

## RESEARCH ON *CYNARA CARDUNCULUS* L. SPECIES UNDER THE CONDITIONS OF SOUTHEASTERN ROMANIA AREA

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### Abstract

*Cynara cardunculus* L. (cardon) is an alternative crop with multiple use (energy biomass, oil extraction, pharmaceuticals, food, honey plant, and others). Research conducted on three varieties of *Cynara cardunculus* L. (Gobbo di Nizza, C 816, Porto spineless) grown under the climatic conditions of Moara Domneasca Didactic Farm in 2012, shows the good ecological adaptability of the plant. By the end of the growing season (November), the average biomass production was 40,554.1 kg/ha<sup>-1</sup> fresh matter and 7,192.0 kg/ha<sup>-1</sup> dry matter, the maximum biomass production was recorded in the variety Porto Spineless (46,600.8 kg/ha<sup>-1</sup> fresh matter, and 7,636.4 kg/ha<sup>-1</sup> dry matter).

**Key words:** alternative crop, *Cynara cardunculus* L., dry matter, fresh matter.

### INTRODUCTION

*Cynara Cardunculus* L. (cardon) is a perennial herbaceous plant of Mediterranean origin (Franco, 1984), with a period of about 10 years of life (Archontoulis et al., 2009). It grows naturally in Europe, North Africa and South America (Gominho, 2001), generally in areas that are characterized by less favorable conditions like: high temperatures in summer, water deficit, thin, rocky and poorly productive soils (Abeliotis et al., 2009).

The interest in growing this species interferes with the increasing development of concepts related to the need to protect the environment, primarily through the increased production of renewable energy. Considering the high performance of the overall biomass production, especially in the Mediterranean climate area (Fernández and Manzanares, 1990, Fernandez et al., 2006; Archontoulis et al., 2009; Angelini et al., 2009), and the rich oil seed production, *Cynara cardunculus* L. is a plant of interest as feedstock for biofuels and bioenergy (Sengo et al., 2010).

Biomass production can vary between 14 and 20 t/ha<sup>-1</sup> in the first year of vegetation, and 30-35 year t/ha<sup>-1</sup> in the second year of vegetation Dalianis et al., 1996, Fernandez 1998, Gherbin and col., 2001, Mantineo et al., 2009).

The vegetation period of the species *Cynara cardunculus* L. comprises nine main stages of growth and development, subdivided into secondary growth stages. Growth begins with seed germination (first year) or sprouting / bud development (in the second year and the following years of vegetation) - stage 0, and ends with the installation of senescence - stage 9 (Archontoulis et al., 2009). Characteristic for the cycle of vegetation of *Cynara cardunculus* is that several growth stages overlap or take place simultaneously; thus, the phenological description takes into account either the code for more advanced stages or both stages are indicated separately (Archontoulis et al., 2009).

### MATERIALS AND METHODS

Research was conducted on the reddish preluvosoil of the Moara Domneasca Didactic Farm belonging to the University of Agronomic Sciences and Veterinary Medicine of Bucharest (44°29'33" N, 26°15'20" E).

The field was organized by the method of subdivided lots in three replications. Three cultivars of the *Cynara cardunculus* L. were analyzed:

V<sub>1</sub> - Gobbo di Nizza

V<sub>2</sub> - *Cynara cardunculus* C 816

V<sub>3</sub> - Porto spineless

Research was also aimed at observing the influence of the fertilization type (unfertilized, fertilized with chemical fertilizers, organic fertilizers).

Dynamic biometric measurements were made during the growing season. Production results were analyzed, both as fresh matter (FM) and as production of dry matter (DM).

Sowing was carried out with the seed drill SPC-6 on 10 April 2012, at a density of 40,000 seeds/ha, with 70 cm in spacing and 4 cm in depth. Under laboratory conditions, seeds had a germination of 94% for the C 816 and Porto spineless varieties and 97% for the Gobbo di Nizza variety.

During the vegetation season of *Cynara cardunculus* L. plants (April-November), the climatic conditions of 2012 were characterized by an average temperature of 19.28°C and a total rainfalls amount of 342.2 mm. Temperature was 2.09°C higher than the average temperature of the area and rainfalls 43.3 mm lower than the multi annual average for this period.

Table 1. Climatic conditions during April-October 2012 - Weather Station - Afumați

Month	Temperature (t°C)		Rainfalls (mm)	
	2012	Normal	2012	Normal
April	14.1	11.2	32.4	48.1
May	18	16.5	180.6	67.7
June	22.9	20.3	14.2	86.7
July	27.0	22.1	9.2	63.1
August	24.4	21.7	47.0	50.5
September	19.4	17.5	42.2	33.6
October	13.7	17.5	16.6	35.8
Average(t°C) / Sum (mm)	19.28	17.19	342.2	385.5

## RESULTS AND DISCUSSIONS

Results of the research conducted on *Cynara cardunculus* L. species in 2012, the first year of life, showing the following aspects:

*The sprouting degree of Cynara cardunculus L. seeds.*

The data presented in Table 2 shows that there are differences between the three *Cynara cardunculus* L. cultivars in their power of germination under field conditions. 63.1% of the sown seeds sprung in the variety Porto Spinelles, 66.45% in C 816, and 68.8% in Gobbo di Nizza.

