Original Research Article

Genetic Variability, Heritability, Correlation and Path Coefficient Analysis in Amaranth (*Amaranthus spp.*) in Western UP.

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Abstract

The field experiment was conducted during *Rabi* season in 2021-22 in randomized block design with three replications. Total 19 diverse germplasm of Amaranth were studied for 12 growth and yield parameters. Analysis of variance for 19 genotypes of Amaranthus revealed significant difference for all the 12 characters, which indicated the presence of wide spectrum of variability among the genotypes. The phenotypic coefficient of variation (PCV) was higher than the respective genotypic coefficient of variation (GCV) for all the traits. High heritability and genetic advance as per cent of mean were observed for all twelve characters. The highest heritability was recorded in biological yield per plant (99.49%) and lowest for Days to germination (69.95%). Correlation coefficient studies indicated that genotypic correlation coefficient was found to be higher than phenotypic correlation coefficients for most of the characters, indicating a strong inherent association between various characters and significantly affected by environmental components in regard to phenotypic expression. Seed yield expressed highly significant and positive correlation with plant height and biological yield per plant at both genotypic and phenotypic level, which implies that these characters were the primer contributing factors to seed yield. All the combination of traits should be considered, while breeding programme for selecting high yielding genotypes and suitable for breeders to achieving improved plant type. Path coefficient analysis revealed that highest positive direct effect on seed yield kg per ha was observed for biological yield per plant, seed yield per plant, number of leaves per plant, days to maturity, days to germination, inflorescence length, fresh leaf weight and plant height. Improvement of these characters might be improved.

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Keywords: Amaranthus, Genetic Variability, heritability, Correlation, Path Coefficient and Seed yield

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Introduction

Ancient amaranth grains of three species, *Amaranthuscaudatus*L., *Amaranthuscruentus*L., and *Amaranthushypochondriacus*L. are still being used. In India, species *A. hypocondriacus*L. known as Rajgeera (the king‘s grain) very similar to Mexican Algeria, is often popped to be used in confections called laddoos. India has been regarded as one of the two main centers of distribution of genus *Amaranthus*and the other was considered tropical America. In India, grain amaranth is a major grain crop in the pre conquest Aztec empire. It is cultivated in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Assam, Meghalaya, Arunachal Pradesh, Nagaland, Tripura, Jharkhand, Chhattisgarh, Maharashtra, Gujrat, Orissa, Karnataka, Kerala and Tamil Nadu both hills and plains. However, as a grain crop it is estimated to be grown in about 40-50 thousand ha. Hand harvested yields have been as high as 1200 kg/ha in India.

Vegetable types are generally smooth leafed, with an indeterminate growth habits that produce new succulent axillary growth. The floral buds arise directly from the leaf axils. Amaranth seeds are borne in an utricle, which are classified as dehiscent, semi dehiscent, or indehiscent types. Seeds are quite small (0.9 to 1.7 mm diameter) varying its weights from 1,000 to 3,000 seeds/g and seed colors can vary from cream to gold and pink to black. Seeds of the vegetable, ornamental and weedy types are shiny black.

Genetic variability is an essential perquisite for crop improvement programme for obtaining high yielding varieties. Because of their flavour and culinary resemblance to cereals, amaranths, which are not grasses, are referred to as pseudo-cereals. Heritability is an index for assessing the influence of environment on genotypic expression. Broad sense heritability estimates the proportion of phenotypic variance resulting due to genetic cause **(Lush, 1949)**. Genetic advance denotes the improvement in the genotypic value of the new population when compared to the original population. An estimate of genetic advance along with heritability is helpful in assessing the reliability of character for selection **(Lynch and Walsh, 1998)**. Path coefficient analysis usually correlates coefficients into direct and indirect effects of various yield components, statistically; path coefficient is a standardized partial regression coefficient, obtained from equations, where the yield related variables are expressed as deviations from the means in units of standard deviation **(Steel and Torrie, 1980)**.Correlation and path co-efficient analysis determines nature and magnitude of association among variables and is the measurement of direct influence of one variable upon the other. All these measures are important for the identification of genetically distant

parental combinations, aiming to use distinct gene sets in crossings for getting superior hybrids and sergeant **(Goncalves*et al.*, 2008 and Munhoz*et al.*, 2009)**.

