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D Sravan

Department of Vegetable Science,
College of Horticulture, Dr. YSR
Horticultural University,
Venkataramannagudem,
Andhra Pradesh, India

K Radha Rani

Mango Research Station,
Dr. YSR Horticultural
University, Nuzvid,
Andhra Pradesh, India

E Padma

Department of Vegetable Science,
College of Horticulture, Dr. YSR
Horticultural University,
Venkataramannagudem,
Andhra Pradesh, India

B Kanaka Mahalakshmi

Mango Research Station,
Dr. YSR Horticultural
University, Nuzvid,
Andhra Pradesh, India

Corresponding Author:

D Sravan

Department of Vegetable Science,
College of Horticulture, Dr. YSR
Horticultural University,
Venkataramannagudem,
Andhra Pradesh, India

Study on morphological characterization of amaranthus (*Amaranthus* ssp. L.) germplasm

D Sravan, K Radha Rani, E Padma and B Kanaka Mahalakshmi

Abstract

The present investigation entitled “Study on morphological characterization of amaranthus (*Amaranthus* ssp. L.) Germplasm” was carried out with an objective of morphological characterization of amaranthus germplasm. About 30 amaranthus germplasm lines were collected from different sources and 2 varieties were used as check to conduct the experiment in Randomized Block Design (RBD) with two replications at Mango Research Station, Nuzvid during *rabi* season of 2022-23. The location of experimental site falls under humid, East Coast Plain and Hills (Krishna zone) with an average rainfall of 904 mm at an altitude of 81 m (266 feet) above mean sea level. The experimental site was geographically situated at 16° 46’ 48’’ N latitude and 80° 50’ 59’’E longitude. The site experiences hot humid summer and mild winter. The results on morphological characterization revealed that the wide range of variability was observed among the lines collected from different sources. Regarding plant growth habit 28 lines have exhibited erect plant growth habit, one showed semi-spreading growth and one showed spreading type of plant growth habit. Leaf colour exhibited a wide range of variation with dark green, medium green, light green as predominant classes while three genotypes had red leaves. Green, pink and red stem colours were noticed among the lines. For stem surface, many had smooth stem surfaces with few having ridged stem surface. Green and yellowish green were the predominant classes for inflorescence colour, however red colour was also noticed in few lines. Inflorescence compactness was lax type for all the germplasm lines. Shape of the inflorescence was erect for most of the germplasm lines while few had semi-erect inflorescence. spines present on inflorescence in majority cases, however few have smooth inflorescence. For seed colour black and brown seed colours were predominant, however, white and green seed colours were also observed in few germplasm lines. Discoid seeds and ellipsoid seeds were noticed among the germplasm.

Keywords: Amaranthus, characterization, morphological

Introduction

Amaranthus is one of the important and popular leafy vegetables of India, belongs to family Amaranthaceae, subfamily Amaranthoideae. Its chromosome number is $2n= 32, 34$. The genus Amaranthus consists of diverse species as leafy amaranth (*Amaranthus tricolor* L., *A. cruentus*, *A. blitum* and *A. dubius*), grain amaranth (*A. hypochondriacus* and *A. caudatus*) and wild amaranth (*Amaranthus graecizans* L.). The primary centres of diversity for amaranthus are Central and South America, India and South East Asia while secondary centres of diversity are West and East Africa. Main vegetable type of leaf amaranth is *Amaranthus tricolor* L. which was originated in South East Asia, particularly in India (Rai and Yadav, 2005) [13]. The amaranthus can be grown round the year under varied soil and agroclimatic conditions (Katiyar *et al.*, 2000) [7] and (Shukla and Singh, 2000) [15]. However, most suitable time for its cultivation is during summer and rainy season. Amaranthus produces high edible matter per unit area and time. It can be used as food, fodder and as medicine in various pharmaceutical and cosmetic products. (Prakash and Pal, 1991) [12] and (Shukla *et al.*, 2003) [16]. Amaranthus being a cross-pollinated crop exhibits wide genetic variability. Thus, it offers a considerable scope to identify suitable type for a particular region. Exploitation of variability present in the germplasm enhances the crop improvement. Characterization and evaluation of genetic resources can provide breeders with valuable information on effective utilization of genetic resources for the breeding programmes. Collection and evaluation of germplasm including land races offer considerable scope to identify suitable types for any particular region (Labiba *et al.*, 2018) [8]. Hence, the present study was executed at Mango Research Station, Nuzvid during *rabi* season of 2022-23.

