Scientific Papers. Series B, Horticulture. Vol. LXIV, No. 1, 2020
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

MAIN PHENOTYPIC EXPRESSION ON VALUABLE AMARANTHUS ACCESSIONS FROM VEGETABLE RESEARCH DEVELOPMENT STATION BUZĂU

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Abstract

Amaranthaceae family has a valuable number of over 600 species, but in Romania is not so much cultivated. The plant has multiple uses: decorative, food, medicinal and energetic, but also is a weed in the wild flora. VRDS Buzau, through Breeding and Biodiversity Laboratory, has shown more interest for this plant, realizing until now a valuable germplasm collection. In this study were selected 11 genotypes of Amaranthus from the germplasm collection. The research aimed was to study the adaptability to the pedoclimatic conditions in south of Romania and analysing the agronomic traits. The agro-morphological characters were statistically analysed and significant differences were found in the diameter of the bush, the length of the panicle, as well as the number of main branches. The genotypes had different types of the inflorescences, thus 9.1% were semi-drooping, completely drooping 36.5% and straight inflorescences 54.4%.The colour of the inflorescence also had variations from light green to dark pink. In conclusion, V.R.D.S. has a large variety of genotypes in this species and the research will continue by enriching the germplasm collection in order to obtain new cultivars.

Key words: *ANOVA, biodiversity, breeding, leafy vegetable, Romania*.

INTRODUCTION

The Amaranthaceae family comprises a number of 175 genera and over 2000 species of herbs, shrubs and small trees, mostly distribute in tropical and also in temperate regions (Rahman and Gulshana, 2014, Mrosczek, 2015). It is considered as one of the most species-rich lineage within the flowering plant in Caryophyllales order (Müller and Borsch, 2005; Simpson, 2010). The Amaranthaceae family are native to tropical and subtropical areas of Central America, Africa and Australia, whereas occur predominantly in arid to semiarid, saline, disturbed, and agricultural habitats of temperate and subtropical regions (Kedereit et al., 2003). The *Amaranthus* is a genus with multiple uses: ornamental purpose known for their multi-coloured foliage and beautiful inflorescence (*A. caudatus*, *A. tricolor*, *A. salixifolius*), or as edible plant (*A. caudatus, A. hybridus, A. spinosus, A. tricolor*), medicinal plant, also as energetic plant (Kiwicha) or as a weed in wild flora (*Amaranthus blitoides, Amaranthus retroflexus, Amaranthus albus*).

The vegetable amaranths it has been reported that vegetable amaranths have been largely ignored by the world of science (National Academy of Science, 2006). Many authors actually labelled them as „neglected crops” (Mnzava et al., 1999; Van der Walt et al., 2009, Vînătoru et al., 2019). In South Africa Amaranthus is regarded as a plant that can reduce poverty and malnutrition (Gerrano, A.S. et al., 2014).

Family Amaranthaceae has 20 times more calcium compared to spinach leaves and 7 times more iron compared to salad (Akaneme F. I. and Ani G.O., 2007).

The modern pharmacological studies showed that extracts from Amaranthaceae plants exhibited antioxidant (Nana et al., 1998; Escudero et al., 2011; Stintzing et al., 2004; Steffensen et al., 2011; Kraujalis et al., 2013), antidiabetic (Lo´pez et al., 2011; Adewale and Olorunju, 2013; Girija et al., 2011; Rahmatullah et al., 2013), tonic (Girija et al., 2011), immunostimulatory (Sun, 2006), antitumor (Sun, 2006), antibacterial (Sun, 2006), antiinflammatory (Sun, 2006; Salvador et al., 2002; Kambouche et al., 2009), anti-osteoporotis (Sun, 2006), antiulcer (Das et al., 2012), hypolipidemic (Pushpa Latha et al., 2011), diuretic (Salvador et al., 2002; Metwally et al., 2012), larvicidal (Doligalska et al., 2011), antihypertensive (Biancardi et al., 2012), hypoglycemic (Biancardi et al., 2012; Ninfali and Angelino, 2013), and analgesic (Yoshikawa et al., 1997; Sun, 2006) activity.