Materials and Methods

The experiment was laid out in randomized block design with three replications at Horticultural Research Center, SardarVallabhbhai Patel University of Agriculture and Technology, Meerut (UP) 250110 during *Rabi*2021-2022. The following observation were recorded on randomly selected plants i.e. Days to germination, Days to 50% flowering, Days to maturity, Plant height (cm), Inflorescence length (cm), Number of leaves per plant, Number of branches per plant, Fresh leaf weight (g), Biological yield per plant (g), Biological yield ton per hectare, Seed yield per plant (g) and Seed yield per hectare (kg/ha).

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Table 1.List of cultivars/Germplasm included in the trial

S. No.	Notation	Germplasm	Source
1	T_1	Arun	Division of Vegetable Science, IARI, New Delhi
2	T_2	ArkaSamraksha	IIHR, Bengaluru
3	T_3	ArkaSuguma	IIHR, Bengaluru
4	T_4	CO-2	Coimbatore, Tamilnadu
5	T_5	CO-3	Coimbatore, Tamilnadu
6	T_6	CO-5	Coimbatore, Tamilnadu
7	T_7	Krishna Sree	Division of Vegetable Science, IARI, New Delhi
8	T_8	IC-151606	Division of Vegetable Science, IARI, New Delhi
9	T_9	IIHR-109-1	IIHR, Bengaluru
10	T_{10}	RNA-1	Division of Vegetable Science, IARI, New Delhi
11	T_{11}	Reni Sree	Division of Vegetable Science, IARI, New Delhi
12	T_{12}	PusaLalChaulai	Division of Vegetable Science, IARI, New Delhi
13	T_{13}	PusaKiran	Division of Vegetable Science, IARI, New Delhi
14	T_{14}	ArkaArunima	IIHR, Bengaluru
15	T_{15}	Arka Verna	IIHR, Bengaluru
16	T_{16}	CO-4	Coimbatore, Tamilnadu
17	T_{17}	Kannara Local	Division of Vegetable Science, IARI, New Delhi
18	T_{18}	IIHR-109-4	IIHR, Bengaluru
19	T_{19}	IC-151608	Division of Vegetable Science, IARI, New Delhi

Statistical Analysis

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The following statistical procedure were followed in the present investigation

Analysis of variance

The mean values of genotypes in each replication were used for statistical analysis by using the formula as suggested by **Panse and Sukhatme (1969).**

Heritability

Heritability in broad sense h^2 (b) was computed by using the formula as suggested by**(Allard, 1960).**

Genetic advance

The expected genetic advance was estimated as suggested by **Allard (1960).**

Estimation of Correlation coefficient

Correlation was estimated as suggested formula by **Searle (1961).**

Path coefficient analysis

The analysis of path-coefficient was conducted following the procedure suggested by **Wright (1921)** and as elaborated by **Dewey and Lu (1959).**

Results and Discussion

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The analysis of variance revealed highly significant differences among all 19 genotypes of Amaranthusfor all 12 characters suggesting considerable genetic variability in the population (Table 2.). The phenotypic coefficient of variation (PCV) was higher than the respective genotypic coefficient of variation (GCV) for all the traits. High heritability were observed for all twelve characters. The highest heritability was recorded in biological yield per plant (99.49%) and lowest for Days to germination (69.95%). Seed yield kg per ha character showing high heritability, could be owing to greater contribution of additive genetic components in the inheritance of these attributes.