Materials and Methods

The present investigation was carried out at Mango Research Station, Nuzvid, Eluru District, Andhra Pradesh during *rabi* season of 2022-23. The location of experimental site falls under humid, East Coast Plain and Hills (Krishna zone) with an average rainfall of 904 mm at an altitude of 81 m (266 feet) above mean sea level. The experimental site was geographically situated at 16° 46' 48'' N latitude and 80° 50' 59'' E longitude. The site experiences hot humid summer and mild winter. Thirty amaranthus germplasm lines were collected from NBPGR-Shimla, NBPGR-Hyderabad, some were collected from different parts of Andhra Pradesh along with two check varieties (Arka Suguna and Dr. YSRHU-Varna) evaluated for various morphological traits. Observations were recorded on various morphological traits in order to characterize the germplasm lines under study as per the NBPGR descriptor (Mahajan *et al.*, 2000) ^[11].

Results and Discussion

The amaranthus germplasm lines were characterised for 10 morphological characters based on descriptors of NBPGR and the results are presented in the Table-1.

Plant growth habit

The results (Table-1) indicating that out of 30 amaranthus germplasm lines, 28 germplasm lines (IC-561297, IC-561304, IC-561306, IC-561314, IC-561315, IC-561317, IC-551321, IC-561327, IC-613599, IC-38174, IC-551459, IC-551462, IC-551466, IC-551468, IC-551482, IC-551486, IC-551494, IC-551506, Local germplasm-1, Local germplasm-2, Local germplasm-3, Local germplasm-4, Local germplasm-5, Local germplasm-6, Local germplasm-7, Local germplasm-8, Local germplasm-9 and Local germplasm-11) exhibited erect growing nature whereas IC-561305 exhibited semi-spreading nature and Local germplasm-10 exhibited spreading nature. Those 28 germplasm lines which are exhibiting erect growing nature are similar with the growth habit of check-1 (Dr. YSRHU-Varna) and check-2 (Arka Suguna). These results of plant growth habit were same as findings of Akaneme and Ani (2013) ^[2] and Bhanu *et al.* (2016) ^[3].

Leaf colour

The leaf colour was varied *viz.*, light green, medium green, dark green and red colour among the germplasm lines evaluated. Out of 30 germplasm lines, 7 germplasm lines (IC-613599, IC-38174, Local germplasm-1, Local germplasm-2, Local germplasm-4, Local germplasm-5 and Local germplasm-11) exhibited light green leaf colour, 14 germplasm lines (IC-561304, IC-561305, IC-561306, IC-561314, IC-551321, IC-561327, IC-551459, IC-551466, IC-551482, IC-551494, Local germplasm-3, Local germplasm-6, Local germplasm-7 and Local germplasm-10) exhibited medium green colour, 7 germplasm lines (IC-561297, IC-561315, IC-561317, IC-551462, IC-551468, IC-551486 and IC-551506) exhibited dark green colour and 2 germplasm lines (Local germplasm-8 and Local germplasm-9) exhibited red colour. Two lines which are exhibited red colour are comparable with the leaf colour of check-1 (Dr. YSRHU-Varna) and seven germplasm lines which are exhibiting light green leaf colour are comparable with the leaf colour of check-2 (Arka Suguna). Similar results for leaf colour were reported by Deepika *et al.* (2017) ^[4] and Ray *et al.* (2019) ^[14].

Stem colour

Stem colour was in 3 variants *viz.*, green, pink and red. Out of 30 germplasm lines tested, 21 germplasm lines (IC-561297, IC-561304, IC-561305, IC-561306, IC-561314, IC-561317, IC-551321, IC-561327, IC-613599, IC-38174, IC-551459, IC-551482, Local germplasm-1, Local germplasm-2, Local germplasm-3, Local germplasm-4, Local germplasm-5, Local germplasm-6, Local germplasm-7, Local germplasm-10 and Local germplasm-11) showed green coloured stem, 6 lines (IC-551462, IC-551466, IC-551468, IC-551486, IC-551494 and IC-551506) showed pink coloured stem, 2 lines (Local germplasm-8 and Local germplasm-9) showed red coloured stem. However, check-1 (Dr. YSRHU-Varna) exhibited red stem colour which was comparable to 2 germplasm lines while check-2 (Arka Suguna) exhibited green stem colour which was comparable with 21 lines exhibiting green stem colour. These results for stem colour were in accordance with the findings of Deepika *et al.* (2017) ^[4] and Ray *et al.* (2019) ^[14].

