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Studies on Yield and Yield Attributing Characters of Amaranth (*Amaranthus spp.*) Genotypes under Prayagraj Agro-Climatic Condition, India

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ABSTRACT

The field experiment entitled "Studies on Yield and Yield Attributing Characters of Amaranth (*Amaranthus* spp.) Genotypes Under Prayagraj Agro-Climatic Condition" was carried out at Central research field, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during Rabi season (2022-2023). Five plants were selected randomly from each plot and were tagged and maintained as observational plants for recording their growth and yield characters of *Amaranthus*. The Experiment was laid out in a Randomized Block Design with 12 Genotype including 2 check variety and 3 replications. Results revealed that the maximum Seed yield quintal/hectare was observed in genotype EC-198136 (13.63qt), influenced most of the characteristics significantly and recorded the highest values of seed yield/plot (187.60 g), seed yield/plant (12.27g), plant height (166.07cm), leaf length (29.93 cm), Days to 50% flowering (48.33), Days to maturity (86.33), Inflorescence length (66.47), Leaf area (49.89cm^2) , Diameter of stem (2.68cm), Biological yield per plant (80.15 g), 1000 seed weight (1.05g) Fiber content (8.08%) and Oil content (9.01%). Genotype EC-198132 recorded highest number of leaves per plant (68.27), Number of branches per plant (29.69) and Harvest index (19.50).

***Key words**: Amaranthus, Genotypes, Yield and Yield Attributing Characters*

Introduction

Amaranth or chaulai (*Amaranthus spp.*) is a very popular leafy vegetable in India as well tropical and sub-tropical areas of globe and it can be grown throughout the year because it has very fast growth habit in short duration and large produce of edible matter per unit area, it fits well in a crop rotation hence amaranths is the largest produced as leafy vegetable in the world. The word "Amaranth" is basically derived from Greek word "Anthos" which means "everlasting" according to Sankaran (1943). *Amaranthus tricolor* is an important vegetable amaranth cultivated in India and numbers of domesticated forms are available in India especially in Tamil Nadu, Andhra Pradesh, Karnataka and Kerala states. Amaranthus preferred for both urban and rural population and it's also considered to be the cheapest leafy vegetable in the market and it could be rightly described as a "poor man's vegetable (Varalakshmi, 2004).

Amaranth, being a cross-pollinated crop, exhibits wide genetic variability. Thus, it offers a considerable scope to identify suitable type for any particu-

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lar region. Collection, evaluation and characterization of germplasm or lines is the first step in any crop improvement programme (Mandal *et al.*, 2010). This study was conducted to evaluate the performance of vegetable Amaranthus genotypes for foliage and quality attributing characters.

Thus, India shares about 12% of world's output of vegetables (Thamburaj and Singh, 2001). In India, it is cultivated in an area of 2500 hectares with an annual production of 50,000 tonnes. One of the reasons there has been recent interest in amaranth is because of its useful nutritional qualities. The grain has 12 to 17% protein, and is high in lysine, an essential amino acid in which cereal crops are low. Amaranth grown at Arlington, WI in 1978 had protein levels of 16.6 to 17.5%. The grain is high in fiber and low in saturated fats, factors which contribute to its use by the health food market. Recent studies have linked amaranth to reduction in cholesterol in laboratory animals.

There are four cultivated species of grain amaranth viz., *A. hypochondriacus (L)., A. cruentus (L)., A. caudatus (L).* and *A. edulies (L).* In India *A. hypochondriacus* is known as the 'king grain' (Narwade and Pinto, 2018). The crop is grown both for its green and grain. It holds cultural significance in remote and tribal areas in many parts of India particularly in the Himalayan region. In India, it is grown from tropical lowlands to 3500 m above mean sea level height in the Himalayas (Sauer, 1967). In some of the Indian languages it is known as rajgara in Gujarat ("king of seeds"), ramdana in Bihar ("seed sent by god"), anardana in Uttar Pradesh, Chuka in Bengal, Kalaghesa central India and Bathu in HP etc.

Amaranth is such a potential crop that is of particular interest because of its higher and quality protein and high micronutrients content. Grain amaranth possess C4 pathway, which confers physiological advantage of high rate of photosynthesis. This crop can be grown even inhospitable environments. The Grain amaranth belongs to the family Amaranthaceae, subfamily Amaranthoideae, and genus *Amaranthus*. The genus amaranth is dibasic with (x = 16, 17) chromosomes, almost equally distributed in section amaranth. (Grant, 1959) has reported the information regarding the chromosome number of 30 species of Amaranthus. Among these, four have 2n = 32, while all others have 2n = 34. Among the 30 species, *Amaranthus caudatus L.* (2n = 32), *Amaranthus cruentus L.* (2n = 34) *and Amaranthus hypochondriacus L.* (2n = 32) are domesticated species and among these three species, *Amaranthus caudatus L.* is drooping type and rest two are erect type species.