In Romania, first vegetable Amaranthus (*Amarantus paniculatus*) was obtained at Vegetable Research and Development Station Buzau in 2017 and it can be find under name "Cezar" in Official Catalogue of Romanian Crop Plants. The aim of this study was to assess from an agro-morphological point of view eleven genotypes of *Amaranthus* sp. in order to start a new breeding program regarding this valuable, yet not really appreciate this species.

MATERIALS AND METHODS

Vegetable Research Development Station (VRDS) Buzau, through the Breeding and Biodiversity Laboratory has shown interest for *Amaranthus* sp., realizing until now a valuable germplasm collection. From the germplasm collection were selected a number of eleven genetically stable genotypes of Amaranthus that are the subject of this work. The research aim was to study the adaptability to the pedo-climatic conditions in Romania and analysing the quantitative and qualitative descriptors. The agro-morphological characters were analysed using the ANOVA followed by the Duncan test.

The sowing was done in the first decade of March in unheated greenhouse. In the first decade of May, the seedlings were manual planted in the research plot of VRDS Buzau. The seedling distance was 70 cm between rows and 25-30 cm within the plants. During the vegetation period, mechanical and manual hoeing was done in order to loosen the soil and for weed control. No chemical treatments were made during the whole growing season.

Throughout out the growing season, biometric and phenological measurements were made. In order to make an accurate characterization of agro-morphological characters it was use the Amaranthus descriptors from the Minimal Descriptors of Agri-Horticultural Crops from the National Bureau of Plant Genetic Resources, India (Mahajan et. al, 2000) In table 1 are found the quality traits used in this study.

The quantitative characters used were: plant height (cm), bush diameter (cm), leaf length (cm), petiole length (cm), number of primary branches, length second panicle (cm), length of primary panicle (cm).

Table 1. The quality descriptors

Plant habit (PH)	1.Erect, 2.Spreading 3. Drooping, 99. Others.
Leaf colour (LC)	1.Yellow, 2. Yellowish orange, 3. Yellowish green, 4. Orange, 5. Green, 6. Greenish orange, 7. Pink, 8. Pinkish green, 9. Reddish yellow, 10. Reddish green, 11. Red, 12. Dark red, 99. Others.
Inflorescence colour (IC)	1. Light yellow, 2. Yellow, 3. Yellowish orange, 4. Yellowish green, 5. Orange, 6. Pink, 7. Pinkish green, 8. Purple, 9. Red, 10. Reddish green, 11. Green, 99.Others.
Inflorescence compactness (IC)	3. Lax, 5. Intermediate, 7. Dense, 99. Others.
Stem colour (CS)	1. Yellow, 2.Yellowish green, 3. Orange, 4. Pink, 5. Red, 6. Reddish green, 7. Reddish orange, 99. Others.
Stem surface (SS)	1. Smooth, 2. Ridged, 99. Others.
Inflorescence shape (IS)	1. Globose, 2. Semi drooping, 3. Completely drooping, 4. Straight, 99. Others.
Inflorescence spininess (IS)	1. Smooth, 2. Glabrous, 3. Prickly, 4. Spiny, 99. Others.
Seed shattering (SSH)	3. Low (%), 5. Intermediate (10-50%), 7. High (50%), 99. Others.
Seed transparency (ST)	1. Translucent, 2. Opaque, 99. Other.
Seed colour (SC)	1. White, 2. Creamish, 3. Pale yellow, 4. Pink, 5. Red, 6. Brown, 7. Black, 8. Golden, 99. Others.

RESULTS AND DISCUSSIONS

The quality traits used in this study and their descriptor values were found in Table 2. In Figures 1-7 are presented the studied accessions.

As regards the port habit it was found that nine genotypes have erect port, one genotype has drooping (A4B) port and one genotype has diffused port (A4A). Concerning leaf colour three genotypes have yellow-green colour (A6A, A7, A12), five genotypes have green leaf (A4B, A5, A6B, A9, A13) and three genotypes have red-green leaf (A1, A4A, A11).