Stem surface

Among the germplasm lines under study, stem surface was categorized into smooth and ridged. Smooth stem surface was observed in 21 lines (IC-561297, IC-561305, IC-561314, IC-561317, IC-38174, IC-551459, IC-551462, IC-551486, IC-551494, IC-551506, Local germplasm-1, Local germplasm-2, Local germplasm-3, Local germplasm-4, Local germplasm-5, Local germplasm-6, Local germplasm-7, Local germplasm-8, Local germplasm-9, Local germplasm-10 and Local germplasm-11), whereas ridged stem was observed in 9 germplasm lines (IC-561304, IC-561306, IC-561315, IC-551321, IC-561327, IC-613599, IC-551466, IC-551468 and IC-551482). However, both check-1 (Dr. YSRHU-Varna) and check-2 (Arka Suguna) exhibited smooth stem surface. Labiba *et al.* (2018) ^[8] also observed the similar findings for the character stem surface.

Inflorescence colour

Three different colours of inflorescence *viz.*, green, yellowish green and red colour were observed among the germplasm evaluated. Out of 30 germplasm lines, 17 lines (IC-561304, IC-561305, IC-561306, IC-561314, IC-561317, IC-551321, IC-613599, IC-551462, IC-551466, IC-551468, IC-551482, IC-551486, IC-551494, IC-551506, Local germplasm-3, Local germplasm-4 and Local germplasm-10) exhibited green coloured inflorescence, 10 lines (IC-561297, IC-561327, IC-38174, IC-551459, Local germplasm-1, Local germplasm-2, Local germplasm-5, Local germplasm-6, Local germplasm-7 and Local germplasm-11) exhibited yellowish green coloured inflorescence while 3 lines (IC-561315, Local germplasm-8 and Local germplasm-9) exhibited red colour inflorescence. However, check-1 (Dr. YSRHU-Varna) exhibited green coloured inflorescence which was comparable with 17 germplasm lines and check-2 (Arka Suguna) exhibited yellowish green coloured inflorescence which was comparable with 10 germplasm lines. Akaneme and Ani (2013) ^[2] and Ishwar *et al.* (2015) ^[6] also reported similar results with respect to inflorescence colour.

Inflorescence compactness

According to NBPGR descriptors inflorescence compactness was categorized into 3 variants *viz.*, lax, intermediate and

dense. The results presented in Table 1. showed that the inflorescence compactness was lax in all 30 germplasm lines (IC-561297, IC-561304, IC-561305, IC-561306, IC-561314, IC-561315, IC-561317, IC-551321, IC-561327, IC-613599, IC-38174, IC-551459, IC-551462, IC-551466, IC-551468, IC-551482, IC-551486, IC-551494, IC-551506, Local germplasm-1, Local germplasm-2, Local germplasm-3, Local germplasm-4, Local germplasm-5, Local germplasm-6, Local germplasm-7, Local germplasm-8, Local germplasm-9, Local germplasm-10 and Local germplasm-11). All the germplasm lines under study has similar inflorescence compactness with the check-1 (Dr. YSRHU-Varna) and check-2 (Arka Suguna). The results of inflorescence compactness under study were same as the results of Varalakshmi *et al.* (2004) [17].

Inflorescence shape

Inflorescence shape was categorized into two variants *viz.*, erect and semi-erect. The erect type of inflorescence was observed in 25 germplasm lines (IC-561297, IC-561304, IC-561305, IC-561306, IC-561314, IC-561315, IC-561317, IC-551321, IC-613599, IC-38174, IC-551459, IC-551462, IC-551466, IC-551468, IC-551482, IC-551486, IC-551494, IC-551506, Local germplasm-1, Local germplasm-3, Local germplasm-6, Local germplasm-8, Local germplasm-9, Local germplasm-10 and Local germplasm-11) while semi-erect type of inflorescence was observed in 5 germplasm lines (IC-561327, Local germplasm-2, Local germplasm-4, Local germplasm-5 and Local germplasm-7). However, both checks *i.e.* check-1 Dr. YSRHU-Varna and check-2 Arka Suguna showed erect type of inflorescence which was comparable with 25 germplasm lines. The results of Ghrease *et al.* (2020) [5] for inflorescence shape were also in accordance with the present germplasm under study.

