

**RESEARCH ON *AMARANTHUS CRUENTUS* L. AND *AMARANTHUS HYPOCHONDRIACUS* L. SPECIES GROWN IN SOUTH-EASTERN ROMANIA (*MOARA DOMNEASCĂ – ILFOV*)**

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**Abstract**

*The Amaranthus species have been grown for food and non-food purposes for at least 5,000 years; in 1967, Calen called Amaranthus “The first grain of the New World”.*

*This paper presents the results obtained under the growing conditions provided by the Didactic Farm of Moara Domnească – Ilfov. Research includes 12 varieties of species *A. cruentus* and *A. hypochondriacus*. Between 2008 and 2010, the average fresh biomass production was 332.38 q/ha for a density of 70,000 plants/ha and 390.82 q/ha for a density of 100,000 plants/ha whereas seed production was 36.533 q/ha for the first density and 40.235 q/ha for the second.*

**INTRODUCTION**

Given the global climate change, Romanian climate is characterized by increasing average temperatures, low amount and uneven distribution of rainfalls, and an increasing frequency of extreme climatic events.

Consequently, in order to provide food resources, it has become paramount to diversify the crops that can respond favourably to different ecological conditions.

Some plant species that were grown for food thousands of years ago (*Amaranthus*, *Quinoa*, *Buckeat*, etc.) have become important again for the agro-food production and non-food sectors (biomass, biofuels, natural dyes, medicines, etc.), [4].

Among the alternative crops, *Amaranthus* is a very well represented plant of high genetic and specific diversity, and is grown for food (as a pseudocereal plant), feeding and ornamental purposes.

The genus *Amaranthus* includes a large number of species (over 60) that are spread worldwide in the temperate, subtropical and tropical areas.

The *Amaranthus* genus has three species that are important to agricultural production (pseudocereals): *Amaranthus caudatus* L., *Amaranthus hypochondriacus* L. and *Amaranthus cruentus* L.

The interest in these species results from their seed quality, comparable and even superior to cereals owing to their high content in carbohydrates, proteins, fats, fibers and essential aminoacids [3, 7, 8].

## MATERIAL AND METHODS

Research was performed within the PN-II-Project No. 51-018/2007-2010, and was carried out in three pedoclimatic areas in Romania (Ilfov, Cluj-Napoca, Călărași).

This paper includes the results achieved during 2008-2010 by the project coordinator UASVM Bucharest under the growing conditions provided by the Didactic Farm of Moara Domnească – Ilfov.

The material analyzed consisted of 12 varieties belonging to the species *A. cruentus* (V<sub>1</sub>-Alegria, V<sub>2</sub>-Amont, V<sub>7</sub>-Chihuahuan, V<sub>9</sub>-MT3) and *A. hypochondriacus* (V<sub>3</sub>-Plaisman, V<sub>4</sub>-Golden, V<sub>5</sub>-Mercado, V<sub>6</sub>-Hopi Red Dye, V<sub>8</sub>-Opopeo, V<sub>10</sub>-Plenitude, V<sub>11</sub>-Intense purple, V<sub>12</sub>- Burgundy).

Soil type: reddish preluvosoil.

Pre-emergent plant: wheat.

Tillage consisted of summer plowing at 18-20 cm, autumn disc harrowing, spring preparation of the germination bed by using the pre-sowing combinator and three hoeings during the vegetation season.

Fertilization by N:P complex fertilizers in rates of 70 kg a.s./ha each, applied during the preparation of the germination bed.

Sowing was performed at a depth of 1 cm between 25<sup>th</sup> April and 3<sup>rd</sup> May, depending on the crop year.

Crop harvest was performed according to variants and repetitions at the end of September.

## RESULTS AND DISCUSSION

The climatic conditions recorded at the Moara Domnească area between 2008 and 2010 are characterized by deviations from the typical average multiannual values of the area (table 1).

Between 2008 and 2009, the average temperature during the vegetation period of the *Amaranthus* plants (May-September) was 20.86°C, exceeding the normal thermal values by 1.24°C. Within the same time length, the average amount of rainfalls was 259 mm, i.e. 42.6 mm under the multiannual values.

The analysis of the data regarding the development of the *Amaranthus* plants (table 2) shows a rapid growth towards the middle of the vegetation period (July-August).

The growth stages recorded differences of up to 7 days between the varieties under analysis. However, plant maturation was uniform within each variety.

