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Short Communication

Stability of foliage yield in vegetable amaranth (*Amaranthus tricolor* L.)

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The vegetable amaranth (*Amaranthus tricolor* L.) is being grown in India especially in hilly areas since centuries as pot herb. Its foliage is rich in proteins, vitamin and minerals like iron and calcium [1]. A considerable amount of vitamin 'C' also remain present in the leaves, which plays a significant role in maintaining the preferred oxidation-reduction potential in human tissues [2]. Due to its nutritional quality, the selection of genotypes for high foliage yield is necessary. A genotype can be considered superior if it has potential for high yield under favorable environment and at the same time has a great deal of phenotypic stability. The stability analysis provides information on genotypes for their stability over wide agro climatic conditions. Numerous statistics, parametric as well as non-parametric have been proposed for the measurement of yield stability [3-7]. These measures grouped into two categories depending upon the underlying basic stability concepts involved biological and agronomical concepts of stability. The agronomic stability measures can be further classified according to whether they are based on genotype x environment interaction component or regression on environmental mean. The genotype (G) × environmental (E) interaction leads to a successful evaluation of stable genotypes, which could be used in breeding program. In vegetable amaranth, no such study has been conducted. Hence, in the present investigation 10 important genotypes were evaluated for G × E interaction to identify stable genotypes as variety for use as commercial cultivation.

The material(s) of the present investigation comprised 10 high yielding and pure breeding genotypes of vegetable amaranth, namely, AV-35, AV-45, AV-35/1, AV-63, AV-64, AV-77, AV-151, AV-N-3, AV-190 and AV-76 were evaluated in randomized block design with 3 replications during 1997-98 to 2001-2002. The crop was sown in the month of March of each crop year. The plot size was 5.76 m^2 with 8 rows/plot spaced 25 cm apart, plant to plant distance was kept at 10 cm. After 4 weeks of sowing, first cutting of foliage started and subsequent cuttings were done at the interval of 10 days. The data on foliage yield (kg) was recorded on plot basis comprising five cuttings and also converted into q/ha. Stability analysis was done as per Eberhart and Russel [4].

The analysis of variance for stability (Table 1) revealed that the mean square due to genotypes was significant for foliage yield, indicating the presence of substantial genetic variations among the genotypes. The significant mean square due to environments suggested that the environment plays a major role in developing genetic variation among the genotypes for foliage yield. G × E interaction was significant revealing that the genotypes interacted considerably with environmental conditions that existed over different years. The significant mean squares due to G × E interactions, linear (environment) and non-linear (pooled deviation) also confirmed the above finding. The stability of genotypes also substantially differed due to deviation from regression. Thus both predictable (linear) and non-predictable (non-linear) components contributed significantly to differences in stability among genotypes.

Table 1. Analysis of variance for stability of foliage yield in Vegetable amaranth

Source	df	MSS
Varieties	9	38.6273**
Environment	4	8.0879**
Variety × environment	36	2.6447**
Env. + (Var. × Env.)	40	3.1891**
Environement (Linear)	1	32.3511**
Var. × Env. (Linear)	9	3.5583**
Pooled deviation	30	2.1062
Pooled error	100	0.3452

The foliage yield (q/ha) recorded over five years (Table 2) showed that the genotype AV190 was most promising with an average yield 264.88±12.15 q/ha followed by AV-45 with a mean 254.77±10.51 q/ha and AV-77 with an average yield 194.64±10.12 q/ha. The genotypes AV-190 and AV-45 were also significantly

Table 2. Mean performance of foliage yield (q/ha) over years and deviation from regression in vegetable amaranth

Cultivars	Foliage yield (q/ha)							bi	S^2di
	Env. I	Env. 2	Env. 3	Env. 4	Env. 5	Mean±SE	PI		
AV-35	122.04	195.99	170.99	178.81	159.71	165.51±12.37	–15.76	–0.061	2.806
AV-45	271.16	231.06	287.31	241.13	243.21	254.77±10.51	73.50	–0.553	1.547
AV-35/1	218.56	157.98	187.83	206.24	147.21	183.56±13.66	2.29	0.406	3.383
AV-63	199.47	205.89	154.68	150.16	136.10	169.26±14.02	–12.01	1.869*	0.009
AV-64	212.31	206.75	125.34	175.16	156.24	175.16±16.15	–6.11	2.194**	0.010
AV-77	210.92	225.68	172.56	184.71	179.33	194.64±10.12	13.37	1.415	–0.464
AV-151	178.11	198.08	138.71	134.02	115.27	152.84±15.25	–28.43	2.019*	0.177
AV-N-3	102.94	170.13	149.12	179.15	143.57	148.98±13.24	–32.29	–0.225	3.255
AV-190	285.22	283.14	234.01	236.27	285.74	264.88±12.15	83.61	0.888	1.848
AV-76	147.16	122.56	34.02	106.07	105.89	103.14±18.85	–78.13	2.049*	2.743
Mean	194.79	199.73	165.45	179.17	167.23	181.2			
SE	018.70	013.87	21.13	013.38	017.82				

*,** Significance at 5% and 1% respectively; SE = Standard error, PI = Phenotypic index

higher yielder than all the genotypes with stable yield performance over years.

In the present study, the mean ($\bar{X}$) and deviations from regression (S^2di) for each genotype were considered for stability and linear regression (bi) was used for testing the genotype response. The magnitude of regression coefficient and deviations from regression varied from genotype to genotype. A simultaneous consideration of all the three parameters ($\bar{X}$, bi and S^2di) showed that the only genotype AV-190 had highest foliage yield (264.88 q/ha), regression coefficient approaching to unity (b = 1) and non significant deviation from regression (S^2di) indicating that this genotype was most adaptable and stable to varying environments. Genotype AV-77 manifested high mean (gi > $\bar{X}$) and highly responsive and adaptable to rich environment. Under intensive agriculture, where inputs are no limitation, it can yield maximum but under poor condition may fail drastically. Contrary to this, genotype AV-35/1 though had high foliage yield (gi > $\bar{X}$) and low regression coefficient (b = 0.406) as well as highest deviation from regression (S^2d_i) indicated that the genotpye is less responsive to environmental conditions. Hence, even under conducive environment, it may not respond well. The regression coefficient was significant and higher than unity for 4 genotypes (AV-63, AV-64, AV-151 and AV-76) revealing that linear regression alone responsible for almost of the G × E interaction. This is in conformity with over all performance of pooled analysis, where linear component was significant and higher in magnitude than non-linear. These cultivars though highly responsive to environment but their foliage yield was low (gi < $\bar{X}$) hence unsuitable for cultivation. The genotypes AV-35 and AV-N-3 had lower foliage yield than arithmetic mean as well as negative responsive (bi) towards environmental variation. Both these genotypes being highly sensitive to environment hence they could not favour rich environment and might be specifically adapted to poor conditions. The genotype AV-45 had next to high foliage yield but showed poor response towards environmental changes.

In general, the genotype AV-190 was most ideal as this showed high foliage yield and adaptability to wide range of climatic conditions, while genotype AV-45 was also most promising and stable to low responsive environment. Consequent upon above findings the genotype AV-190 may be recommended for commercial cultivation.

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