Eco. Env. & Cons. 29 (3) : 2023; pp. (1172-1176)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i03.025

Evaluation and identification of high yielding genotypes for varietal development in Amaranthus (*Amaranthus spp.*) Under hilly region of Uttarakhand, India

Anita Trivedi[1]*, Navprabhat Singh[2] and Girish Chandra[3]

[1&2]Mount Valley Development Association, Ghansali, Tehri Garhwal, Uttarakhand, India
[3]Department of seed sci. & Tech. SAS, SGRR University, Dehradun, Uttarakhand, India

(Received 8 January, 2023; Accepted 15 March, 2023)

ABSTRACT

Evaluating *Amaranthus* genotypes is a key task for *Amaranthus* improvement programs. Generally, the genotypes that were found as being steady and high yielding are often recommended for cultivation at the farmer level. For this purpose, 20 *Amaranthus* genotypes were subjected to stability analysis to determine the nature and extent of genetic stability for across locations, village Pakh, Ghansali, Tehri Garhwal district for grain yield and yield components. A randomized complete block design (RCBD) was used in this study with three replications for the identification of stable and high yielding genotypes. The results showed that genotype probability level of 0.05 significantly influenced the grain yields of *Amaranthus* genotypes. Genotypes IC-340943 (43.03g) and IC-317517 (39.49g) with more than unity regression indicated the genotype's suitability for favorable conditions. GenotypeIC-340943 was stable among all the genotypes. Thus, to improve the production of Amaranthus in the hills of Uttarakhand, the genotypeIC-340943 were put forward for release as a variety.

Key words: *Grain Amaranth, Genotype, Yield potential*

Introduction

Amaranth (*Amaranthus spp*.) is a cross-pollinated annual crop belongs to the family *Amaranthaceae*. Grain Amaranth is a very versatile pseudo-cereal crop and grown in a wide range of agro-climatic conditions (temperature 20-40 ºC, elevation 500-2500 meter MSL and rainfall 800 mm to 1500 mm). The genus *Amaranthus* consists of approximately 60 species out of which about 18 species are occurring in India. There are three major grain 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 (National Research Council, 1984; Yadav *et al.*, 2014). Grain amaranth (*A. hypochondriacus* L.) is a traditional crop in the Himalayan region, where it is cultivated as a mixed crop and as a part of subsistence agriculture with comparatively lower rainfall under neglected agricultural conditions. Grain amaranths

(Programme Manager[1], Manager Strategy & Planning[2], Associate Professor[3])

are generally rich in protein, with significantly higher lysine content than other cereal grains. Grains are peculiar and nutritionally rich. Amaranth leaves are an excellent source of proteins for various samples. Grain amaranth (*Amaranthus hypochondriacus* L.) is a traditional crop of himalayan region generally cultivated as a mixed crop as well as part of subsistence agriculture in the hilly areas with comparatively lower rainfall under neglected agriculture conditions.

With advent of green revolution, the cultivation of this crop has seen a conspicuous decline mainly due to the lack of awareness of its complementary nutritive value, non-availability of suitable high yielding varieties and lack of improved production techniques. To reverse this declining trend of cultivation, quick varietal improvement is being used as one of the important criteria in increasing the yield potential of this crop. Apart from that, traditionally this crop was grown by broadcasting the seeds thereby resulting in very low yield. Adoption of scientific cultivation practices including proper plant densities and other inputs are essential in maximizing grain yield. In this context, there is an imperative need for the breeders to evaluate and identify the stable genotypes that could give standard performance when tested under different plant density levels (Shrivastav *et al.,* 2020).

