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Screening of Amaranths genotypes for yield and quality under hot climatic condition of semiarid ecosystem of western India.

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Abstract

An experiment on the "Screening of Amaranthus genotypes for yield and quality under semiarid condition of western India" was conducted using twenty eight accessions including released varieties were collected from diversified areas. The experiment was laid out in a randomized complete block design with three replications. The experiment results revealed that the significant differences among the genotypes for all the characters under study indicating the wide variability present in the germplasm. Among the genotypes studied in the present experiment, the highest plant height was recorded in IC-4469674 followed by IC-469676. The leaf size is considered an important character which decided by the leangth and breadth of the leaf. Arka Suguna, IC-469646, IC-469620, IC-469601 and IC-464521 recorded the lengthiest leaves over 10.0cm against IC-469645 (5.0cm). Arka Suguna, IC-469646, IC-469620 recorded the higher leaf breadth over 7.0cm against IC-469624 (2.6cm). The highest total leaf yield per plot was recorded in Arka Suguna (5.66 Kg) followed by Arka Arunima and IC-469646. This result indicate that the Arka Suguna, IC-469646, IC-469620 are broader leafy type and would be preferred by consumers. Study on quality parameters indicated that the highest protein (3.8g) and Fe (0.521mg) per 100 g has been recorded in IC-469646. Hence, Arka Suguna (Green type) and Arka Arunima (purple type) have exhibited a high yielding genotypes and IC-469646 (Green type) has registered high yield coupled with high protein and high Fe content under semiarid condition.

Key words: *Amaranthus, yield, quality, Semi arid ecosystem*

Introduction

Amaranthus sp is an important leafy vegetable grown in every part of India. It has centers of diversity in central and South America, India and South East Asia (Randle, 1959). Its cultivation believed to started back 7000 and 2000 years for grain and vegetable purpose respectively. Due to its anatomical feature, C4 metabolism and cheapest source of minerals and vitamins, Amaranthus occupied a predominant position in the diet for both grain and leaves (Brenner *et al*, 2000). The leaves of amaranths are nutritionally significant sources of carbohydrates, several vitamins and minerals, and dietary fiber (Betschart *et al.* 1981, Teutonico and Knorr 1985, Tucker 1986). Unlike other leafy vegetables, vegetable amaranth is cultivated during hot summer months when no other green vegetables are available in the market (Singh & Whitehead, 1996) and suits for cultivation under varied soil and agro climatic conditions (Katiyar *et al.*, 2000; Shukla & Singh, 2000) and reasonable yields can be produced even in poor soils (Afolabi et al. 1981, Dean 1986, Uzo and Okorie 1983). However, the consumer acceptability and preference varies from region to region depending on its leaf colour. Xiao *et al* (2000) also used stem and leaf color as a useful indices in classifying 31 vegetable amaranthus for 17 biological characters in the evaluation. Varalaksmi (2004) reported wide genetic variability existing in amaranthus for most agronomic traits evaluated under Bangalore condition. So far not much work has been done for its genetic improvement (Shukla et al., 2003, 2004a), recently the emphasis for its genetic improvement to enhance potentiality for foliage yield through different contributing traits has been put up. Hence, identification of genotypes with high yield and quality for semiarid region is a prerequisite. In order to identify a high yielding leafy type a preliminary investigation was designed as there is little information available for this region.

Material and Methods

An experiment was carried out at the Central Horticultural Experiment Station (CIAH), Vejalpur.. The experimental site is located at 22 °41 33 and 73 °33 22 and lies between 110-115m above mean sea level. The annual rainfall mainly is confined to three months (July to September) with an average of 35 rainy days a year. The annual maximum and minimum temperature ranged from 42-43C in May and 6-7C in January, respectively. The annual potential evapo-transpiration ranged from 1500-1600mm against the annual precipitation of 750 mm.

