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Camelina sativa as a double crop using the minimal tillage system

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Abstract

*Camelina sativa was cultivated as a second crop, after the main crop represented by triticale. To reduce energy consumption, the minimum tillage system (i.e. without ploughing) was used. The camelina sowing was done on 22 July 2013. The cultivar tested was 'Calena', originating from Austria. Two seed rates were tested, 6 kg/ha and 8 kg/ha, respectively. After sowing, on half of the trials asprinkler irrigation was applied. In order to have low production cost, no fertilizers were applied. The climatic conditions were monitored (temperature and precipitation) during the experiment. It should be noted that camelina crop faced a droughty period and high temperatures in the first two months. This study shows that the yield potential of the irrigated trials was considerably higher (*1104.3 -1203 *kg/ha) in comparison with non-irrigated trials (*494.2 - 800.5 *kg/ha) characterized by the fact that emergence lacked uniformity. Also it has been concluded that the sowing must be done in the late June- early July and watering is mandatory after camelina sowing in order to stimulate plant emergence.*

Keywords: second crop, minimum tillage, irrigated trials, yield potential

Introduction

Camelina (*Camelina sativa* L. Crantz) is an annual plant member of the *Brassicaceae* family (PUTNAM & al. [1],; ZUBR [2]), native to the south-eastern Europe and the south-western Asian steppe region (ZOHARY & HOPF [3], EYNCK & al. [4]). The oil content of camelina seeds is about 40% (PUTNAM & al. [1], GUGEL & FALK [5], HUNSAKER & al. [6]) and it is rich in polyunsaturated fatty acids (MOSER [7], IMBREA & al. [8], TONCEA & al. [9]). Camelina has recently been studied for sustainable biofuel production (FRÖHLICH & RICE [10], SHONNARD & al. [11], HENDRICKS & al. [12], BLACKSHAW & al. [13]). One of the main advantages of camelina crop is its low production cost (MOSER [7], FRÖHLICH & RICE [10], PAVLISTA & al. [14]). This plant is not a demanding one, and its cultivation technology is being under research.

Camelina can be successfully cultivated in late autumn (GESCH & ARCHER [15]) and spring (PAVLISTA & al. [14], BERTI & al. [16]). From our knowledge, no research has been done regarding camelina as a second crop sown in summer.

The aim of this paper is to provide an in-depth view of the technology and methods used in cultivating camelina as a second crop in Romania in order to maximize economic benefits by using the same field effectively. Being a short-season crop (85-100 days) *Camelina sativa* is being tested in order to be introduced in double cropping after harvesting the main crop.

To reduce energy consumption, we have chosen the ”minimum tillage” soil work, i.e. no ploughing.

Material and methods

The experiment took place in 2013 at Moara Domneasca, Ilfov county (17 km from Bucharest). The didactic farm Moara Domneasca belongs to SDE Belciugatele - University of Agronomic Sciences and Veterinary Medicine of Bucharest. The soil type is reddish preluvosoil, having loam-clay texture.

The previous crop was triticale, which was sown in the autumn of 2012. Its harvesting was delayed by high amounts of precipitation recorded in the early summer of 2013. Consequently, camelina sowing was delayed by 20 days. Triticale harvesting was done by means of a combine equipped with a straw cutter. However, it was necessary to remove the vegetal remains from the field tested because they hindered camelina sowing. A combinator was used for this work.

On 22 July 2013 the soil tillage took place after vegetal remains removal, and consisted in two passes done with a disc harrow GDU-3,2 (the first pass was done following the direction of the rows from the previous crop, and the second one was done diagonally). Where necessary, a disc harrowing was additionally carried out. Once these soil works were completed, the field was ready for sowing (see **Fig. 1**).

Fig.1 Field prepared for camelina sowing, 22 July 2013.

Camelina sowing was done on the same day as the preparation of the field in order to prevent water losses. The work was performed using an SC-21 DD sowing machine, equipped with double feed devices. A rolling was done once the sowing ended. The cultivar tested was ’Calena’, originating from Austria. Two seed rates were tested, 6 kg/ha and 8 kg/ha, respectively. The row distance was of 12.5 cm, and the sowing depth was of 1.5 – 2 cm.

During the first week after sowing on half of the trials a sprinkler irrigation was applied. The quantity of water used was of 140 m^3/ha. No fertilizer was applied. A herbicide was used during flowering in order to prevent the development of monocot weeds (especially *Setaria viridis*).The work was carried out using ground equipment. The herbicide sprayed was Panther 0.5 l/ha. The quantity of herbicide was lower than the one recommended for rapeseed in order not to affect camelina crop. No diseases and pests were noticed (**see Fig. 2**).

The measurements were done in the field, when the plants started to reach maturity. The plants were randomly chosen from each replicate. The final results represent the average of the measured values.

The following formula was used for yield potential:

Potential yield = (plant density per sq.m.* number of silicules per plant* number of seed per silicula* 1000 grain mass) /100

Climatic conditions were recorded by the Weather Station located in Moara Domneasca.

Fig. 2 *Camelina sativa* during flowering - irrigated trial

Results and discussions

The phenological growth stages of *Camelina sativa* were described by MARTINELLI & GALASSO [17] using the extended BBCH scale.