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The heritable variation can be found with the help of heritability estimates and genetic gain; the present investigation heritability could be estimated in only broad sense. Although high heritability denotes high proportion of genetic effects in the determination of these characters and can be adopted for improving seed yield kg per ha. Seed yield kg per ha character showing high heritability, could be owing to greater contribution of additive genetic components in the inheritance of these attributes. Similar results also found earlier by

Sarker*et. al.* (2015), Dhangrah*et. al.* (2015), Malaghan*et. al.* (2018), Adeniji (2018), Vipin*et. al.* (2020) and Kumar *et. al.* (2021) in various crops**.**

The high percent of genotypic co-efficient of variation (>20%) was observed for biological yield ton per hectare (35.59), seed yield per plant (32.38), fresh leaf weight (30.11) and biological yield per plant (24.97). Number of branches per plant, plant height and number of leaves per plant, observed moderate genotypic coefficient of variation (10%-20%). Remaining characters showed low coefficient of variation.

Mean Performance

As per Table No.6.there is a vast difference for the 12 characters among the 19 genotypes of Amaranthus. PusaLalChaulai had highest mean performance for the different characters such as biological yield per plant (212.82), Biological yield tonne per ha (45.14), Seed yield per plant (15.91) and Seed yield kg per ha (184.70) and these are significantly differed with the other varieties. Whereas IC-151608 line found best performer for Plant height (71.21), Number of leaves per plant (45.07) and Number of branches per plant (3.80). Variety IIHR-109-4 found best for two characters such as Inflorescence length (34.61) and Fresh leaf weight (7.35). ArkaArunima Variety found best for Days to germination (5.67). Arun Variety showed best result for 50% flowering (40.53) and Variety IIHR-109-1 found best for Days to maturity (91.60). These findings found similar to earlier findings of **Bhargava*et. al.* (2003), Kumar *et. al.* (2014), Dhangrah*et. al.* (2015) and Nandi *et. al.* (2017).**

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Correlation Coefficient

Seed yield kg per ha expressed highly significant and positive correlation with seed yield per plant, biological yield ton per ha, biological yield per plant. Positive and significant correlation with number of leaves per plant. Positive and non-significant correlation with days to germination, plant height, days to maturity, 50 percent flowering, whereas number of branches per plant, fresh leaf weight showed negative and non-significant correlation, while inflorescence length showed highly significant and negative correlation. Therefore, it can be concluded that strains with high yields will be identified through selection based on any one of these traits, either individually or in combination. **Husna, *et.al,* (2011), Ahammed*et. al.* (2012), Kendre*et. al.* (2014), Jakhwal*et.al.* (2022), Shuklа*et al.*, (2016)** and **Tejaswini *et.al.* (2017),**were found similar trends in their investigation.

Direct and Indirect effect

The genotypic direct as well as indirect effects were slightly higher in magnitude as compared to corresponding phenotypic direct and indirect effects. The high and positive direct effect on seed yield kg per ha was observed forbiological yield per plant, seed yield per plant, number of leaves per plant, days to maturity, days to germination, inflorescence length, fresh leaf weight, plant height was observed very high, which indicates that these characters play the significant role to increase the seed yield kg per ha. High but negative direct effect exhibited by number of branches per plant on seed yield kg per ha at genotypic level, therefore these characters may be selected for amaranth crop improvement.

At the phenotypic level, also the estimates of direct and indirect were generally similar to those exhibited by genotypic level with little variation in magnitude. The magnitude of residual effects at both phenotypic and genotypic level were observed to be low. These results are in agreement with**Khurana*et al.*, (2009), Anuja (2012), Hasan*et. al.* (2013)**,**Venkatesh*et. al.* (2014), Patial*et. al.* (2014), and Jangde*et. al.* (2017).**