Materials and Methods

The present experiment "Studies on Yield and Yield Attributing Characters of Amaranth genotypes Under Prayagraj Agro Climatic Conditions" was done in central research field, Department of Genetics and Plant Breeding, Naini Agricultural Institute, SHUATS, Prayagraj region was conducted during *Rabi season* 2022-23. The experiment was comprised of ten genotypes and two check variety of Amaranthus *viz*. EC-198117, EC-198118, EC-198124, EC-198129, EC-198130, EC-198131, EC-198132, EC-198133, EC-198135, EC-198136 check variety Pusa Kiran and Pusa Kirti. The basic material for the study involved Twelve genotypes of Amaranth which were collected from NBPGR. The experiment was comprised of twelve genotypes of Amaranthus, laid out in Randomized Block Design (RBD) with three replications. Observation was recorded on the five randomly selected plants, for different genotypes and was used for calculating the mean performance for different parameters Observation was recorded field emergence %, 50% flowering, plant height, number of leaves per plant, number of branches per plant, Days to maturity, Inflorescence length, Diameter of stem, leaf length, leaf area, biological yield per plant, seed yield per plant, harvest index, 1000 seed weight, fiber content and oil content %.

The data collected on different parameters during the course of investigation were subjected to statistical analysis as per method of analysis of variance (Panse and Sukhatme, 1957). The significance and non – significance of the treatment effect was judged with the help of "F" variance ratio test. Calculated "F" value was compared with the table value of "F" at 5 % level of significance. If calculated value exceeds the table value, the effect was considered to be significant. The significant differences between the means were tested critical differences at 5% level of significance.

Results and Discussion

The analysis of variance of all the characters under study is presented in Table (1, 2&3). This analysis of

variance revealed that mean sum of squares due to genotypes was highly significant for all the studied characters. This is an indication of existence of sufficient variability among the genotypes for seed yield and its component traits. Significant mean sum of squares due to seed yield and attributing characters revealed existence of considerable variability in material studied for improvement of various traits. These findings are in general agreement with the findings of Martirosyan *et al.* (2007), Tejaswini *et al.* (2017), Diwan *et al.* (2017), Bhalekar *et al.* (2019), Kumar *et al.* (2019), Solanki *et al.* (2021) and Rana *et al.* (2022).

Field emergence percent ranged from 81.67% to 97.00% with an overall mean of 88.39%. Maximum field emergence percent was recorded in the genotype EC-198136 (97.00%) whereas, minimum field emergence percent was noticed in genotype EC-198133 (81.67%).

Days to 50% flowering ranged from 48.33 to 69.33 with an overall mean of 59.50. Earliest days to 50 % flowering was recorded in the genotype EC-198136 (48.33) whereas, late days to 50 % flowering was noticed in genotype EC-198118 (69.33).

Plant height ranged from 103.93cm to 166.07cm with an overall mean of 140.48 cm. Maximum plant height was recorded in the genotype EC-198136 (166.07cm) whereas, minimum plant height was noticed in genotype EC-198129 (103.93cm).

Number of leaves per plant ranged between 39.07 to 68.27 with an average mean of 53.07. Maximum number of leaves per plant recorded in genotype EC-198132 (68.27) whereas, genotype EC-198118 (39.07) was noted for minimum number of leaves per plant.

Number of branches per plant ranged from 5.60 to 19.60 with overall mean of 3.11. Maximum number of branches per plant recorded in genotypes EC-198132 (19.60) whereas, minimum number of branches per plant recorded in genotype EC-198124 (5.60).

Days to maturity ranged from 86.33 to 108.00 with an overall mean of 96.07. Earliest days to maturity was recorded in the genotype EC-198136 (86.33) whereas, late days to was noticed in genotype EC-198129 (108.00).

The range of inflorescence length lies between 43.07cm to 66.47cm with an overall mean of 55.39cm. The highest inflorescence length 66.47cm was recorded in genotype EC-198136, whereas Genotype EC-198129 (43.07cm) were noted for minimum inflorescence length.