Traditionally, India having highest number of indigenous varieties that are adapted to various micro ecological conditions. Historically, many Amaranth varieties have used in several values added products and are being used by rural people (Tigga, *et al.,* 2018). To harness the benefits of traditional agro-biodiversity UN Environment implemented Global Environment Facility (GEF) project named "Mainstreaming agricultural biodiversity conservation and utilization in the agricultural sector to ensure ecosystem services and reduce vulnerability" was initiated in Tehri Garhwal districts located in the Northern hill zone of the state. Crop improvement has played a pivotal role in sustaining and strengthening food, nutrition, and health and livelihood security in the world from the earliest days of domestication (Nyadanu *et al.,* 2014). With the introduction of high yielding varieties and new technologies become a great threat to the security of the age-old practice of growing traditional varieties and landraces which may have immense potential for different important traits. The GEF project focused on supporting the use of the rich and unique intra-specific diversity of crops that are of global importance to agricultural environments, to buffer against the increasing unpredictability in the amount and occurrence of rainfall, temperature extremes and the frequency and severity of pest and pathogen occurrence. Amaranthus is an environmentally sensitive crop. Stable genotypes are required to ensure sustainable crop production. Mainly for stabilization of crop performance, varietal adaptability to different environments is important both over location and years. Adaptability is measured in terms of the phenotypic stability of a genotype in several environments. This research was carried out to assess promising Amaranthus genotypes in terms of stable grain yield potential.

Materials and Methods

The experiments was conducted at village Pakh, Tehriunder the supervision of Mount valley development association, Doni, Tehri Garhwal district during 2020. The research field in Pakh is located in a mid-hill region of Uttarakhandand is characterized by a cool temperate climate. December and January were the coldest months. From mid-April to mid-September, the earth experiences hottest days of the year with a mean maximum temperature above 20 %C.

The twenty genotypes of Amaranth namely IC-469791, IC-469777, IC-429977, IC-392542, IC-392525, IC-392498, IC-342476, IC-391561, IC-391517, IC-391468, IC-391433, IC-317631, IC-317580, IC-317549, IC-317517, IC-340971, IC-340943, IC-340918, IC-340803, IC 340899were obtained from the ICAR-NBPGR, Regional Station Bhowali, Uttarakhand. These genotypes were replicated thrice in randomized complete block design (RCBD). The plot size was net 4 m^2. The seeds were sown continuously at a plant to plant distance of 40 cm at a spacing of 2–3 cm deep. The spacing between plant to plant and row to row were maintained 12-15 cm and 25-30 cm respectively. All agronomic package of practices were used as per the crop requirement time to time. The observation were recorded by randomly selected five plants from each plot. The morphological and yield parameters like days to 50 % flowering, days to maturity, plant height (cm), inflorescence length (cm), No. of spikelet per plant, No. of leaves per plant, 1000 seed weight (g), and seed yield per plant were taken from experimental plots.

Results and Discussion

The statistical analysis showed highly significant differences among the genotypes for all the characters studied, indicating considerable amount of genetic variation in the material. The mean, range, variance, co-efficient of variation, heritability and genetic advance for 10 traits including grain yield are presented in the Table 1.

Days to 50% flowering

The range of days to 50 per cent flowering varied from 65.28 days (IC-IC-317580 and IC-317549) to 78.08 (IC-429977) days with a general mean of 70.83 days.While, IC-429977 (78.08 days) followed by IC-469777(77.08 days), IC-391433(75.28 days) took more time to flowering. A range of high variability in days to 50 % flowering is desirable for selecting the genotypes for earliness. A wide range of variability in days to 50 % flowering has also been reported by Kusuma *et al.* (2003), Akaneme and Ani (2013) and Venkatesh *et al.* (2014) in amaranth.

Plant height (cm)

Plant height is usually a good index of plant vigor which may contribute towards productivity. The plant growth habit serves as a guide to determine the suitable planting distance for a crop/variety and the optimum plant population per unit area for harvesting maximum yields. Variation in plant height is attributed to inherent genetic difference of the crop/variety. Significant highest plant height (122.39 cm) was found in IC-317580 followed by IC-317631 (120.79 cm), IC-317549 (117.39 cm), IC-391433 (116.59 cm), IC-340971 (113.35 cm), IC-317517 (112.79 cm), and IC-391468 (111.23 cm). However, minimum value was observed for IC-340918 (86.55 cm). Variability in plant height of amaranth has also been reported by Verma *et al.* (2001); Vujacic *et al.* (2005); Rana *et al*. (2005); Anuja (2012); Haghighi *et al.* (2012); Chattopadhyay *et al.* (2013); Venkatesh *et al.* (2014), Yadav *et al.* (2014) and Srivastava *et al.* (2015).