Table 2. Sprouting degree of *Cynara cardunculus* L. seeds

Variety	Density		%
	No Seed ha <sup>-1</sup> 04/10/2012	Plants sprung No ha <sup>-1</sup> 05/15/2012	
V <sub>1</sub>	40,000	27,531	68.8
V <sub>2</sub>	40,000	26,580	66.5
V <sub>3</sub>	40,000	25,236	63.1
Average	40,000	26,449	66.1

V<sub>1</sub> - Gobbo di Nizza; V<sub>2</sub> - C 816; V<sub>3</sub> - Porto spineless.

*Crop plants development and biomass production.*

The data in Table 3 regarding the development stage of *Cynara cardunculus* L. plants on 07/14/2012, shows that their height ranged from 22.63 cm in V<sub>1</sub> (Gobbo di Nizza) to 25.15 cm in V<sub>3</sub> (Porto spineless). The number of leaves per plant varied between 8.4 and 10.3, and leaf length recorded a minimum in the Gobbo di Nizza variety and a maximum in C 816.

The fresh matter production of *Cynara cardunculus* L. plants in the first year of life, as seen in the determinations made in September (Table 4) ranged from 923.5 g/plant in the Gobbo di Nizza variety to 1,333.0 g/plant in Porto spineless, which means an addition of 22.4% to the average production of the three varieties. Fresh matter production per hectare (Table 5) varied between 25,419.3 kg.ha<sup>-1</sup> in V<sub>1</sub> (Gobbo di Nizza), i.e. 88.7% of the average yield for the three varieties, and 3,3647.2 kg.ha<sup>-1</sup> at V<sub>3</sub> (Porto spineless), i.e. 117.4% of the average of for three varieties.

In November 2012, the fresh matter and dry matter production of a plant (Table 6) ranged between 1,327.3 g/plant in V<sub>1</sub> (Gobbo di Nizza) and 1,846.8 g/plant in V<sub>3</sub> (Porto spineless). The highest dry matter content was registered in the Gobbo di Nizza variety (17.4% in leaves and 28.3% in root).

The average biomass production per ha (Table 7) was 40,554.1 kg.ha<sup>-1</sup>, the maximum being recorded in V<sub>3</sub> - 46,600.8 kg.ha<sup>-1</sup>. This variety also developed a maximum foliar biomass of 41,033.7 kg.ha<sup>-1</sup>. The maximum root recorded was 6,036.3 kg.ha<sup>-1</sup> in the variety C 816.

Table 3. Development of crop plants on July 14, 2012

Variety	Plants height (cm)	%	Leaf number plant	%	Leaf length min-max (cm)	%
V <sub>1</sub> - Gobbo di Nizza	22.63	95.5	9.3	100	17.1 - 52.5	91 - 98
V <sub>2</sub> - C 816	23.30	98.3	8.4	90.3	18.5 - 55.9	99 - 104.3
V <sub>3</sub> - Porto spineless	25.15	106.1	10.3	110.7	20.5 - 52.5	109.6 - 98
Average	23.70	100	9.3	100	18.7 - 53.6	100

Table 4. Fresh matter production (g/plant) of *Cynara cardunculus* L. on September 15, 2012

Variety	Total biomass (TB) g/pl	%	Leafes biomass (LB) g/pl	%	Root biomass (RB) g/pl	%
V <sub>1</sub>	923.5	84.8	798.6	84.9	124.7	83.9
V <sub>2</sub>	1,012.0	92.9	864.2	91.9	147.8	99.4
V <sub>3</sub>	1,333.0	122.4	1,159.7	123.3	173.6	116.7
Average	1,089.6	100	940.8	100	148.7	100

V<sub>1</sub> - Gobbo di Nizza; V<sub>2</sub> - C 816; V<sub>3</sub> - Porto spineless

Table 5. Fresh matter production (kg/ha-1) of *Cynara cardunculus* L. on September 15, 2012

Variety	Total biomass (TB) kg/ha <sup>-1</sup>	%	Leafes biomass (LB) kg/ha <sup>-1</sup>	%	Root biomass (RB) kg/ha <sup>-1</sup>	%
V <sub>1</sub>	25,419.3	88.7	21,986.2	88.9	3,433.1	87.7
V <sub>2</sub>	26,898.9	93.9	22,970.4	92.84	3,928.5	100.4
V <sub>3</sub>	33,647.2	117.4	29,266.2	118.3	4,381.0	112
Average	28,655.0	100	24,740.9	100	3,914.2	100

V<sub>1</sub> - Gobbo di Nizza; V<sub>2</sub> - C 816; V<sub>3</sub> - Porto spineless

Table 6. Fresh matter and dry matter in plant of *Cynara cardunculus* L. on November 15, 2012