Inflorescence spininess

Spines on inflorescence were present in 18 germplasm lines (IC-561304, IC-561306, IC-561314, IC-561315, IC-561317, IC-551321, IC-561327, IC-613599, Local germplasm-1, Local germplasm-2, Local germplasm-3, Local germplasm-4, Local germplasm-5, Local germplasm-6, Local germplasm-7, Local germplasm-8, Local germplasm-9 and Local germplasm-11) while spines were absent in 12 lines (IC-

561297, IC-561305, IC-38174, IC-551459, IC-551462, IC-551466, IC-551468, IC-551482, IC-551486, IC-551494, IC-551506 and Local germplasm-10). Both checks *i.e.* check-1 (Dr. YSRHU-Varna) and check-2 (Arka Suguna) were showed spines on inflorescence. Similar findings for the character inflorescence spininess were reported by Varalakshmi *et al.* (2004) [17] and Labiba *et al.* (2018) [8].

Seed colour

Seed colour was caagorized into 4 variants *viz.*, black, brown, white and green. Out of 30 germplasm lines, 19 lines (IC-561297, IC-561304, IC-561305, IC-561306, IC-561314, IC-561317, IC-551321, IC-561327, IC-613599, Local germplasm-1, Local germplasm-2, Local germplasm-3, Local germplasm-4, Local germplasm-5, Local germplasm-6, Local germplasm-7, Local germplasm-8, Local germplasm-9 and Local germplasm-11) have black coloured seed, 9 lines (IC-38174, IC-551459, IC-551462, IC-551466, IC-551468, IC-551482, IC-551486, IC-551494 and IC-551506) have brown coloured seed, one line (IC-561315) have white coloured seed and one line (Local germplasm-10) have green coloured seeds. However, both checks *i.e.* check-1 Dr. YSRHU-Varna and check-2 Arka Suguna exhibited black colour of seed which was similar with 18 germplasm lines in the present study. Andini *et al.* (2012) [1] also reported similar results with respect to seed colour.

Seed shape

The results (Table-1) revealed that the seed shape was discoid in 27 germplasm lines (IC-561297, IC-561304, IC-561305, IC-561306, IC-561314, IC-551321, IC-561327, IC-613599, IC-38174, IC-551459, IC-551462, IC-551466, IC-551468, IC-551482, IC-551486, IC-551494, IC-551506, Local germplasm-1, Local germplasm-2, Local germplasm-3, Local germplasm-4, Local germplasm-5, Local germplasm-6, Local germplasm-7, Local germplasm-8, Local germplasm-9 and Local germplasm-11) which were comparable with both check varieties *i.e.* check-1 Dr. YSRHU-Varna and check-2 Arka Suguna. However, the seed shape was ellipsoid in 3 germplasm lines (IC-561317, IC-561315, Local germplasm-10). Similar findings for seed shape were reported by Wu *et al.* (2004) [18] and Labiba *et al.* (2018) [8].

Table 1: Characterization of amaranthus germplasm lines for morphological characters as per NBPGR descriptors