Inflorescence length (cm)

The mean value of inflorescence length was ranged from 32.73 cm (IC-340803) to 67.81 cm (IC-391561) with an overall mean of 50.74cm. Such a large extent of variability in inflorescence length might have also resulted due to diverse origin of accession coupled with environmental effect. Differences in inflorescence length of amaranth genotypes have also been expressed by Rana *et al*. (2005); Parveen *et al*. (2013) and Yadav *et al.*(2014).

No. of spikelet per plant

The mean number of spikelets per plant range from 35.13 to 62.73 with an overall mean of 48.98. IC-342476 showed the highest mean value of number of spikelets per plant (62.73) followed IC 340899 (61.09), IC-340971 (58.29). Lowest value for number of spikelets per plant was observed in IC-391468(35.13). Variability in amaranth genotypes was also reported by Erum *et al.* (2012) a range of 1.0 to 19.6 spikelets per plant.

No. of leaves per plant

Maximum number of leaves was observed for IC-340971(93.60) which was significantly higher than other all genotypes. However, the significantly lowest value was recorded for IC-317580(35.00). The general mean for this character was 68.98. The range of variability in number of leaves per plant was also observed by Chattopadhyay *et al.* (2013) and Venkatesh *et al.* (2014) in amaranth.

Spikelet length (cm)

The maximum length of spikelet was recorded in IC-391561(27.46 cm) which was significantly higher than in the rest of genotypes. Minimum spikelet length was observed in IC-391517 (12.06 cm) which were statistically at par. The overall mean for this character was 20.25cm. Spikelet length is principal yield contributing character in grain amaranths. The spikelet length mainly governed by genetic constitution of the genotype but environmental effect is also supposed to play crucial role in increasing the length of spikelet. Spikelet length of grain amaranth genotypes have also been expressed by Yadav *et al.* (2014).

Stem thickness (mm)

The range of stem thickness ranged from 7.15 mm to 13.67 mm. Genotype IC-392525 had largest mean stem thickness (13.67 mm) while genotype IC-429977 exhibiteds mallest stem thickness (7.15 mm). The general mean for this character was 9.90 mm. Stem thickness is a character expressing vigor of the genotype. This trait is also important in the view of selecting the population for resistance lodging. A wide range of variability among the genotypes included in this investigation could offer better opportunity of population improvement for this character through selection breeding. Sravanthi *et al.* (2012) have also observed a wide range of variability in stem thickness of grain amaranth genotypes rang 1.91 cm to 5.57 cm.

Days to maturity

The days to maturity ranged from 135.08 days IC-391468 to 144.40 days IC-340971 with a general mean of 138.85 days. The lowest value for days to maturity was found in IC-391468(135.08 days) followed by IC-317580(135.32 days), IC-340803 (135.80 days) Highest value for days to maturity was found in IC-340971 (144.40 days) followed by IC-469791(144.12 days) Delay maturity genotypes look 144.40 days.

1000 seed weight (g)

Genotype IC-317580 showed highest 1000 seed weight (1.15 g) which was significantly higher than remaining other genotypes. Minimum 1000 seed weight was recorded in IC-392525(0.61g). Overall mean for this character was 0.885 g.

Seed yield per plant (g)

Range of variability in seed yield per plant was in therange of 7.10 g to 42.03 g. Maximum value for this character was observed in IC-340943(42.03 g) followed by IC-317517(39.49 g), IC-392525(39.41 g), IC-317549(39.18g) Lowest value was observed for IC-429977(7.10 g). The general means for this character was 25.21 g. Seed yield is the major determinant variable for selecting a particular crop for its commercialization and income generation capability. The above results indicated a wide range of variability in grain yield per plant across the genotypes and check varieties. Such a pronounced lead of variability could be used to improve the population of

Table 1. Mean performance of different genotypes of amaranth for Field parameters