Stem diameter ranged from 0.96cm to 2.68cm with an average mean of 1.85 cm. Maximum Stem diameter recorded in genotype EC-198136 (2.68cm) whereas, minimum Stem diameter recorded in genotype EC-198129(0.96cm).

Leaf length ranged from 9.67cm to 29.93cm with an overall mean of 18.48cm. The highest leaf length (29.93 cm) was recorded in genotype EC -198136 whereas, genotype EC -198129(9.67cm) were noted for minimum leaf length.

Leaf area ranged from 29.90cm^2 to 49.89cm^2 with an overall mean of 38.80 cm^2. Maximum Leaf area (49.89cm^2) was recorded in genotype EC-198136 whereas, Genotype EC-198129 (29.90cm^2) were noted for minimum Leaf area.

1000 seed weight range from 051 to 1.05 with an overall mean 0.80g. Maximum 1000 seed weight (1.05g) was recorded in genotype EC - 198136 where as genotype EC-198124 (0.51g) were noted for minimum 1000 seed weight.

Biological yield per plant ranged from 49.47g to 80.15g with an overall mean of 64.90g. Maximum biological yield per plant (80.15g) was recorded in genotype EC-198136 whereas, minimum biological yield per plant found in EC-198129 (49.47g).

Table 1. Analysis of Variance for yield and yield related traits for pre - harvest and post - harvest parameters in Amaranth crop

Characters	Mean Sum of Square	
	Treatment (df=11)	Error (df=22)
Field emergence %	82.05*	3.30
Days to 50 % flowering	128.94*	2.30
Plant height (cm)	1606.15*	7.83
Number of leaves per plant	359.10*	2.42
Number of branches per plant	70.67*	0.23
Inflorescence length (cm)	175.05*	2.69
Stem diameter (cm)	0.97*	0.00
Leaf length (cm)	158.22*	1.40
Leaf area (cm^2)	106.40*	1.41
Days to seed maturity	191.99*	2.39
1000 seed weight (gm)	0.08*	0.00
Biological yield per plant (gm)	292.11*	4.53
Seed yield per plant (gm)	15.34*	0.49
Seed yield per plot (gm)	9951.19*	55.43
Seed yield per hectare (qt)	18.90*	0.54
Harvest index %	47.63*	0.56
Fiber content %	1.89*	0.04
Oil content %	3.59*	0.12

*Significant at 5% level of significance

Seed yield per plant ranged from 4.98g to 12.27g with an overall mean of 8.02g. Maximum seed yield per plant (12.27g) was recorded in genotype EC-198136 whereas, minimum seed yield per plant found in EC-198124 (4.98g).

Seed yield per plot ranged from 16.33g to 187.60g with an overall mean of 88.05g. Maximum seed yield per plot (187.60g) was recorded in genotype EC-198136 whereas, minimum seed yield per plot found in EC-198124 (16.33g).

Seed yield quintal per hectare ranged from 5.53qt to 13.63qt with an overall mean of 8.90qt. Maximum seed yield per hectare (13.63qt) was recorded in genotype EC-198136 whereas, minimum seed yield per hectare found in EC-198124 (5.53qt).

Harvest index % varied from 7.82 to 19.50 with

Table 2. Mean performance of different genotypes for pre-harvest characters in grain Amaranth.

Sr. No.	Genotype	Field emergence %	Days to 50% flowering	Plant height (cm)	No. of leaves per plant	No. of branches per plant (cm)	Inflores-cences length	Stem diameter (cm)	Leaf length (cm)	Leaf area (cm^2)	Days to seed maturity
1.	EC-198117	87.67	62.33	159.53	42.20	8.60	60.93	2.18	24.40	44.13	103.33
2.	EC-198118	85.00	69.33	158.93	39.07	7.80	61.47	2.22	26.33	46.23	106.67
3.	EC-198124	83.00	64.00	153.60	47.53	5.60	57.00	2.11	19.40	39.90	108.00
4.	EC-198129	92.67	58.00	103.93	60.40	14.73	43.07	0.96	9.67	29.90	91.00
5.	EC-198130	84.00	67.67	162.73	49.13	9.73	62.60	2.50	27.07	38.97	101.33
6.	EC-198131	81.67	66.00	156.20	44.13	6.20	56.20	2.41	21.67	41.97	103.67
7.	EC-198132	96.33	51.00	109.33	68.27	19.60	46.57	1.57	10.37	32.90	86.67
8.	EC-198133	94.67	56.33	106.93	63.87	16.13	45.10	1.14	10.73	33.00	88.67
9.	EC-198135	90.67	54.67	126.93	65.53	17.13	50.23	1.38	12.57	34.63	90.67
10.	EC-198136	97.00	48.33	166.07	66.80	18.07	66.47	2.68	29.93	49.80	86.33
11.	Pusa Kiran	89.00	57.00	139.87	44.87	10.40	55.47	1.52	13.77	35.89	92.33
12.	Pusa Kirti	91.00	59.33	141.70	45.07	13.87	56.53	1.54	15.87	38.40	94.00
Mean	89.39	59.50	140.48	53.07	12.32	55.30	1.85	18.48	38.80	96.06	
S. Em±	1.05	0.88	1.62	0.90	0.28	0.93	0.04	0.68	0.69	0.89	
CV (%)	2.03	2.55	1.99	2.93	3.88	2.91	1.38	6.40	3.06	1.61	
C.D. at 5%	3.08	2.57	4.74	2.64	0.81	2.73	0.11	2.00	2.00	1.62	