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Twenty eight accessions including released varieties were collected from, NBPGR, New Delhi, IIHR, Bangalore, UAS, Bangalore. The experiment was laid out in a randomized complete block design with three replications. The raised seed beds of 2 m length, 1 m width and 20 cm height were prepared. Well decomposed farmyard manure @ 5 Kg was applied to each bed and mixed well. Seeds were sown in a raised bed for subsequent transplanting where plants are to be grown. Seeds were sown about 4 mm deep at 5 cm apart and covered with 4 mm of soil for good germination. The beds were then mulched with paddy straw and watered daily with rose can. Because of the shallow depth, special care has been taken to prevent drying out of the soil until plants are established. Transplanting has been done in about four weeks old seedlings in a 2.0 X 3.0m plot. Granulated fertilizer 15:15:15 of NPK was applied at 62.5 kg/ha as basal at sowing. Urea was top dressed at 250 kg/ha at 28 DAS. Furrow irrigation was carried out once in a week. The crop was harvested at 40 DAT by clipping of shoots from ground level and the fresh shoot yield was recorded (Alfaro *et al*, 1987). Collection of data was based on 5 randomly selected plants per genotypes and five measurements for each character trait per plant. Five plants were removed with roots from each treatment for recordings on plant and root weight. In the present study, twenty two characters have been studied including four quality parameters.

Results and Discussion

The experiment results revealed that the significant differences among the genotypes for all the characters under study indicating the wide variability present in the germplasm. Among the genotypes studied in the present experiment, the highest plant height was recorded in IC-4469674 followed by IC-469676. The lowest height was registered by IC-469558. The mean plant height of the genotypes observed was 25.78cm. Number of branches per plant is thought to be character which differentiates the grain and leafy types. It was also observed that there are two types of branches ie. Long ,Thick branch having sparsely arranged leaves and Short , thin branch having densely arranged leaves. In the present study, the highest number of branches per plant was recorded in Arka Suguna and IC-469705 producing more than eleven branches of later types. The lowest branches were recorded in IC-469677 (3.3). The internode length is a commercially important parameter which decides whether the genotype fits for ratoon type or clipping type. In the field observation, the plant with longer internode produced generally smaller sized leaves indicating its suitability for clipping. Whereas the plant with smaller internode length produced larger leaves shows its fitness to ratooning. In the present study, IC-469558, IC-469703, Arka Arunima and Kannara local showed lower inter node length indicating its possibility of ratooning. IC-469676 and IC469601 showed internode length over 5.0cm indicating its clipping nature. From the consumer point of view, the ratooning type is most preferred that of clipping type. However, it further depends on leaf size and leaf yield of the genotype.

The number of leaves per plant is an important economical character's consequently reflects on yield, however, it cannot decide the consumer preference from the fact that small size leaf is an unpreferable character in terms of handling in preparation. The higher number of leaves were observed in IC-469676 (272.6) followed by IC-469678 are found to smaller leafy types. Leaf length is an important and preferred character by the consumers uniformly in every region. Arka Suguna, IC-469646, IC-469620, IC-469601 and IC-464521 recorded the lengthiest leaves over 10.0cm against IC-469645 (5.0cm). The similar trend was observed for leaf breadth too. Arka Suguna , IC-469646, IC-469620 recorded the higher leaf breadth over 7.0cm against IC-469624 (2.6cm). This result indicate that the Arka Suguna, IC-469646, IC-469620 are broader leafy type and would be preferred by consumers. Bola Oboh (2007) also reported wide variability for leaf length, width among the sixteen accessions of Amaranthus.