Table 2. The quality descriptors and their value on studied accessions

Character	A 1	A 4A	A 4B	A 5	A 6A	A 6B	A 7	A 9	A 11	A 12	A 13
PH	1	3	2	1	1	1	1	1	1	1	1
LC	10	10	5	5	3	5	3	5	10	3	5
CI	9	6	6	6	9	8	6	4	8	4	11
I	5	3	3	3	5	5	5	7	7	5	5
IT	5	2	2	2	4	2	4	2	4	2	6
CT	1	2	2	2	2	2	2	2	2	2	2
IF	4	3	2	3	4	4	3	4	4	3	4
IS	4	1	1	3	3	4	3	4	4	3	3
DS	5	7	7	5	5	5	3	5	5	5	3
TT	2	2	2	2	2	2	1	2	2	1	2
SC	7	7	6	6	7	7	2	2	2	3	7

The greatest variability was recorded by the colour of the inflorescence: two genotypes were having yellow-green inflorescence (A9, A12), four genotypes were having pink inflorescence colour (A4A, A4B, A5, A7), two genotypes were having purple inflorescence (A6B, A11), two genotypes were having red colour inflorescence (A1, A6A) and one genotype was having green inflorescence (A13).

Figure 1. Crop view A13 and A4A (from left to right)

The type of inflorescences varied was dense on percentage of 18.2%, 27.3% had lax type and 54.5% had intermediate type. A wide variability can also be found in the colour of stem: six genotypes with yellow-green stem (54.5%), three genotypes having pink stem (A6A, A7, A11), one genotype having the red stem (A1) and one genotype having the red-green stalk (A13). The surface of the stem was smooth in one genotype (A1) and ten accessions with ridged surface.

Figure 2. Crop view A12 and A5 (from left to right)

Figure 3. Crop view A11 and A9 (from left to right)

The inflorescence shape recorded a maturity time was semi drooping on 9.1%, completely drooping on 36.5% accessions and straight on 54.4% accessions. Regarding spininess of inflorescence, two genotypes had a smooth surface, without pubescence (A4A, A4B), four genotypes had spiny inflorescence (A1, A6B, A9, A11) and five genotypes (A5, A6A, A7, A12, A13) had prickly surface. Seed shattering is essential for propagation of their off springs in wild types, but is a major cause of yield loss in crop, from the studied accessions, just two genotypes (A4A, A4B), had a high degree of shattering, six genotypes had intermediate degree of shattering and two genotypes had low rate of shattering (A5, A6A). The seed transparency was translucent on 18.2% and opaque on 81.8% on studied accessions. The colour of seed differed from pale yellow (A12), to creamish (A7, A9, 11), brown (A4B, A5) and black (A1, A4A, A6A, A6B, A13), as can be seen in Figure 8.

Figure 4. Crop view A6B and A7 (from left to right)

Figure 5. Crop view A1 (Cezar) and A6A (from left to right)

Figure 6. Crop view A4B

The quantitative traits were the subject to ANOVA followed by Duncan test and their results can be found in Table 3. Different letters means significant differences between studied accessions. Accession 9 had the highest height of 254 cm and it can be used as an efficient energy source plant, at the other end, the lowest height was recorded by A6 with 57.86 cm and the plant might to suitable for ornamental borders.