Table 3. Mean performance of different genotypes for post-harvest characters in grain Amaranth.

Sr. No.	Genotype	1000 Seed weight (gm)	Biological yield/ plant (gm)	Seed yield/ plant (gm)	Seed yield/plot (gm)	Seed yield/ha (quintal)	Harvest index %	Fiber content %	Oil content %
1.	EC-198117	0.74	76.02	6.48	37.47	7.19	8.52	6.94	6.12
2.	EC-198118	0.60	72.52	6.88	41.40	7.64	9.48	6.05	6.06
3.	EC-198124	0.51	63.68	4.98	16.33	5.53	7.82	5.88	5.36
4.	EC-198129	0.83	49.47	7.36	48.70	8.17	14.88	7.34	7.39
5.	EC-198130	0.77	77.56	7.92	80.43	8.80	10.21	7.44	7.12
6.	EC-198131	0.65	67.13	6.04	34.73	6.72	8.99	6.17	5.70
7.	EC-198132	0.85	57.16	11.15	175.40	12.38	19.50	8.03	8.06
8.	EC-198133	1.01	54.37	9.45	135.53	10.49	17.38	7.83	7.46
9.	EC-198135	0.96	61.39	10.25	135.57	11.38	16.69	8.04	8.18
10.	EC-198136	1.05	80.15	12.27	187.60	13.63	15.40	8.08	9.01
11.	Pusa Kiran	0.81	57.83	7.29	85.47	8.09	12.60	6.85	6.56
12.	Pusa Kirti	0.83	60.93	6.14	78.00	6.82	10.07	7.02	7.21
Mean	0.80	64.90	8.02	88.05	8.90	12.63	7.17	7.02	
S. Em±	0.01	1.23	0.40	4.30	0.43	0.43	0.11	0.20	
CV (%)	2.63	3.28	8.72	8.45	8.29	5.93	2.68	5.00	
C.D. at 5%	0.04	3.60	1.18	12.61	1.25	1.27	0.32	0.59	

an overall mean of 12.63%. Maximum harvest index % (19.50%) was recorded in genotype EC-198132, Whereas, Minimum harvest index % (7.82 %) was recorded in genotype EC-198124.

Fiber content ranged from 5.88 to 8.08 with an overall mean of 7.17%. Maximum fiber content recorded in genotype EC-198136 (8.08 %) While, minimum fiber content noticed in genotype EC-198124 (5.88%).

Oil content ranged from 5.36 to 9.01 with an overall mean of 7.17%. Maximum oil content recorded in genotype EC-198136 (8.18%) While, minimum oil content noticed in genotype EC-198124 (5.36%).

Conclusion

It is concluded from the present study that the genotype EC-198136 was identified as the best genotype for earliest days to 50% flowering, plant height, inflorescence length, diameter of stem, leaf length, leaf area, biological yield, 1000 seed weight, seed yield per plant, seed yield per plot, seed yield per hectare, fiber content and oil content. Genotype EC-198132 recorded for highest number of leaves per plant, number of branches per plant and harvest index as compared with check variety pusa kiran and pusa kirti. Significant variation was observed for all the different morphological and physiological characters studied among the genotypes. Hence these genotypes (EC-198136 and EC-198132) can be used as parents for future crop improvement programme.

So, from the above conclusion it is clear that two genotypes (EC-198136) and (EC—198132) has performed best in Prayagraj Agro-climatic region. So, these two Genotypes (EC-198136) and G7(EC-198132) are recommended for Prayagraj Agro-Climatic Condition.

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Conflict of interest

None

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