Variety	Total Biomass (TB) g/pl	%	Leaf Biomass (LB) g/pl	%	Dry Matter %	%	Root Biomass (RB) g/pl	%	Dry Matter %	%
V <sub>1</sub>	1,327.3	86.1	1,153.4	86.8	17.4	106.5	173.9	84	28.3	103
V <sub>2</sub>	1,449.2	94	1,222.1	91.6	16.5	101	227.1	109.6	28.2	102.7
V <sub>3</sub>	1,846.6	119.8	1,626.0	122	15.1	92.5	220.6	106.5	25.9	94.3
Average	1,541.0	100	1,333.8	100	16.3	100	207.2	100	27.5	100

V<sub>1</sub> - Gobbo di Nizza; V<sub>2</sub> - C 816; V<sub>3</sub> - Porto spineless

Table 7. Fresh matter production (FM kg. ha<sup>-1</sup>), on November 15, 2012

Variety	Total Biomass (TB) kg/ha <sup>-1</sup>	%	Leafs Biomass (LB) kg/ha <sup>-1</sup>	%	Root Biomass (RB) kg/ha <sup>-1</sup>	%
V <sub>1</sub>	36,541.8	90.1	31,754.2	90.5	4,787.6	87.6
V <sub>2</sub>	38,519.7	94.98	32,483.4	92.57	6,036.3	110.5
V <sub>3</sub>	46,600.8	114.9	41,033.7	116.93	5,567.1	101.9
Average	40,554.1	100	35,090.4	100	5,463.7	100
LSD 5%=3,320 LSD 1%=5,959.4 LSD 0.1%= 7,162.5 kg TB/ha <sup>-1</sup>						

V<sub>1</sub> - Gobo di Nizza; V<sub>2</sub> - C 816; V<sub>3</sub> - Porto spineless

Table 8. Dry matter production per plant of *Cynara cardunculus* L. on November 15, 2012

Variety	Total Biomass (TB) g/pl	%	Leafs Biomass (LB) g/pl	%	Root Biomass (RB) g/pl	%
V <sub>1</sub>	249.9	91.6	200.7	93	49.21	86.6
V <sub>2</sub>	265.6	97.4	201.6	92.7	64.04	113
V <sub>3</sub>	302.6	111	245.5	113.7	57.14	101.8
Average	272.7	100	215.9	100	56.8	100
LSD 5%= 23.5 LSD 1%= 37.2 LSD 0.1%= 43.9 g TB/pl						

V<sub>1</sub> - Gobbo di Nizza; V<sub>2</sub> - C 816; V<sub>3</sub> - Porto spineless

Dry matter production per plant in November (Table 8) shows the average of the three varieties was 272.7 g/plant.

Leaves accumulated 215.9 DM g/plant and roots 56.8 DM g/plant on average.

Dry matter production per hectare (Table 9) was 7,192.0 kg. ha<sup>-1</sup> on average and the lowest amount of dry matter was registered in V<sub>1</sub>, i.e. 6,880.0 DM kg. ha<sup>-1</sup> while the highest amount, 7,636.4 DM kg. ha<sup>-1</sup> was recorded in V<sub>3</sub>.

Table 9. Dry matter production (DM kg. ha<sup>-1</sup>) on November 15, 2012

Variety	Total Biomass (TB) kg/ha <sup>-1</sup>	%	Leaf Biomass (LB) kg/ha <sup>-1</sup>	%	Root Biomass (RB) kg/ha <sup>-1</sup>	%
V <sub>1</sub>	6,880.0	95.66	5,525.5	97.1	1,354.5	90.3
V <sub>2</sub>	7,059.6	98.16	5,358.5	94.1	1,701.1	113.5
V <sub>3</sub>	7,636.4	106.2	6,195.4	108.8	1,441.0	96.1
Average	7,192.0	100	5,693.1	100	1,498.9	100
LSD 5%=465.2 LSD 1%= 796.3 LSD 0.1%= 1,022.6 kg TB/ha <sup>-1</sup>						

V<sub>1</sub> - Gobbo di Nizza; V<sub>2</sub> - C 816; V<sub>3</sub> - Porto spineless

Leaf production of dry matter per hectare was 5,693.1 kg ha<sup>-1</sup> and root biomass 1,498.9 kg ha<sup>-1</sup> on average, with the highest production recorded in the variety C 816 (1,701.1 kg ha<sup>-1</sup>).



Figure 1. *Cynara cardunculus* L. on 15 November, 2012 - Moara Domnească Experimental Field (original photo)



Figure 2. *Cynara cardunculus* L. root on November 15, 2012 – Moara Domnească Experimental Field (original photo)

## CONCLUSIONS

Results of the research conducted in 2012 on the *Cynara cardunculus* L. species show the following:

- Seed germination was 66.1% on average, this aspect is important for seeding density determination.
- Plant development was generally good, accumulating a significant amount of biomass even in a year with water deficit, which shows the good adaptability of the species to different ecological conditions.
- The maximum level of biomass at the end of the growing season was achieved at Porto spineless variety (46,600.8 FM kg ha<sup>-1</sup> and 7,636.4 DM kg ha<sup>-1</sup>).

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