Table 1

## Climatic conditions of Moara Domnească (2008-2009)

Month	Average temperature (°C)				Rainfalls (mm)			
	2008	2009	2010	Normal	2008	2009	2010	Normal
X	12.3	13.0	12.1	11.0	5.1	32.8	33.8	35.8
XI	5.1	5.7	9.8	5.3	8.8	35.8	10.8	40.6
XII	2.8	2.3	0.8	0.4	4.2	29.4	46.6	36.7
I	-2.4	-0.4	-3.2	-3.0	31.2	58.6	34.6	30.0
II	3.2	2.6	0.7	-0.9	0.5	20.4	31.4	32.1
III	8.8	6.3	5.5	4.4	16.4	26.4	31.2	31.6
IV	13.3	12.0	12.3	11.2	63.2	5.4	29.8	48.1
V	<b>17.4</b>	<b>17.8</b>	<b>17.3</b>	<b>16.5</b>	<b>44.6</b>	<b>44.2</b>	<b>49.6</b>	<b>67.7</b>
VI	<b>22.1</b>	<b>21.6</b>	<b>21.6</b>	<b>20.3</b>	<b>29.0</b>	<b>96.2</b>	<b>67.4</b>	<b>86.7</b>
VII	<b>22.4</b>	<b>23.7</b>	<b>23.3</b>	<b>22.1</b>	<b>52.4</b>	<b>163.2</b>	<b>58.4</b>	<b>63.1</b>
VIII	<b>21.5</b>	<b>23.1</b>	<b>25.8</b>	<b>21.7</b>	<b>8.4</b>	<b>22.4</b>	<b>27.6</b>	<b>50.5</b>
IX	<b>17.8</b>	<b>18.6</b>	<b>18.9</b>	<b>17.5</b>	<b>63.2</b>	<b>31.4</b>	<b>21.8</b>	<b>33.6</b>
Average (°C)	12.0	12.2	11.98	10.5	327.0	566.4	443.0	556.1
Sum (mm)								

Table 2

Vegetative development of *Amaranthus* plants under the conditions of Moara Domnească (average 2008-2010)

Date of measurements	30 May	15 June	30 June	15 July	30 July	15 August	30 August
Plant height (cm)	8-12	21-24	34-58	68-112	76-130	81-167	85-196
No. of leaves/ plant	7-12	12-16	18-23	24-30	27-34	28-37	28-39
Fresh biomass g/plant	30-39	72-186	110-225	140-288	202-367	288-564	391-475
Occurrence time of inflorescences:	26 June-4 July						
Flowering time:	1-10 July						
Flowerinf time length:	1-25 July						
Harvest time:	24 -29 September						

On an average for the 2008-2010 period, **green biomass production** (table 3) resulted from the *Amaranthus* varieties was 332.38 q/ha for a density of 70,000 plants/ha (D<sub>1</sub>), and 390.82 q/ha for a density of 100,000 plants/ha (D<sub>2</sub>). The highest production achieved was 467.31 q/ha, recorded in the *Amaranthus cruentus* species - MT 3 variety in D<sub>2</sub>.

**Seed production** (table 4) in D<sub>1</sub> varied between 28.289 q/ha in V<sub>11</sub> - Intense purple and 42.804 q/ha in V<sub>7</sub>-Chihuahuan while the average production for the 12 varieties was 36.533 q/ha. In a density of 100,000 pl/ha (D<sub>2</sub>), the average production was 40.235 q/ha while the highest was 46.088 q/ha in V<sub>7</sub> - Chihuahuan belonging to the *A. cruentus* species.

Table 3

***Amaranthus* biomass production depending on variety and density, average for 2008-2010**

Plants density/ha	Varieties	Green biomass (q/ha)	%	Difference (q/ha)
70,000 (D <sub>1</sub> )	Average V <sub>1</sub> -V <sub>12</sub>	332.38	100	Control
	V <sub>1</sub> -Alegria	330.34	99.4	-2.04
	V <sub>2</sub> -Amont	353.64	106.4	21.26
	V <sub>3</sub> -Plaisman	283.64	86	-48.74
	V <sub>4</sub> -Golden	358.23	107.8	25.85
	V <sub>5</sub> -Mercado	222.42	66.9	-109.96
	V <sub>6</sub> -Hopi Red Dye	358.51	107.9	26.13
	V <sub>7</sub> -Chihuahuan	377.45	113.6	45.07
	V <sub>8</sub> -Opopeo	375.18	112.9	42.80
	V <sub>9</sub> -MT3	381.01	114.6	48.63
	V <sub>10</sub> -Plenitude	311.19	93.6	-21.19
	V <sub>11</sub> - Intense purple	310.67	93.5	-21.71
	V <sub>12</sub> - Burgundy	324.25	97.6	-8.13
100,000 (D <sub>2</sub> )	Average V <sub>1</sub> -V <sub>12</sub>	390.82	100	Control
	V <sub>1</sub> -Alegria	341.52	87.4	-49.30
	V <sub>2</sub> -Amont	399.24	102.2	8.42
	V <sub>3</sub> -Plaisman	350.90	89.8	-39.92
	V <sub>4</sub> -Golden	415.62	106.3	24.80
	V <sub>5</sub> -Mercado	271.68	69.5	-119.14
	V <sub>6</sub> -Hopi Red Dye	431.09	110.3	40.27
	V <sub>7</sub> -Chihuahuan	427.17	109.3	36.35
	V <sub>8</sub> -Opopeo	432.08	110.5	41.26
	V <sub>9</sub> -MT3	467.31	119.6	76.49
	V <sub>10</sub> -Plenitude	408.58	104.5	17.76
	V <sub>11</sub> - Intense purple	362.74	92.8	-28.08
	V <sub>12</sub> - Burgundy	378.85	96.9	-11.97
DL 5%=20.64 q/ha; DL 1%=29.79 q/ha; DL 0.1%=36.50 q/ha				