Conclusion

Mean performance values showed that all the characters have significant difference for all the twelve characters of nineteen genotypes of Amaranthus. As the value of mean performance changes, it may laid direct impact on seed yield and seed yield will also changes. Phenotypic coefficient of variance (PCV) was higher than the genotypic coefficient (GCV) of variation for all traits indicating that environmental factor influencing their expression and their susceptibility to environmental fluctuations. Variability studies suggest that all the characters revealed that direct selection is more effective to improve all the characters in Amaranth. Seed yield kg per ha expressed highly significant and positive correlation with seed yield per plant, biological yield ton per ha, biological yield per plant. Positive and significant correlation with number of leaves per plant at both genotypic and phenotypic correlation, which indicates that these characters play the significant role to increase the seed yield kg per ha. It is concluded that PusaLalChaulaiand PusaKiran varieties shows better result in terms of yield attributing characters therefore thesevarieties can be used further in breeding improvement programme in Amaranthus.

References

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Table 2. Analysis of variance in 19 genotypes of Amaranth for 12 characters

Source of variation	DF	Days to Germination	50% Flowering	Days to maturity	Plant height (cm)	Inflorescence length (cm)	No. of leaf per plant	No. of branches per plant	Fresh leaf weight (g)	Biological yield per plant (g)	Biological yield ton/ha	Seed yield per plant (g)	Seed yield per ha (kg/ha.)
Replication	2	0.065	2.17	5.95	4.97	0.50	7.55	0.06	0.04	34.96	3.04	0.56	49.41
Treatment	18	0.722**	70.38**	49.45**	159.39**	12.14**	55.55**	0.51**	4.80**	4696.00**	207.35**	20.52**	599.68**
Error	36	0.091	1.79	2.35	0.93	0.68	2.05	0.03	0.06	7.95	2.09	0.13	8.76
Total	56	0.293	23.85	17.62	52.01	4.36	19.45	0.19	1.59	1515.79	68.10	6.70	200.15

Table 3.Estimation of genetic variability of 19 genotypes for 12 characters of Amaranthus

Genotypes	Mean	Min	Max	var (g)	var (p)	Heritability (%)	GCV (%)	PCV (%)
Days to Germination	6.48	5.67	7.47	0.21	0.30	69.95	7.08	8.47
50% Flowering	48.67	40.53	57.53	22.87	24.65	92.76	9.82	10.20
Days to maturity	97.41	91.60	104.93	15.70	18.05	86.99	4.07	4.36
Plant height (cm)	55.49	44.83	71.21	52.82	53.75	98.27	13.10	13.21
Inflorescence length (cm)	31.03	25.93	34.61	3.82	4.50	84.79	6.30	6.84
No. of leaf per plant	40.02	28.62	45.07	17.83	19.89	89.67	10.55	11.14
No. of branches per plant	2.64	2.20	3.80	0.16	0.19	83.20	15.11	16.57
Fresh leaf weight (g)	4.17	2.88	7.35	1.58	1.64	96.16	30.11	30.71
Biological yield per plant (g)	158.32	87.26	212.82	1562.68	1570.6	99.49	24.97	25.03
Biological yield ton/ha	23.24	11.00	45.14	68.42	70.51	97.04	35.59	36.12
Seed yield per plant (g)	8.05	4.81	15.91	6.79	6.93	98.07	32.38	32.70
Seed yield per ha (kg/ha.)	158.13	126.81	184.70	196.98	205.73	95.74	8.88	9.07