After monitoring the phonological growth stages of Camelina sativa, the results obtained are the following:

- The period between sowing and emergence was of 8 – 9 days (22.07 – 30.07.2013) in the case of irrigated trials, and of 11 – 12 days in the case of the non-irrigated ones. The emergence lacked uniformity because of the very high temperatures recorded in the emergence period.
- The period between the cotyledon stage and the two-leaf stage lasted 9 – 11 days (30.07- 08.08.2013);
- The period between the two-leaf stage and the 5- or 6-leaf stage lasted 14 – 16 days;
- The stem elongation stage lasted 15 – 16 days;
- The inflorescence emergence and the flowering stage lasted 10 – 12 days;
- The silicules development lasted 12 – 14 days**;**

The low temperatures recorded in early October and the precipitation and clouds prevented the silicula ripening. The graphs below (**Fig. 3, Fig. 4**) show the quantity of precipitation and the temperature recorded from sowing to plant silicules development.

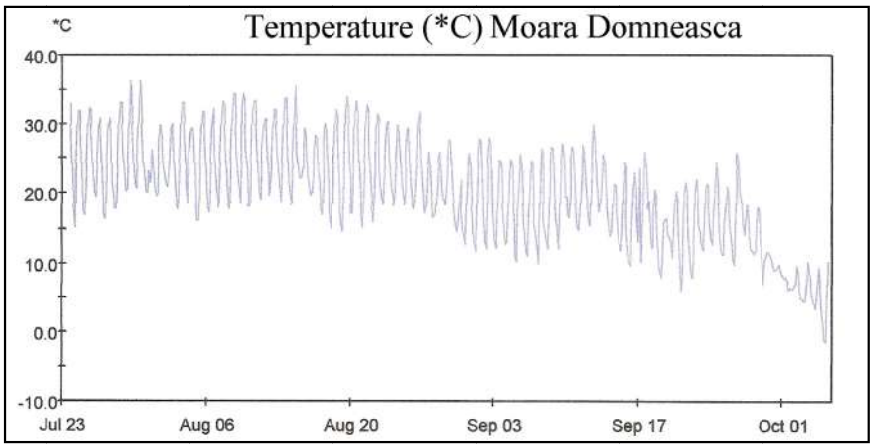
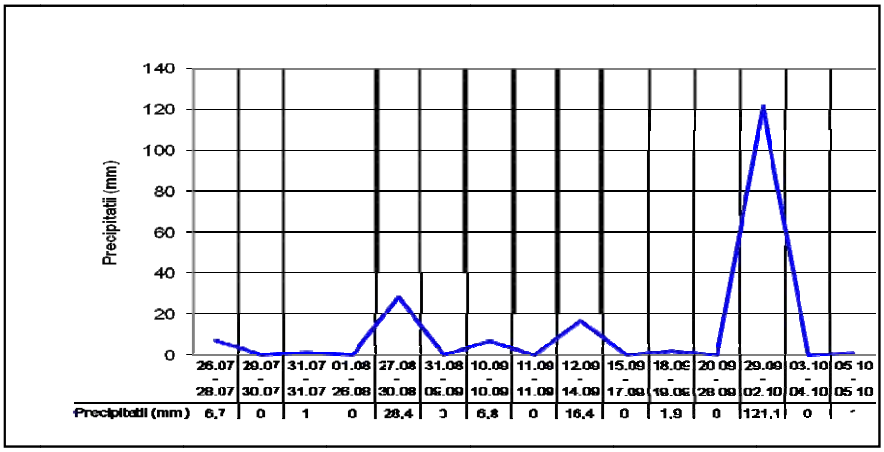


Fig. 3 Graphical representation of the temperature recorded from 23 July to 05 October 2013,



Moara Domneasca - Ilfov county.Fig. 4 Graphical representation of the rainfall recorded from 23 July to 05 October 2013, Moara Domneasca - Ilfov county.

The major problem regarding camelina sown in summer is that its emergence lacks uniformity.

The climatic conditions delayed the previous crop harvesting by 20 days caused a considerable delay in camelina sowing, which compromised camelina harvesting because some of silicules failed to ripen. It should be noted that camelina crop faced a droughty period and high temperatures in the first two months.

After 10 – 12 days from herbicide application the monocot weeds and the triticales emerged after harvest stopped developing. The camelina crop was not affected and responded well to the herbicide application.

The results of the field investigation are presented in the table below. ***Table 1***

The yield potential of camelina as a second crop

Trial	Seed rate (kg/ha)	Density (pl/m$^{2)}$	No. of silicules/ plant	No. of silicules/ m^2	No. of seeds/ silicula	Mass of 1000 grains (g)	Potential yield (g/m$^{2)}$	Potential yield (kg/ha)
V1 non-irrigated	6	121	31.2	3775	9.5	1.378	49.42	494.2
V2 non-irrigated	8	138.5	42.1	5830	10	1.373	80.05	800.5
V3 irrigated	6	168	49.9	8383	10.3	1.390	120.30	1203
V4 irrigated	8	192	42.1	8083	9.9	1.381	110.43	1104.3

The best results were obtained from the irrigated trial with a seeding rate of 6 kg/ha. The plant density of the non-irrigated trials is lower than that of the irrigated ones. The yield potential of the irrigated trials was considerably higher (1104.3 - 1203 kg/ha) in comparison with non-irrigated trials (494.2 - 800.5 kg/ha) characterized by the fact that emergence lacked uniformity.

Conclusions

As a conclusion, camelina can be cultivated as a double crop in Romania if the following requirements are met:

- The sowing must be done at least 3 – 4 weeks prior to the sowing date of this trial.
- Fertilizer application is needed in order to increase camelina yield.
- Watering is mandatory after camelina sowing in order to stimulate plant emergence.

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