Sl. No.	Characters / Genotypes	Days to 50% flowering	Plant height (cm)	Inflorescence length (cm)	No. of spikelet per plant	No. of leaves per plant	Spikelet length (cm)	Stem thickness (mm)	Days to maturity	1000 seed weight (g)	Seed yield per plant (g)
1	IC-469791	69.08	110.19	50.97	55.77	66.76	21.82	8.59	144.12	0.86	17.63
2	IC-469777	77.08	96.19	49.37	47.17	77.36	17.02	9.89	136.12	0.77	9.15
3	IC-429977	78.08	95.59	37.37	38.17	46.56	16.62	7.15	142.52	0.82	7.10
4	IC-392542	71.08	101.39	51.77	39.77	59.76	19.42	7.84	137.52	0.91	17.84
5	IC-392525	68.08	109.39	60.17	44.77	87.16	25.02	13.67	138.72	0.61	39.41
6	IC-392498	69.68	110.03	57.61	52.93	61.72	25.66	8.77	137.08	1.04	22.50
7	IC-342476	72.68	104.63	55.81	62.73	46.12	23.26	9.96	140.68	0.74	18.48
8	IC-391561	69.68	99.43	67.81	52.13	66.72	27.46	12.03	140.28	0.86	34.20
9	IC-391517	73.68	109.03	50.21	41.13	91.52	12.06	11.17	137.48	0.98	30.84
10	IC-391468	68.68	111.23	66.81	35.13	62.72	25.86	9.66	135.08	0.80	27.37
11	IC-391433	75.28	116.59	49.89	47.57	87.00	15.70	10.16	139.92	0.83	28.43
12	IC-317631	73.28	120.79	47.69	51.77	74.40	18.50	7.64	136.12	0.83	26.91
13	IC-317580	65.28	122.39	34.89	41.97	35.00	16.90	9.28	135.32	1.15	10.61
14	IC-317549	65.28	117.39	53.49	53.57	81.00	23.10	11.25	138.12	1.02	39.18
15	IC-317517	70.28	112.79	54.29	54.17	77.20	21.70	13.28	138.32	1.04	39.49
16	IC-340971	68.68	113.35	58.73	58.29	93.60	22.86	10.67	144.40	0.86	37.54
17	IC-340943	68.68	97.15	50.73	55.69	91.00	21.26	9.81	140.60	0.96	42.03
18	IC-340918	70.68	86.55	45.53	38.49	72.40	20.06	7.48	141.00	0.84	27.98
19	IC-340803	68.68	92.75	32.73	47.29	40.60	16.46	9.06	135.80	0.90	16.60
20	IC 340899	72.68	92.35	38.93	61.09	61.00	14.26	10.59	137.80	0.79	10.83
21	Mean	70.83	105.96	50.74	48.98	68.98	20.25	9.90	138.85	0.88	25.21
22	Std. Dev.	3.45	10.26	9.54	8.06	17.49	4.24	1.80	2.77	0.12	11.28
23	Std. Error	1.22	0.98	0.84	1.1	0.75	0.79	1.29	1.36	0.77	0.54
24	C. V. %	2.99	2.54	2.42	2.86	1.98	2.06	3.13	3.23	2.02	1.25
25	C. D. %	3.54	2.86	2.76	3.25	2.25	2.35	3.69	3.76	2.31	1.62
26	Minimum	65.28	86.55	32.73	35.13	34.92	11.14	6.41	135.08	0.61	7.10
27	Maximum	78.08	122.39	67.81	62.73	93.60	27.46	13.67	144.40	1.15	42.03

grain amaranth. Similar results also reported by Sravanthi *et al*. (2012) Parveen *et al*. (2013) Gimplinger *et al.* (2007) and Venkatesh *et al.* (2014) in grain amaranth.

Conclusion

The performance and yield stability across different environments varied among amaranthus genotypes. Based on results, amaranthus genotypesnamely IC-340943 and IC-317517 gave higher grain yield and showed adaptability under favorable environments. The genotype namely IC-340943 was identified more stable, high yielding and adaptive genotypes across the mid hill environment of Uttarakhand. Thus, this genotype was recommended for possible release for wider adaptability across Pakh and other areas with similar agro-ecology in the country.

Acknowledgement

The authors appreciate all field staff who supported for conducting this research. This study was conducted under the UN implemented a program of Global Environment Facility (GEF) entitled "Mainstreaming agricultural biodiversity conservation and utilization in the agricultural sector to ensure ecosystem services and reduce vulnerability" funded by Bioversity International, Rome. Special thanks to NBPGR (National Bureau of Plant Genetic Resources), Bhawoli, Almora, Uttarakhand for extending support throughout. We are also thankful to all the farming community who trusted us and adopted the practice or research we had performed.