Table 4.1. Estimation of correlation at genotypic level

Characters	Days to Germination	50% Flowering	Days to maturity	Plant height (cm)	Inflorescence length (cm)	No. of leaf per plant	No. of branches per plant	Fresh leaf weight (g)	Biological yield per plant (g)	Biological yield ton/ha	Seed yield per plant (g)	Seed yield per ha (kg/ha.)
Days to Germination	1.000	0.808**	0.466**	-0.248	0.011	0.180	0.009	0.122	0.034	0.181	0.201	0.237
50% Flowering		1.000	0.787**	0.000	0.232	0.049	0.098	0.266*	0.123	0.155	-0.084	0.026
Days to maturity			1.000	0.249	0.324*	-0.296*	0.106	0.265*	0.191	0.182	-0.075	0.070
Plant height (cm)				1.000	-0.187	-0.127	0.299*	0.294*	0.545**	0.588**	0.139	0.200
Inflorescence length (cm)					1.000	-0.511**	-0.083	0.307*	-0.009	-0.290*	-0.694**	-0.510**
No. of leaf per plant						1.000	0.446**	-0.172	-0.237	-0.164	0.221	0.294*
No. of branches per plant							1.000	0.215	-0.205	-0.153	0.071	-0.051
Fresh leaf weight (g)								1.000	0.073	-0.015	-0.294*	-0.131
Biological yield per plant (g)									1.000	0.904**	0.148	0.461**
Biological yield ton/ha										1.000	0.494**	0.618**
Seed yield per plant (g)											1.000	0.791**
Seed yield per ha (kg/ha.)												1.000

*, ** significant at 5% and 1% level, respectively

Table 4.2. Estimation of correlation at phenotypic level

Characters	Days to Germination	50% Flowering	Days to maturity	Plant height (cm)	Inflorescence length (cm)	No. of leaf per plant	No. of branches per plant	Fresh leaf weight (g)	Biological yield per plant (g)	Biological yield ton/ha	Seed yield per plant (g)	Seed yield per ha (kg/ha.)
Days to Germination	1.000	0.652**	0.393**	-0.202	0.039	0.150	-0.025	0.110	0.041	0.170	0.151	0.201
50% Flowering		1.000	0.712**	0.006	0.197	0.069	0.090	0.247	0.115	0.146	-0.072	0.027
Days to maturity			1.000	0.244	0.265*	-0.242	0.067	0.241	0.174	0.167	-0.065	0.061
Plant height (cm)				1.000	-0.171	-0.116	0.258	0.282*	0.539**	0.572**	0.140	0.196
Inflorescence length (cm)					1.000	-0.471**	-0.041	0.282*	-0.009	-0.269*	-0.638**	-0.482**
No. of leaf per plant						1.000	0.382**	-0.162	-0.220	-0.159	0.206	0.256
No. of branches per plant							1.000	0.181	-0.187	-0.125	0.056	-0.038
Fresh leaf weight (g)								1.000	0.070	-0.015	-0.282*	-0.125
Biological yield per plant (g)									1.000	0.890**	0.145	0.449**
Biological yield ton/ha										1.000	0.480**	0.600**
Seed yield per plant (g)											1.000	0.765**
Seed yield per ha (kg/ha.)												1.000

Table 5.1.Path coefficient analysis at genotypic level of19 genotypes for 12 characters of Amaranthus

Characters	Days to Germination	50% Flowering	Days to maturity	Plant height (cm)	Inflorescence length (cm)	No. of leaf per plant	No. of branches per plant	Fresh leaf weight (g)	Biological yield per plant (g)	Biological yield ton/ha	Seed yield per plant (g)	R with Seed yield per ha (kg/ha.)
Days to Germination	**0.3092**	-0.5534	0.2754	-0.0194	0.0020	0.1129	-0.0031	0.0218	0.0359	-0.1522	0.2079	0.237
50% Flowering	0.2497	**-0.6853**	0.4644	0.0000	0.0437	0.0307	-0.0353	0.0476	0.1285	-0.1303	-0.0872	0.026
Days to maturity	0.1442	-0.5390	**0.5904**	0.0195	0.0611	-0.1858	-0.0382	0.0474	0.1997	-0.1525	-0.0771	0.070
Plant height (cm)	-0.0767	0.0001	0.1469	**0.0782**	-0.0352	-0.0796	-0.1081	0.0525	0.5712	-0.4934	0.1441	0.200
Inflorescence length (cm)	0.0033	-0.1588	0.1914	-0.0146	**0.1885**	-0.3204	0.0299	0.0549	-0.0098	0.2437	-0.7184	-0.510**
No. of leaf per plant	0.0557	-0.0336	-0.1750	-0.0099	-0.0964	**0.6267**	-0.1616	-0.0308	-0.2477	0.1377	0.2289	0.294*
No. of branches per plant	0.0026	-0.0669	0.0623	0.0234	-0.0156	0.2798	**-0.3620**	0.0385	-0.2150	0.1287	0.0732	-0.051
Fresh leaf weight (g)	0.0378	-0.1824	0.1565	0.0230	0.0579	-0.1080	-0.0779	**0.1787**	0.0760	0.0125	-0.3046	-0.131
Biological yield per plant (g)	0.0106	-0.0841	0.1126	0.0427	-0.0018	-0.1482	0.0743	0.0130	**1.0472**	-0.7586	0.1532	0.461**
Biological yield ton/ha	0.0561	-0.1065	0.1073	0.0460	-0.0548	-0.1029	0.0555	-0.0027	0.9468	**-0.8390**	0.5116	0.618**
Seed yield per plant (g)	0.0621	0.0577	-0.0440	0.0109	-0.1308	0.1386	-0.0256	-0.0526	0.1550	-0.4148	**1.0350**	0.791**