S. No	Accession No./ Germplasm name	Plant growth habit	Leaf colour	Stem colour	Stem surface	Inflorescence colour	Inflorescence compactness	Inflorescence shape	Inflorescence spininess	Seed colour	Seed shape
1	IC-561297	Erect	Dark green	Green	Smooth	Yellowish green	Lax	Erect	Absent	Black	Discoid
2	IC-561304	Erect	Medium green	Green	Ridged	Green	Lax	Erect	Present	Black	Discoid
3	IC-561305	Semi-spreading	Medium green	Green	Smooth	Green	Lax	Erect	Absent	Black	Discoid
4	IC-561306	Erect	Medium green	Green	Ridged	Green	Lax	Erect	Present	Black	Discoid
5	IC-561314	Erect	Medium green	Green	Smooth	Green	Lax	Erect	Present	Black	Discoid
6	IC-561315	Erect	Dark green	Red	Ridged	Red	Lax	Erect	Present	White	Ellipsoid
7	IC-561317	Erect	Dark green	Green	Smooth	Green	Lax	Erect	Present	Black	Ellipsoid
8	IC-561321	Erect	Medium green	Green	Ridged	Green	Lax	Erect	Present	Black	Discoid
9	IC-561327	Erect	Medium green	Green	Ridged	Yellowish green	Lax	Semi-erect	Present	Black	Discoid
10	IC-613599	Erect	Light green	Green	Ridged	Green	Lax	Erect	Present	Black	Discoid
11	IC-38174	Erect	Light green	Green	Smooth	Yellowish green	Lax	Erect	Absent	Brown	Discoid
12	IC-551459	Erect	Medium green	Green	Smooth	Yellowish green	Lax	Erect	Absent	Brown	Discoid
13	IC-551462	Erect	Dark green	Pink	Smooth	Green	Lax	Erect	Absent	Brown	Discoid
14	IC-551466	Erect	Medium green	Pink	Ridged	Green	Lax	Erect	Absent	Brown	Discoid
15	IC-551468	Erect	Dark green	Pink	Ridged	Green	Lax	Erect	Absent	Brown	Discoid
16	IC-551482	Erect	Medium green	Green	Ridged	Green	Lax	Erect	Absent	Brown	Discoid
17	IC-551486	Erect	Dark green	Pink	Smooth	Green	Lax	Erect	Absent	Brown	Discoid
18	IC-551494	Erect	Medium green	Pink	Smooth	Green	Lax	Erect	Absent	Brown	Discoid

19	IC-551506	Erect	Dark green	Pink	Smooth	Green	Lax	Erect	Absent	Brown	Discoid
20	Local gerplasm-1	Erect	Light green	Green	Smooth	Yellowish green	Lax	Erect	Present	Black	Discoid
21	Local gerplasm-2	Erect	Light green	Green	Smooth	Yellowish green	Lax	Semi-erect	Present	Black	Discoid
22	Local gerplasm-3	Erect	Medium green	Green	Smooth	Green	Lax	Erect	Present	Black	Discoid
23	Local gerplasm-4	Erect	Light green	Green	Smooth	Green	Lax	Semi-erect	Present	Black	Discoid
24	Local gerplasm-5	Erect	Light green	Green	Smooth	Yellowish green	Lax	Semi-erect	Present	Black	Discoid
25	Local gerplasm-6	Erect	Medium green	Green	Smooth	Yellowish green	Lax	Erect	Present	Black	Discoid
26	Local gerplasm-7	Erect	Medium green	Green	Smooth	Yellowish green	Lax	Semi-erect	Present	Black	Discoid
27	Local gerplasm-8	Erect	Red	Red	Smooth	Red	Lax	Erect	Present	Black	Discoid
28	Local gerplasm-9	Erect	Red	Red	Smooth	Red	Lax	Erect	Present	Black	Discoid
29	Local gerplasm-10	Spreading	Medium green	Green	Smooth	Green	Lax	Erect	Absent	Green	Ellipsoid
30	Local gerplasm-11	Erect	Light green	Green	Smooth	Yellowish green	Lax	Erect	Present	Black	Discoid
31	Dr. YSRHU-Varna	Erect	Red	Red	Smooth	Green	Lax	Erect	Present	Black	Discoid
32	Arka Suguna	Erect	Light green	Green	Smooth	Yellowish green	Lax	Erect	Present	Black	Discoid

Conclusions

The results on morphological characterization revealed that the wide range of variability was observed among the lines collected from different sources. Regarding plant growth habit, 28 lines have exhibited erect plant growth habit, one showed semi-spreading growth and one showed spreading type of plant growth habit. Leaf colour exhibited a wide range of variation with dark green, medium green, light green as predominant classes. Three genotypes had red leaves. Green, pink and red stem colours were noticed among the lines. For stem surface many had smooth stem surfaces with few having ridged stem surface. Green and yellowish green were the predominant classes for inflorescence colour, however red colour was also noticed in few lines. Inflorescence compactness was lax type in all the germplasm lines. Shape of the inflorescence was erect for most of the germplasm lines while few had semi-erect inflorescence. Spines present on inflorescence in majority cases, however few have smooth inflorescence. For seed colour, black and brown seed colours were predominant, however, white and green seed colours were also observed in few germplasm lines. Discoid seeds and ellipsoid seeds were noticed among the germplasm.

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