



Characterization of Drought Tolerant Grain Amaranth (*Amaranthus hypocondriacus* L.) Germplasm for Alfisol of Jharkhand

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Grain amaranth (*Amaranthus hypocondriacus* L.) is a winter crop in India. Productivity improvement through exploitation of variability in 99 accessions was carried out at Birsa Agricultural University, Jharkhand (23°17' N latitude and 85°19' E longitude, 625m altitude) in augmented incomplete block design with three checks (BGA 2, GA 2 and Suvarna) during Rabi 2012-2013 and 2013-14. The data on 11 quantitative and 9 qualitative characters were recorded. A wide range of variability was observed for all the morphological characters. High variability was observed with respect to seed yield (kg/ha), g/10ml seed weight, days to 80% maturity, inflorescence length (cm), plant height (cm), number of branches/plant, days to 50% flowering, petiole length (cm), leaf width (cm), leaf length (cm) and seed yield/plant. The accession viz., IC94661, SKGPA-106, IC35713 and IC35735 for more than 28 g seed yield/plant; SKGPA-79, SKGPA-101, SKGPA-69, IC-35665, IC-35642 and SKGPA-100 for days to maturity and IC-35642, IC-21803-A, IC-120670 and IC-95244 for g/10ml seed weight with superior desirable traits can be utilized in different breeding programmes.

Key words: Grain amaranth, *Amaranthus hypocondriacus*, Germplasm, Characterization.

In India grain amaranth (*Amaranthus hypocondriacus* L.) is a potential crop. The diversity of this crop is found to be maximum (De candolle, 1884; Vavilov, 1926 and Zhukovsky, 1950). The productivity of grain amaranth requires genetic improvement through exploitation of germplasm. The present paper deals with characterization, preliminary evaluation and identification of promising accessions of grain amaranth with desirable traits.

Materials and Methods

The preliminary characterization and evaluation of 99 accessions was carried out during rabi 2012-13 and 2013-14 at the Research farm of Birsa Agricultural University, Kanke, Ranchi, which is situated at 23°17' north latitude and 85°19' east longitude with an altitude of about 625 m above MSL. The soil is mostly red lateritic with pH value ranging from 4.5 to 6.3, poor in fertility and low in water retentive capacity. The normal annual precipitation is around 1088 mm, mostly confined to four monsoon months (June to September). The germplasm accessions were raised in an augmented incomplete block design with 3 checks (BGA 2, GA 2 and Suvarna) in each block. The accessions were grown in 4m row with spacing of 45 x 15 cm. The trial was unprotected for diseases. The data on 11 quantitative leaf length (cm), leaf width (cm), petiole length (cm), days to 50% flowering, number of branches/plant, plant height

(cm), inflorescence length (cm), days to 80% maturity, seed yield/plant, g/10ml seed weight and seed yield (kg/ha) and 9 qualitative characters viz., early plant vigour, plant growth habit, leaf colour, inflorescence colour, inflorescence compactness, stem colour, stem surface, inflorescence shape and inflorescence spininess were recorded using minimal descriptors developed by Mahajan *et al.*, (2000). All the quantitative data were analyzed statistically for mean and range. The qualitative characters have been reported as such and their frequencies alone have been calculated.

Results and Discussion

Ninety nine accessions of grain amaranth germplasm were characterized for 11 quantitative and 9 qualitative characters. Wide range of variability was recorded in both quantitative and qualitative traits. The range of variability and frequency observed for qualitative traits are presented in Table 1. The early plant vigour showed poor in 40 accessions, good in 30 accessions and very good in 29 accessions. Plant growth habit was expressed as erect in 67 accessions, spreading in 27 accessions and drooping in 5 accessions. The leaf colour expressed its yellow in 10 accessions, yellowish orange in 9 accessions, yellowish green in 23 accessions, yellowish orange in 9 accessions, green in 21 accessions, pinkish green in 25 accessions, pink in 2 accessions, redish green in 5 accessions, and red in 1 accession. The

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Table 1. Frequency distribution of grain amaranthus accessions for various qualitative characters