Table 5.2.Path coefficient analysis at phenotypic levelof19 genotypes for 12 characters of Amaranthus

Characters	Days to Germination	50% Flowering	Days to maturity	Plant height (cm)	Inflorescence length (cm)	No. of leaf per plant	No. of branches per plant	Fresh leaf weight (g)	Biological yield per plant (g)	Biological yield ton/ha	Seed yield per plant (g)	R with Seed yield per ha (kg/ha.)
Days to Germination	**0.0411**	-0.1377	0.1020	0.0315	0.0003	0.0463	0.0023	0.0158	0.0289	-0.0525	0.1230	0.201
50% Flowering	0.0268	**-0.2112**	0.1848	-0.0009	0.0015	0.0214	-0.0082	0.0355	0.0816	-0.0452	-0.0589	0.027
Days to maturity	0.0162	-0.1504	**0.2595**	-0.0381	0.0020	-0.0748	-0.0062	0.0347	0.1230	-0.0516	-0.0532	0.061
Plant height (cm)	-0.0083	-0.0012	0.0633	**-0.1562**	-0.0013	-0.0358	-0.0236	0.0407	0.3813	-0.1768	0.1141	0.196
Inflorescence length (cm)	0.0016	-0.0415	0.0689	0.0267	**0.0075**	-0.1458	0.0038	0.0406	-0.0065	0.0831	-0.5200	-0.482**
No. of leaf per plant	0.0062	-0.0146	-0.0627	0.0181	-0.0035	**0.3093**	-0.0350	-0.0233	-0.1559	0.0492	0.1679	0.256
No. of branches per plant	-0.0010	-0.0189	0.0174	-0.0403	-0.0003	0.1182	**-0.0916**	0.0261	-0.1322	0.0387	0.0455	-0.038
Fresh leaf weight (g)	0.0045	-0.0521	0.0626	-0.0441	0.0021	-0.0500	-0.0166	**0.1440**	0.0495	0.0048	-0.2300	-0.125
Biological yield per plant (g)	0.0017	-0.0244	0.0451	-0.0841	-0.0001	-0.0681	0.0171	0.0101	**0.7081**	-0.2751	0.1185	0.449**
Biological yield ton/ha	0.0070	-0.0309	0.0433	-0.0893	-0.0020	-0.0493	0.0115	-0.0022	0.6301	**-0.3091**	0.3912	0.600**
Seed yield per plant (g)	0.0062	0.0153	-0.0170	-0.0219	-0.0048	0.0638	-0.0051	-0.0407	0.1030	-0.1485	**0.8147**	0.765**