References

Akaneme, F.I. and Ani, G.O. 2013. Morphological assessment of genetic variability among accessions of *Amaranthushybridus*. *The Sci. Tech., J. of Sci. and Tech.* 2(2): 26-30.

Anuja, S. 2012. Correlation and path coefficient analysis inamaranthus. *Crop Res*. 43 (1): 106-111.

Chattopadhyay, A., Das, S., Pandia, R., Seth, T. and Dutta, S. 2013. Estimation of genetic parameters, inter-relationships and genetic divergence of vegetable amaranths. *Inter. J. of Plant Breeding*. 7(2). 111-115.

Erum, S., Naeemullah, M., Masood, S., Qayyum, A. and Rabbani, M.A. 2012. Genetic in amaranthus collected from Pakistan, *J. of Animal and Plant Sci.* 22(3): 653-658.

Gimplinger, D. M., Dobos, G., Schonlechner, R. and Kaul, H.P. 2007. Yield and quality of grain amaranth (*Amaranthus* sp.) in Eastern Austria. *Plant Soil Environ.* 53(3): 105-112.

Haghighi, M.L., Abbaszadeh, B., Lebaschi, M.H. and Shahrebabaki, M.A.V. 2012. Evaluating effective traits on yield of two medicinal amaranths (*Amaranthus hypochondriacus* L. var. Cim and var. Kharkofski) in Karaj, Iran. *Annals of Biological Research*. 3(2): 1014-1019.

National Research Council, 1984. Amaranth modern prospects for an ancient crop. National Academy Press.

Nyadanu, D., Mudita, I.I., Gatachew, A.D., Bocar, A. Crop breeding for agriculture risk management. In: Agricultural Risk Management. *African Journal of Agronomy* (in press), 2014.

Parveen, M., Chattopadhyay. C.N. and Tah, J. 2013. Biometric evaluation of genotypic variability and genetic advance in amaranth cultivars. *J. of Sci. and Tech.* 2(2): 26-30.

Rana, J.C.,Yadav, S.K., Mandal, S. and Yadav, S. 2005. Genetic divergence and interrelationship analysis in grain amaranth (*Amaranthus hypochondriacus*) germplasm. *Indian J. Genet*. 65(2): 99-102.

Sravanthi, V., Begum, H., Sunil, N. and Reddy, M.T. 2012. Variance component analysis for grain yield and agro-economic traits in grain amaranths (*Amaranthus* spp*.). Advances in Agric. Sci. and Engineering Research.* 2(7): 233-244.

Srivastava, R. 2015. Assessment of morphological diversity of selected *Amaranthus* sp. *J. of Global Bio Sci.* 4(8) : 3044-3048.

Tigga, R. and Singh, S. 2018. Yield gap analysis of Jeeraphool rice in Batauli block of Surguja. *International Journal of Current Microbiology and Applied Sciences.* 7(12): 907-914.

Venkatesh, L., Murthy, N., Manjappa and Nehru, S. D. 2014. Character association and path co-efficient analysis for various traits in grain amaranth (*Amaranthus spp*.). *Asian J. of Bio Sci*. 9: 97-100.

Venkatesh, L., Murthy, N., Nehru, S.D. and Manjappa. 2014b. Genetic variability, heritability and genetic advance in grain amaranth (*Amaranthus* spp.). *Asian J. of Bio Sci.* 9(1): 67-70.

Verma, P.K., Gupta, S.N., Deen, M.K. and Shrama, G.D. 2001. Genetic variation, correlation and path co-efficient analysis for seed yield and quality characters in grain amaranth. *Indian. J. Plant Genet. Resources*. 14: 171-172.

Vujacic, V., Zemun, S. and Montenegro, 2005. Variability and factor analysis of morphological and productive characteristics of species of the genus *Amaranthus. Genetika.* 37(1): 1-13.

Yadav, R., Rana, J.C. and Ranjan, K. 2014. Analysis of variability parameter for morphological and agronomical traits in grain amaranth (*Amaranthus* spp) genotype. *Inter. Quarterly J. of Life Sci.* 9(4): 1661-1665.