Characters	Parameters	Score	Frequency
Early plant vigour	Poor	1	40
	Good	2	30
	Very good	3	29
Plant growth habit	Erect	1	67
	Spreading	2	27
	Drooping	3	5
Leaf colour	Yellow	1	10
	Yellowish orange	2	9
	Yellowish green	3	23
	Green	5	23
	Pink	7	2
	Pinkish green	8	25
	Reddish green	10	6
Inflorescence colour	Red	11	1
	Light yellow	1	13
	Yellow	2	12
	Yellowish green	4	5
	Pink	6	22
	Pinkish green	7	3
	Red	9	23
Inflorescence compactness	Green	11	21
	Lax	3	22
	Intermediate	5	45
	Dense	7	32
Stem colour	Yellow	1	26
	Yellowish green	2	28
	Orange	3	11
	Pink	4	14
	Red	5	10
	Reddish green	6	10
Stem surface	Smooth	1	48
	Ridged	2	51
Inflorescence shape	Globose	1	12
	Semi drooping	2	11
	Completely drooping	3	2
	Straight	4	74
Inflorescence spininess	Smooth	1	2
	Glabrous	2	34
	Prickly	3	61
	Spiny	4	2

inflorescence colour was pink and red colour in 22 accessions, green in 19 accessions, light yellow in 13, yellow in 12, yellowish green in 5 and pinkish green in 3 accessions. The inflorescence compactness expressed as lax in 21 accessions, as intermediate in 45 accessions and as dense in 30 accessions. The stem colour showed yellowish green in 28 accessions, yellow in 25 accessions, pink in 14 accessions, orange in 10 accessions, red in 10 accessions and reddish green in 9 accessions. Stem surface was smooth in 46 accessions and ridged in 50 accessions. Inflorescence shape expressed as straight in 74 accessions, as semi drooping in 11 accessions, as globose in 9 accessions and as completely drooping in 2 accessions. Inflorescence spininess observed as prickly in 61 accessions, whereas glabrous observed in 31 accessions, smooth and spiny in 2 accessions.

The quantitative characters also showed wide range of variation. The result such as descriptive statistical analysis is presented in Table 2. The characters of leaf length, leaf width, petiole length, days to 50% flowering, number of branches/plant, plant height, inflorescence length, days to 80% maturity, seed yield/plant, g/10ml seed weight and seed yield (kg/ha) were highly variable based on the variance. Leaf length ranged from 3-15 with mean value 8.7. Leaf width ranged from 2-7 having mean value 4.7. Petiole length ranged from 2-12 with mean value 5.6. Days to 50% flowering ranged from 57-93 with mean value 73.3. Number of branches/plant ranged from 1-8 with mean value 4.38. Plant height ranged from 14-98 with mean value 50.9. Inflorescence length ranged from 12.5-40 with mean value 23.7. Days to 80% maturity ranged from 126-170 with mean value 144. Seed

Table 4. Grain amaranth accessions showing high 100 seed weight (>10.3 g)

Accession number	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)	Days to 50% flowering	Number of branches/plant	Plant height (cm)	Inflorescence length (cm)	Days to 80% maturity	Seed yield/plant	g/10ml seed weight	Seed yield (kg/ha)
IC21803-A	7.5	3.5	5.5	78	2.5	61.7	21.0	159	28.6	10.5	4237
IC33193	9.0	6.5	5.5	85	1.0	79.7	30.0	155	20.1	10.3	2978
IC35642	5.0	2.0	3.0	76	4	23.0	14.0	128	18.3	10.5	2711
IC95244	9.0	5.2	5.0	81	4	39.0	15.0	146	22.4	10.4	3319
IC120670	10.0	4.0	5.0	80	6	40.0	17.0	132	17.0	10.4	2519
IC120689	6.0	5.0	4.0	70	3	45.0	20.0	148	30.4	10.3	4504
SKGPA-64	12.0	7.0	7.0	78	7	36.0	29.0	136	24.6	10.3	3644
SKGPA-79	7.0	3.0	4.0	67	4	14.0	21.0	126	21	10.3	3111
Checks											
GA 2	13.0	6.0	9.0	90	7	98.3	35.0	160	23.3	9.1	3452
Suvarna	8.5	4.5	6.0	96	1	78.1	15.0	168	19.9	8.2	2948
BGA 2	11.5	5.0	8.3	93	6	77.0	25.0	161	20.6	6.1	3052

weight per 10ml ranged from 6.7-10.5 with mean value 9.5, whereas seed yield/plant ranged from 9.5-34 g with mean value 21g and seed yield (kg/ha) ranged from 1407-5037 with mean value 3107. It is reported in early studies that the earliness is due to additive action (Chowdhury *et al.*, 2003 and Ramanujam *et al.*, 1974) in mungbean.