In Amaranthus, leaf, succulent stem are also been used for edible purpose, hence, observation on plant weight, shoot weight, leaf weight, petiole weight are imperative to assess the total yield of the plant. The highest plant weight was observed in Arka Suguna (142.0g) followed by Arka Arunima and IC-469646 against IC-469558 and IC-469692. The leaf weight per plant indicated the genotypes Arka Suguna (43.79g) followed by Arka Arunima, IC-469646, IC-469678 are high producer of edible part producing more than 30.0g per plant. The highest petiole weight per plant was recorded by IC-469646 (7.72g) followed by IC-469658 and Arka Suguna. The total shoot weight per plant indicates that Arka Suguna, Arka Arunima and IC-469646 (more than 50.0g) are producer of higher succulent stem among the genotypes. Considering its medium height coupling with higher stem weight indicates its worthiness of succulent stem for consumption. The similar trend was observed for total shoot weight per plant too. Arka Suguna, Arka Arunima and IC-469646 produced highest shoot weight (more than 86.0g) against IC-469708 (9.28g). The highest total yield per plot was recorded in Arka Suguna (5.66Kg) followed by Arka Arunima and IC-469646. This result is in concordance with finding of Sudhir Shukla *et al* (2006). Alfaro *et al* (1987) also reported the differential yield, quality on stage of harvest and harvesting at 40 days after transplanting found appreciable for high quality in Amaranthus.

In order to ensure succulence, and therefore, quality, vegetative growth should be rapid and un-interrupted for which the rooting growth is considered to be very important. The semiarid region is highly prone to moisture stress deficit. Further, the success of a genotype under prevailing climatic condition is based on its adaptability. In order to assess the rooting ability of genotypes to tackle the moisture stress has been studied. The result indicate that the highest root weight too was recorded in Arka Suguna (13.38g), followed by Arka Arunima and IC-469646, IC-469658 (more than 8.20g) under summer season of semiarid condition. Total fresh matter partition of each genotype has been studied. The

lowest total shoots to root ratio observed in IC-469646,Arka Arunima, IC-4696708, and Arka Suguna . The leaf to stem ratio is an indicator that the genotype with lowest value shows the biomass partitioned towards leaf yield. Among the genotypes studied, IC-469624, IC-469678, IC-469645, IC-469677 and IC-469676 showed value more than 1.00. Though, IC-469558 showed more shoots to root ratio, the major partitioned towards stem rather than leaf indicated the probable reason for low yielding under semiarid condition. Akando (2006) also reported that root growth and development had positive effect on yield of Amaranthus.

Four quality parameters have been analyzed during this study. The results indicate that the highest protein has been recorded in IC-469646(3.8g/100g) followed by IC-469624 and IC-469678. The lowest protein was observed in IC-469658 (1.1). The highest Ca was recorded in IC-469545 (322.0 mg/100g). Arka Suguna, IC-469703, IC-469528 showed Ca at par value. As regard to Fe, the highest value was recorded in IC-469646 (0.521) followed by Dharwad Local, Panchmahal Local, and IC-469620. Vit-C content showed the highest value in IC-469545 (150.5) followed by IC-469703 and IC-469521. The high yielding genotypes Arka Suguna, Arka Arunima and IC-469646 did not showed higher value for Vit-C. Zafar *et al*, (2006) have also been opined that qualitative character to be important for plant description and are mainly influenced by the consumers preference, socio economic scenario and natural selection. Shudir Shukla *et al* (2006) also reported the variability of mineral content and their differential accumulation based on leaf size and foliage yield of Amaranthus. Ghafoor and Ahmad (2003) reported that these characters are useful in separating varieties especially when the range of quantitative characters is limited. The study on mineral content not only exhibits the nature of varital quality but also guide the breeder to choose the variety based on the region where the particular mineral is deficient. In the present study too, ICC-469646 had exhibited higher Fe compared to other commercially released varieties under this climatic condition.

It is concluded from the result that Arka Suguna and Arka Arunima have exhibited a high yielding genotypes and IC-469646 has registered high yield coupled with high protein and high Fe content under semiarid condition. Hence, these genotypes can be recommended for semiarid ecosystem.

Table 1: Characterization of Amaranthus germpalsm collected from diversified sources.