The analysis of the climate conditions during the experimental period, in relation with the production achieved, shows that, for each 1 mm of rainfalls during the vegetation period, the *Amaranthus* plants recorded an average green biomass production of 1.283 q/ha/mm in D<sub>1</sub> and 1.509 q/ha/mm in D<sub>2</sub>, while seed production was 0.141 q/ha/mm in D<sub>1</sub> and 0.155 q/ha/mm in D<sub>2</sub>.

**Table 4**

***Amaranthus* seed production depending on variety and density, average for 2008-2010**

Plants density/ha	Varieties	Seed production (q/ha)	%	Difference (q/ha)
70,000 (D <sub>1</sub> )	Average V <sub>1</sub> -V <sub>12</sub>	36.533	100	Control
	V <sub>1</sub> -Alegria	40.458	110.8	3.925
	V <sub>2</sub> -Amont	38.877	106.4	2.344
	V <sub>3</sub> -Plaisman	31.914	87.4	-4.619
	V <sub>4</sub> -Golden	35.015	95.8	-1.518
	V <sub>5</sub> -Mercado	28.538	78.1	-7.995
	V <sub>6</sub> -Hopi Red Dye	35.408	96.9	-1.125
	V <sub>7</sub> -Chihuahuan	42.804	117.2	6.271
	V <sub>8</sub> -Opopeo	38.841	103.3	2.308
	V <sub>9</sub> -MT3	39.082	107	2.549
	V <sub>10</sub> -Plenitude	41.499	113.6	4.966
	V <sub>11</sub> - Intense purple	28.289	77.4	-8.244
	V <sub>12</sub> - Burgundy	38.647	105.8	2.114
100,000 (D <sub>2</sub> )	Average V <sub>1</sub> -V <sub>12</sub>	40.235	100	Control
	V <sub>1</sub> -Alegria	43.769	108.8	3.534
	V <sub>2</sub> -Amont	41.477	103.1	1.242
	V <sub>3</sub> -Plaisman	35.075	87.2	-5.160
	V <sub>4</sub> -Golden	39.506	98.2	-7.290
	V <sub>5</sub> -Mercado	32.276	80.2	-7.959
	V <sub>6</sub> -Hopi Red Dye	38.886	96.6	-1.349
	V <sub>7</sub> -Chihuahuan	46.088	114.5	5.853
	V <sub>8</sub> -Opopeo	43.367	107.7	3.132
	V <sub>9</sub> -MT3	42.321	105.2	2.086
	V <sub>10</sub> -Plenitude	45.763	113.7	5.528
	V <sub>11</sub> - Intense purple	31.222	75.6	-9.013
	V <sub>12</sub> - Burgundy	43.078	107.1	2.843
DL 5%=1.99 q/ha; DL 1%=2.85 q/ha; DL 0.1%=4.05 q/ha				

**CONCLUSIONS**

1. Green biomass production was higher in D<sub>2</sub>, with an average of 390.82 q/ha and the highest production of 467.731 q/ha in V<sub>9</sub>-MT3.
2. Seed production recorded an average of 36.533 q/ha for a density of 70,000 plants/ha, and 40.235 q/ha for a density of 100,000 plants/ha.
3. Between 2008 and 2010, out of the 12 *Amaranthus* varieties studied, 7 recorded seed productions over 40 q/ha in D<sub>2</sub> (4 varieties belonging to *A. cruentus* L. and 3 varieties of *A. hypochondriacus* L.).

4. To achieve a high productions, both of seeds and green biomass, the best density was 100,000 plants/ha.
5. The results of the research on the *Amaranthus cruentus* and *Amaranthus hypochondriacus* species show their high adaptability to the ecological conditions of south-eastern Romania. Therefore, these species are highly recommended for agricultural production in the respective area.



**Fig. 1. Photographs taken at Moara Domnească - Experimental Field**

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