Grain amaranth accessions showing high seed yield/plant (>28g) along with other yield attributing characters were presented in Table 3. The accessions IC94661, SKGPA-106, IC35713, IC35735, IC21803-A, IC21937, IC95516, IC120689, SKGPA-80, SKGPA-88, SKGPA-101 and SKGPA-105 showed more than 28g seed yield/plant. The

Table 5. Promising accessions of grain amaranth identified during evaluation

Trait	Promising accessions
Leaf length (cm)	IC35735 (12.5), IC95556 (13), SKGPA-88 (13), SKGPA-91 (13), IC94654(14), SKGPA-98 (14), SKGPA-99 (15)
Leaf width (cm)	SKGPA-64 (7), SKGPA-66 (7), SKGPA-77 (7), SKGPA-80 (7), SKGPA-99 (7), SKGPA-107 (8)
Petiole length (cm)	SKGPA-80 (12), SKGPA-106 (9), SKGPA-107 (9), SKGPA-99 (9), SKGPA-91 (9), IC-95556 (9), IC-120649 (9)
Days to 50% flowering	IC-93382-B (57), SKGPA-100 (59), SKGPA-75 (59), SKGPA-105 (60), SKGPA-107 (60), SKGPA-66 (61), SKGPA-87 (61), SKGPA-93 (61), SKGPA-65 (62), SKGPA-89 (62), SKGPA-69 (63)
Number of branches/plant	IC-95406 (8), IC-120621 (8), SKGPA-80 (8), SKGPA-100 (8)
Plant height (cm)	SKGPA-79 (14), SKGPA-108 (16), SKGPA-68 (19), SKGPA-67 (19.3)
Inflorescence length (cm)	SKGPA-90 (40), SKGPA-98 (40), SKGPA-104 (38), IC-95510 (38)
Days to 80% maturity	SKGPA-79 (126), SKGPA-101 (126), SKGPA-69 (127), IC-35665 (128), IC-35642 (128), SKGPA-100 (128)
Seed yield/plant	IC-94661 (34), SKGPA-106 (33.4), IC-35713 (32.5), IC-35735 (31.6)
g/10ml seed weight	IC-35642 (10.5), IC-21803-A (10.5), IC-120670 (10.4), IC-95244(10.4), IC-33193 (10.3), SKGPA-79 (10.3), SKGPA-64 (10.3), IC-120689 (10.3), SKGPA-66 (10.1), IC-95516 (10.1), IC-95556 (10.1), IC-35661 (10.1), IC-35713 (10.1), IC-35638 (10.1), IC-35735 (10.1)
Seed yield (kg/ha)	IC-94661 (5037), SKGPA-106 (4948), IC-35713 (4815), IC-35735 (4681)

accession IC94661 have had the highest seed yield/plant (34g) with leaf length (10 cm), leaf width (6 cm), petiole length (6 cm), days to 50% flowering (72 days), Plant height (39 cm), number of branches/plant (4), inflorescence length (30 cm), days to 80% maturity (142 days) and 10ml volume weight (9.6 g).

Grain amaranth accessions showing high test weight (>10.3 g) along with other yield attributing characters were presented in Table 4. The accessions IC21803-A and IC35642 showed test weight more than 10.5 g. Based on the screening

for different quantitative and qualitative traits of 99 grain amaranth accessions showing promise for different characters were presented in Table 5. IC35735, IC95556, SKGPA-88, SKGPA-91, IC94654, SKGPA-98 and SKGPA-99 accessions for leaf length; SKGPA-64, SKGPA-66, SKGPA-77, SKGPA-80, SKGPA-99 and SKGPA-107 for leaf width; IC-93382-B, SKGPA-100, SKGPA-75, SKGPA-105, SKGPA-107, SKGPA-66, SKGPA-87, SKGPA-93, SKGPA-65, SKGPA-89 and SKGPA-69 for Days to 50% flowering; SKGPA-79, SKGPA-101, SKGPA-69, IC-35665, IC-35642 and SKGPA-100 for days to 80%