Sl.No	Accession	Plant habit	Stem color	Petiole color	Leaf shape	Stem surface	Leaf surface	Venation	Leaf color
1	IC- 469558	Erect	Deep purple	Purplish green	Oblong	Ridged	Smooth	Green	Dark green
2	IC- 469530	Erect	Purplish green	Green	Broad ovate	Smooth	Smooth	Green	Dark green
3	IC- 469521	Erect	Greenish purple	Greenish purple	Broad ovate	Smooth	Smooth	Green	Green
4	IC- 469708	Erect	Yellowish green	Green	Obovate	Smooth	Smooth	Green	Green
5	IC- 469645	Erect	Green	Green	Obovate	smooth	Smooth	Green	Dark green
6	IC- 469601	Erect	Yellowish green	Green	Ovate	Smooth	Smooth	Green	Green
7	IC- 469692	Erect	Purplish green	Green	Ovate	Smooth	Smooth	Green	Green
8	IC- 469658	Erect	Deep purple	Purplish green	Broad ovate	Smooth	Smooth	Green	Green
9	IC- 469646	Erect	Green	Green	Ovate	Smooth	Smooth	Green	Green
10	IC- 469620	Erect	Greenish purple	Purplish green	Ovate	Angular	Smooth	Green	Green
11	IC- 469546	Erect	Greenish purple	Green	Broad ovate	Smooth	Smooth	Green	Dark green
12	IC- 469624	Erect	Greenish purple	Green	Ovate	Smooth	Smooth	Green	Dark green
13	IC- 469605	Erect	Green	Green	Ovate	Smooth	Smooth	Green	Dark green
14	IC- 469705	Erect	Purplish green	Green	Ovate	Smooth	Smooth	Green	Dark green
15	IC- 469703	Erect	Green	Green	Ovate	Smooth	Smooth	Green	Dark green
16	IC- 469677	Erect	Purplish green	Green	Broad ovate	Ridged	Smooth	Green	Dark green
17	IC- 469679	Erect	Green	Green	Ovate	Smooth	Smooth	Green	Green
18	IC- 469678	Erect	Purplish green	Green	Ovate	Smooth	Smooth	Green	Dark green
19	IC- 469674	Erect	Purplish green	Green	Ovate	Smooth	Smooth	Green	Dark green
20	IC- 469676	Erect	Green	Green	Oblong	Smooth	Smooth	Green	Green
21	IC- 469545	Erect	Purplish green	Green	Broad ovate	Smooth	Smooth	Green	Green
22	Arka Arunima	Erect	Dark purple	Dark purple	Broad ovate	Ridged	Smooth	Purple	Purplish green
23	Arka Suguna	Erect	Green	Green	Broad ovate	Smooth	Smooth	Green	Green
24	IC- 469528	Erect	Purplish green	Greenish purple	Triangular	Ridged	Smooth	Green	Dark green
25	Kannara local	Erect	Deep purple	Dark purple	Broad ovate	Angular	Smooth	Deep purple	Greenish purple
26	Panchmahal local-2	Erect	Purplish green	Green	Ovate	Ridged	Smooth	Green	Green
27	Panchmahal local	Erect	Greenish purple	Green	Broad ovate	Ridged	Smooth	Green	Dark green
28	Dharwad collection	Erect	Green	Green	Ovate	Angular	Smooth	Green	Green

Table 2: Morphomatric parameters of Amaranthus germplasm evaluated under summer season.