Table 6. Mean performance of 19 genotypes for 12 characters of Amaranthus

S.no	Genotypes	Days to Germination	50% Flowering	Days to maturity	Plant height (cm)	Inflorescence length (cm)	No. of leaf per plant	No. of branches per plant	Fresh leaf weight (g)	Biological yield per plant (g)	Biological yield ton/hec	Seed yield per plant (g)	Seed yield per hec (kg/ha.)
1	Arun	6.27	40.53	92.47	44.83	30.74	41.93	2.67	3.45	125.86	16.49	8.32	161.96
2	ArkaSamraksha	6.13	43.73	92.67	53.87	29.74	40.87	3.07	2.88	87.26	11.29	6.63	126.81
3	ArkaSuguna	5.73	45.53	93.73	54.09	30.59	43.07	2.93	3.35	194.74	26.67	9.20	165.38
4	CO-2	6.07	46.80	97.47	53.85	31.24	44.20	2.67	3.05	126.16	17.32	9.45	162.97
5	CO-3	7.00	50.73	97.47	54.54	31.50	43.20	2.87	3.33	126.44	18.48	9.37	167.22
6	CO-5	6.67	51.60	94.67	52.25	31.67	41.13	2.83	3.19	197.78	30.08	7.20	160.50
7	Krishna Sree	7.07	52.33	99.40	45.97	29.45	43.93	2.30	3.20	134.19	19.49	10.07	170.63
8	IC-151606	7.47	57.53	104.73	47.97	33.93	36.13	2.30	3.57	183.69	24.12	4.85	146.55
9	IIHR-109-1	6.60	43.87	91.60	53.68	32.50	40.60	2.20	4.67	194.36	28.35	6.46	157.57
10	RNA-1	6.00	50.33	103.27	60.66	31.07	37.47	2.40	3.69	182.69	24.69	5.15	150.02
11	Reni Sree	6.47	49.73	96.47	50.94	30.63	42.60	2.30	3.75	131.53	17.59	8.22	163.11
12	PusaLalChaulai	7.00	49.53	96.27	61.50	25.93	39.20	2.20	3.36	212.82	45.14	15.91	184.70
13	ArkaArunima	5.67	41.47	92.67	69.30	29.47	40.27	2.47	3.89	190.38	26.47	5.93	151.69
14	Arka Verna	6.33	49.07	97.40	47.80	33.63	33.77	2.67	4.63	88.32	11.00	6.65	130.43
15	CO-4	6.67	53.93	99.00	54.57	30.47	40.53	2.40	5.97	136.08	20.52	6.11	154.31
16	Kannara Local	6.53	46.07	96.60	54.91	28.53	43.80	3.27	5.95	129.54	17.26	9.36	168.33
17	IIHR-109-4	6.40	50.27	98.40	57.48	34.61	33.93	2.40	7.35	178.16	21.40	4.81	145.22
18	IC-151608	7.07	57.47	104.93	71.21	31.37	45.07	3.80	6.05	186.00	31.85	8.97	164.08
19	PusaKiran	6.00	44.27	101.60	64.87	32.56	28.62	2.47	3.96	202.14	33.44	10.29	173.00
	Mean	**6.48**	**48.67**	**97.41**	**55.49**	**31.03**	**40.02**	**2.64**	**4.17**	**158.32**	**23.24**	**8.05**	**158.13**
	Min	5.67	40.53	91.60	44.83	25.93	28.62	2.20	2.88	87.26	11.00	4.81	126.81
	Max	7.47	57.53	104.93	71.21	34.61	45.07	3.80	7.35	212.82	45.14	15.91	184.70
	SE(d)	0.25	1.09	1.25	0.79	0.68	1.17	0.15	0.21	2.30	1.18	0.30	2.42
	C.D. at 5%	0.50	2.22	2.55	1.60	1.38	2.38	0.30	0.42	4.69	2.40	0.61	4.92
	C.V. (%)	4.64	2.75	1.57	1.74	2.67	3.58	6.79	6.02	1.78	6.22	4.54	1.87

Fig. 1. Biological Yield per Plant (g) of 19 genotypes of Amaranth

Fig. 2.Seed Yield Kilogram per Ha.of 19 genotypes of Amaranth