-20	4.29	4.64	5.25	**4.73**
14.	KVA-21	3.05	8.54	4.27	**5.29**
15.	KVA-23	4.78	7.25	4.04	**5.36**
16.	KVA-24	3.34	4.54	5.38	**4.42**
17.	KVA-28	12.30	16.61	16.44	**15.12**
18.	KVA-29	5.64	6.78	5.21	**5.87**
19.	KVA-31	7.00	10.81	9.04	**8.95**
20.	KVA-32	13.89	16.83	14.59	**15.10**
21.	KVA-33	6.40	9.53	4.66	**6.87**
22.	KVA-34	15.22	20.66	16.57	**17.49**
23.	Suchino Red	7.44	7.05	4.05	**6.18**
24.	AAS-1	3.36	5.14	7.28	**5.26**
25.	AAS-2	4.28	6.84	4.51	**5.21**
26.	Rajgiri Red	5.90	7.95	6.89	**6.91**
27.	Arun	9.47	10.62	8.85	**9.64**
28.	Renushree	8.01	10.85	9.86	**9.57**
29.	Aka Suguna	17.03	25.38	22.16	**21.52**
30.	Arkar Samraksha	5.09	6.62	6.71	**6.14**
31.	ArkaVarna	4.31	7.15	6.17	**5.88**
32.	Pusa Kiran	12.88	17.67	15.80	**15.45**
33.	Pusa Lal Chauli	8.14	18.43	11.71	**12.76**
34.	Konkan Durangi	5.63	8.87	8.56	**7.69**
35.	CO-1	18.21	23.70	19.89	**20.60**

CONCLUSION

Thus, while studying the different genotypes of vegetable amaranthus during *kharif* 2019 and pooled across the seasons, it was concluded that all the characters *viz*., growth parameters, earliness and yield parameters were varied significantly. Among locally collected genotypes *viz*., KVA-18, KVA-28 and KVA-34 were performed better for yield and yield attributing traits along with some of the released varieties such as Arka Suguna, CO-1, Pusa Lal Chauli, Pusa Kiran and Nisco Red during *kharif* (2019 and 2020) and summer (2020) season compared to *rabi* (2019-20) season. Hence, these genotypes can be utilized as donor parent to improve the yield and yield attributing traits in future crop improvement programme for selection of variety in Northern Dry Zone of Karnataka.

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