Sl.No	Accessions	Plant height (cm)	No of branches per plant	Internode length (cm)	No of leaves per plant	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	Node to flower initiation	Plant weight (g)	Leaf weight per plant	Root weight (g)
1	IC-469558	5.9	5	0.66	41.3	7.6	3.2	3.3	4.1	17.01	5.62	2.60
2	IC-469530	7.6	3.6	3.65	10.3	5.9	3.9	1.9	3.6	24.68	6.96	2.90
3	IC-469521	17.9	4	2.23	27.3	10.1	5.5	3.6	3.6	37.04	5.33	2.46
4	IC-469708	38.6	5.6	2.83	41.6	6.7	5.1	3.6	3.6	31.56	12.91	1.86
5	IC-469645	15.4	5.3	3.43	21.3	5.0	3.7	2.9	3.7	27.90	13.72	2.16
6	IC-469601	13.9	4.3	5.16	33.4	10.2	5.4	5.7	2.3	26.83	8.36	2.92
7	IC-469692	17.5	5.3	1.16	34.6	5.6	3.4	2.7	2.3	24.11	6.76	3.22
8	IC-469658	12.1	6.6	1.66	43.3	9.3	5.4	2.7	4.1	72.89	27.06	8.20
9	IC-469646	12.3	4.3	1.74	28.6	12	7.9	3.3	2.3	94.54	34.22	8.34
10	IC-469620	24.1	8.6	2.22	41.6	11.7	7.1	4.1	3.6	49.98	12.98	3.53
11	IC-469546	22.2	5.3	1.93	27.7	8.3	5.1	3.6	3.3	45.23	12.58	4.01
12	IC-469624	39.7	4.6	3.73	30.3	5.7	2.6	2.0	4.3	25.87	13.73	3.96
13	IC-469605	23.5	5.1	2.53	96.3	9.3	5.9	3.6	3.4	43.55	12.12	5.36
14	IC-469705	26.7	11.2	1.46	35.3	7.1	4.4	4.0	7.3	26.03	9.64	3.31
15	IC-469703	25.3	5.3	0.63	48.3	7.3	4.5	3.1	6.3	40.05	14.61	3.39
16	IC-469677	46.5	3.3	1.53	48.3	7.7	5.7	4.4	6.3	33.12	14.27	4.69
17	IC-469679	42.5	9.6	6.21	272.6	5.6	4.1	2.9	2.6	42.52	16.37	3.99
18	IC-469678	45.4	4.1	3.43	117.3	7.7	3.9	4.0	4.3	56.97	31.32	5.29
19	IC-469674	53.5	4.3	1.43	52.4	6.5	4.6	2.9	1.3	41.90	19.36	4.89
20	IC-469676	47.3	6.3	3.96	129.3	5.8	4.2	3.6	1.3	29.58	12.63	2.91
21	IC-469545	11.5	5.3	2.16	51.3	7.0	4.0	2.7	5.4	51.19	16.90	5.56
22	Arka Arunima	10.6	4.6	0.53	32.8	5.2	2.8	3.2	2.6	96.53	33.95	8.28
23	Arka Suguna	22.8	11.2	1.71	98.4	12.5	9.3	4.8	4.6	142.09	43.79	13.38
24	IC-469528	18.4	7.33	1.06	57.3	7.3	4.2	3.3	5.2	55.20	16.38	6.43
25	Kannara local	9.2	7.3	0.83	50.3	9.3	5.0	3.7	8.1	38.66	19.64	3.46
26	Panch mahal local-2	34.9	5.4	4.44	43.3	5.9	3.5	1.8	3.8	72.68	17.31	6.07
27	Panchmahal local	40.6	3.3	1.92	81.1	5.9	3.4	3.1	5.2	45.34	21.60	5.13
28	Dharwad collection	36.0	5.3	2.76	38.3	6.1	3.8	3.5	5.2	36.32	12.74	4.07
	Mean	25.78	5.71	2.37	58.25	7.61	4.73	3.37	3.96	47.47	16.88	4.80
	SE	7.26	1.54	0.73	24.0	1.53	1.09	0.65	0.92	4.53	1.93	0.65

Table 3: Morphomatric parameters of Amaranthus germplasm evaluated under summer season.