Table 3. Means and standard deviation of quantitative characters

Acc-ssion	**PH (cm)**	**PD (cm)**	**LL (cm)**	**PL (cm)**	**NB**	**LSP (cm)**	**LPP (cm)**
A1	*63.9+ 10.51A*	62.33+ 7.23CDE	**7.36+ 1.1 A**	*5.96+ 1.19AB*	14.3+ 1.15B	12 + 2.08 ABC	22.36+ 3.23B
A4A	137.33+ 5.21 BC	*29.66 + 4.93 A*	17.73+ 3.86 BC	6.43+ 1.2 AB	**21.7+ 6.65D**	7.83 + 3.01 ABC	39.63+ 7.05 DE
A4B	105.33+ 14.01B	53.00+ 15.39 BCDE	14.53+ 8.26 ABC	**11.33+ 6.55C**	20 + 5.29 CD	16.36+ 5.32 BCD	28.66+ 7.02 BCD
A5	113.83+ 5.61 CD	**28.66+ 3.21 A**	**19.6+ 2.47C**	7.1+ 1.21 ABC	18 + 1 BCD	17.46+ 5.25 CD	*45.16+ 4.35E*
A6A	**57.86+ 6.77A**	47 + 3.6 ABCD	11.2+ 1.73 AB	*5.53+ 1A*	7.66+ 1.52A	**35.33+ 3.21 F**	35.83+ 2.84 DE
A6B	125.96+ 18.27D	**88.33 + 7.63F**	13.56 + 1.18 ABC	**5.23 + 0.9A**	15.66+ 2.08 BC	21.73+ 7.34 DE	24.36+ 4.75 BC
A7	89.33+ 11.23B	49.33 + 8.32 ABCDE	14.16+ 2.38 ABC	*6.86+ 1.52AB*	13.3+ 4.16B	25.7+ 5.08DE	45.2+ 16.5E
A9	**254+ 20.51E**	69+ 12.12 DEF	*19.5+ 6.76C*	10.16+ 0.76 BC	4.33+ 0.57A	11.5+ 1.5ABC	27.33+ 2.51 BC
A11	*62.66+ 2.51 A*	41.66+ 13.2ABC	14.76 + 2.82 ABC	7.8 + 0.51 ABC	**2.33 + 0.57A**	6.56+ 0.92AB	**10.4+ 0.83A**
A12	90.33+ 5.68B	71.66 + 28.43EF	18.0+ 2.6BC	6.93 + 1.22 AB	15 + 1 BC	28.33+ 12.01 EF	**74.2+ 7.12F**
A13	59+ 3.6A	34.66+ 4.16 AB	12.+ 2.53 ABC	*5.5+ 2.34A*	3.33+ 0.57A	**5.43+ 0.05A**	22.1+ 0.15B

The plant diameter (PD) recorded the highest value with the accession 6B and a value of 88.33 cm, and the smallest value was recorded by A5 with 28.66 cm, followed very close by A4A with 29.66 cm. Accession A1 had the shortest leaf with a length of 7.36 cm, and the longest was recorded by A9 with a length of 19.5 cm. The petiole length varied from 11.33 cm to A4B to 5.23 to A6A.

Figure 7. Crop view A5 (detail)

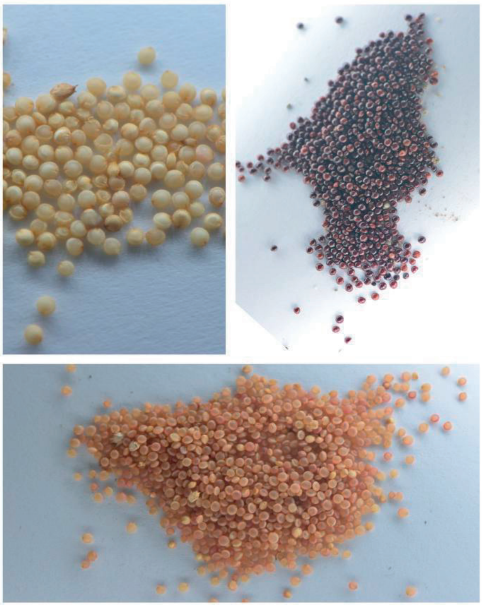

Figure 8. Seed types of Amaranthus

The number of main branches per plant varied from 21.7 registered by A4A to 2.33 branches recorded by A11. The lateral spikelet length had great variations from 5.43 cm to A13 from 35.33 cm to A6A. The length of inflorescences had also a great variation from 10.46 cm on A11 to 74.23 cm to A12.

CONCLUSIONS

Significant differences were found in the diameter of the bush, the length of the panicle, as well as the number of main branches. The genotypes had different forms of the inflorescences, thus 9.1% were semi-flowing, flowing 36.5% and straight inflorescences 54.4%. The colour of the inflorescence also had variations, from yellow to green (18.2%), to pink (36.4%), purple (18.2%), green (9.1%) and red (18.2%). In conclusion, VRDS Buzau has a large variety of genotypes in this species and the research will continue by enriching the germplasm collection and also due to the breeding program obtaining of new cultivars suitable for growing in pedoclimatic conditions of Romania.

ACKNOWLEDGEMENTS

The work was supported by a grant of the Romanian Ministry of Research and Innovation, CCCDI - UEFISCDI, project number PN-III-P1-1.2-PCCDI-2017-0850/ contract 14 PCCDI/2018, within PNCDI III.

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