Table 2. Range and mean for various traits in grain amaranth germplasm

Characters	Range		Mean	Checks		
	Minimum	Maximum		GA 2	Suvarna	BGA 2
Leaf length (cm)	3	15	8.7	13	8.5	11.5
Leaf width (cm)	2	7	4.7	6	4.5	5
Petiole length (cm)	2	12	5.6	9	6	8.3
Days to 50% flowering	57	93	73.3	90	96	93
Number of branches/plant	1	8	4.38	7	1	6
Plant height (cm)	14	98	50.9	98.3	78.1	77.0
Inflorescence length (cm)	12.5	40	23.7	35	15	25
Days to 80% maturity	126	170	144.1	160	168	161
Seed yield/plant	9.5	34	21.0	23.3	19.9	20.6
g/10ml seed weight	6.7	10.5	9.5	9.1	8.2	6.1
Seed yield (kg/ha)	1407	5037	3107	3452	2948	3052

maturity; IC-94661, SKGPA-106, IC-35713 and IC-35735 for seed yield/plant; IC-35642 (10.5), IC-21803-A (10.5), IC-120670 (10.4), IC-95244 (10.4), IC-33193 (10.3), SKGPA-79 (10.3), SKGPA-64 (10.3), IC-120689 (10.3), SKGPA-66 (10.1), IC-95516 (10.1), IC-95556 (10.1), IC-35661 (10.1), IC-35713 (10.1),

Table 3. Grain amaranth accessions showing high seed yield (>28 g)

Accession number	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)	Days to 50% flowering	Number of branches/plant	Plant height (cm)	Inflorescence length (cm)	Days to 80% maturity	Seed yield/plant	g/10ml seed weight	Seed yield (kg/ha)
IC21803-A	7.5	3.5	5.5	78	2.5	61.7	21.0	159	28.6	10.5	4237
IC21937	10.5	4.0	5.0	81	3.5	51.0	32.0	144	30.2	9.5	4474
IC35713	7.0	3.0	4.0	74	5	46.0	25.0	141	32.5	10.1	4815
IC35735	12.5	6.0	6.5	73	3	81.1	22.0	155	31.6	10.1	4681
IC94661	10.0	6.0	6.0	72	4	39.0	30.0	142	34.0	9.6	5037
IC95516	9.0	6.0	5.0	77	6	34.0	25.0	135	29.8	10.1	4415
IC120689	6.0	5.0	4.0	70	3	45.0	20.0	148	30.4	10.3	4504
SKGPA-80	3.0	7.0	12.0	68	8	77.0	28.0	155	28.5	9.1	4222
SKGPA-88	13.0	6.0	7.0	79	5	49.0	31.0	155	28.3	9.0	4193
SKGPA-101	8.0	4.0	5.0	67	4	31.0	25.0	126	30.4	9.5	4504
SKGPA-105	12.0	6.0	7.0	60	5	72.2	25.0	153	28.4	8.0	4207
SKGPA-106	10.0	6.0	9.0	62	5	28.0	19.0	132	33.4	10.0	4948
Checks											
GA 2	13.0	6.0	9.0	90	7	98.3	35.0	160	23.3	9.1	3452
Suvarna	8.5	4.5	6.0	96	1	78.1	15.0	168	19.9	8.2	2948
BGA 2	11.5	5.0	8.3	93	6	77.0	25.0	161	20.6	6.1	3052

IC-35638 (10.1), IC-35735 (10.1) for g/10ml seed weight and IC-94661, SKGPA-106, IC-35713, IC-35735 for Seed yield (kg/ha) were found to be promising.

These accessions with superior desirable qualities can be utilized in different breeding programmes for improvement of a particular character or to develop a new variety with multiple desirable traits for amaranth growing areas of Jharkhand or can be extended to other parts of India having similar climatic conditions. The future thrust may be germplasm collection from unexploited areas, utilization of superior accessions for improvement of specific trait, hybridization for promising recombination, incorporation of disease and pest resistance and tolerance to abiotic stresses.

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