Sl.No	Accessions	Petiole weight	Stem weight (g)	Shoot weight (g)	Yield per plot (kg)	Shoot /plant ratio	Root /Shoot ratio	Leaf/ Stem ratio	Protein (g/100g)	Ca (mg/100g	Fe	Vit-C (mg/100g)
1	IC-469558	1.22	7.55	14.41	0.634	0.844	0.190	0.838	2.7	182.6	0.357	66.2
2	IC-469530	1.23	13.59	21.78	0.958	0.882	0.133	0.526	1.9	210.3	0.278	81.3
3	IC-469521	1.30	27.97	34.58	1.521	0.933	0.072	0.197	2.7	280.8	0.224	148.5
4	IC-469708	1.11	15.81	29.71	1.306	0.941	0.062	0.819	3.1	235.7	0.214	85.8
5	IC-469645	2.13	9.88	25.73	1.132	0.922	0.084	1.396	3.3	156.4	0.198	66.6
6	IC-469601	1.39	14.17	23.93	1.053	0.891	0.121	0.603	2.8	143.7	0.246	52.3
7	IC-469692	1.88	12.25	20.92	0.919	0.866	0.155	0.556	2.5	122.3	0.314	44.1
8	IC-469658	6.61	31.00	64.68	2.846	0.885	0.130	0.871	1.1	148.2	0.218	48.3
9	IC-469646	7.72	44.27	86.19	3.792	0.911	0.096	0.797	3.8	167.2	0.521	59.3
10	IC-469620	3.54	27.92	44.45	1.955	0.889	0.125	0.468	2.4	218.9	0.411	78.4
11	IC-469546	3.06	25.56	41.21	1.813	0.911	0.097	0.496	3.2	165.8	0.262	16.0
12	IC-469624	3.28	4.89	21.90	0.963	0.845	0.183	4.017	3.7	243.8	0.367	77.6
13	IC-469605	3.90	22.18	38.19	1.680	0.873	0.146	0.555	2.4	128.0	0.351	38.0
14	IC-469705	1.86	11.22	22.73	1.000	0.867	0.153	0.984	1.9	298.5	0.340	123.8
15	IC-469703	3.67	18.37	36.65	1.612	0.914	0.093	0.838	2.2	312.2	0.288	149.3
16	IC-469677	2.46	11.68	28.42	1.250	0.857	0.166	1.368	2.9	187.9	0.318	67.7
17	IC-469679	2.32	19.83	38.53	1.695	0.906	0.103	0.873	2.8	213.3	0.237	85.8
18	IC-469678	4.43	15.92	51.67	2.273	0.906	0.103	2.064	3.6	125.8	0.289	44.3
19	IC-469674	3.23	14.44	37.01	1.628	0.883	0.132	1.368	3.2	150.2	0.295	52.6
20	IC-469676	3.73	10.30	26.67	1.173	0.901	0.110	1.457	2.4	213.5	0.215	71.4
21	IC-469545	3.23	25.48	45.62	2.007	0.890	0.123	0.671	3.1	322.1	0.211	150.5
22	Arka Arunima	3.59	50.71	88.24	3.882	0.914	0.093	0.685	3.1	273.6	0.185	67.3
23	Arka Suguna	4.53	80.38	128.71	5.663	0.904	0.105	0.569	3.4	312.4	0.321	44.4
24	IC-469528	3.37	29.01	48.77	2.145	0.883	0.132	0.594	2.9	312.9	0.394	86.5
25	Kannara local	2.76	12.79	35.23	1.548	0.910	0.098	1.625	3.1	286.8	0.323	93.8
26	Panch mahal local-2	2.83	46.47	66.61	2.931	0.915	0.092	0.374	2.0	176.4	0.378	63.9
27	Panchmahal local	4.22	14.38	40.20	1.769	0.885	0.131	1.569	2.5	216.9	0.417	71.0
28	Dharwad collection	3.10	16.38	32.22	1.418	0.888	0.125	0.903	2.6	205.2	0.443	78.4
	Mean	3.13	22.66	42.67	1.887	0.893	0.120	1.000	2.34	198.5	0.236	75.50
	SE	0.34	4.48	4.59	0.41	0.01	0.09	0.31	0.23	1.23	0.02	0.59

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