Research on the Effect of Differential Organic Fertilization of Cauliflower Hybrids Grown in Open Field

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Bulletin UASVM Horticulture 74(2)/ 2017

Print ISSN 1843-5254, Electronic ISSN 1843-5394

DOI:10.15835/buasvmcn-hort: 0017

ABSTRACT

Use of manufactured fertilizers has been increasingly incorporated into regular farming practice in EU since its introduction in mid to late nineteenth century. In 2014, mineral fertilizer consumption in EU was 18 million tons. Given intensive use of fertilizers and pesticides, horticulture and vegetable growing are considered to be major contributors to some existing environmental impacts, such as water and soil pollution. Therefore farmers need to be aware and use only necessary amount of fertilizer for good plant development and to obtain high productions and to move from classical fertilization to organic fertilization. Cauliflower is not a pretentious culture but applying fertilizers can have a beneficial effect on production. Experience was carried out in 2016 in Apahida village, near Cluj-Napoca. It followed the effects of differentiated organic fertilization on three cauliflower hybrids: 'Casper' F₁, 'Cercy' F₁ and 'Charlot' F₁. Experiment was carried out in open field and was started with seedlings. Experimental factors were: hybrid and number of fertilizations. Each experimental factor had three graduations which combined resulted in a number of nine variants. During vegetation period, growth measurements were made and also the specific technology for autumn grown cauliflower in open field was applied.

Keywords: *cauliflower, hybrid, fertilization, growth measurements, production*

INTRODUCTION

In Apahida area, near Cluj-Napoca there are a lot farmers that grow brassicas, in particular cabbage and cauliflower. It is important to introduce brassicas in people's diet because of the positive influence on the human body. Cruciferous vegetables contain fibers that help digestion but more importantly isothiocyanates that have anticancer effect by inhibiting the formation of tumors (Gherghi et al., 2002). The consumption of cauliflower can prevent the following types of cancer: breast, colorectal, ovarian, prostate, lung cancer (Mohanty and Srivastava, 2002) and especially the gastrointestinal form (Prohens and

Nuez, 2008). In our country there is a high demand for fresh local produced vegetables because a big quantity of the vegetables found in stores in Romania are brought from other countries (Apahidean and Apahidean, 2016). In order to fill this need, the cultivated acreage should be increased, new hybrids that are more productive should be used, and crops should be fertilized properly, for maximum results. Fertilizing agricultural soils is one of the most expensive agricultural practices, although its economic return is usually higher due to its effects on productivity, product uniformity and quality (Singh et al., 2006). Fertilizers are essential to sustaining

vegetable production, increasing the yield and improving soil characteristics. However, when the quantity of the nutrients applied exceeds the plant's nutritional requirements, there is a higher risk of nutrient losses from agricultural soils into the ground and surface water. The resulting higher concentration of nutrients can severely deplete the ecosystems (Quirós *et al.*, 2014). In this context, the paper shows an analysis on the influence of organic fertilizer and the number of fertilization on the production of autumn cauliflower grown in open field.

MATERIALS AND METHODS

The experiment was conducted in Apahida, Cluj County, located between 46°09' and 47°00' parallels, north latitude and 23°55' and 25°14' meridians, west longitude, has a harmonious landscape. Average annual temperatures are between 8-10.1°C in plateau and hilly areas, generally the summer months are warm. During the growing season (June-October 2016) monthly average temperature was between 15.3-17.3°C. Rainfall distribution was uneven across Cluj County, with average values of 550 mm/year in the plain part of the county, gradually increasing towards the mountains to values of 1000-1200 mm/year. Rainfall is lower in the cold season and abundant in spring and autumn. Average monthly rainfall during the growing season ranged from 16.6 to 21.3 mm.

For this experiment three cauliflower hybrids were used. 'Casper' F₁ is a versatile hybrid, used for spring and autumn cultures. It has a vegetation period of 85-90 days and leaves protect the inflorescences very well. The average weight is between 2.5-3 and it is great for industrialization.

Another hybrid was 'Cercy' F₁, which is also versatile with a vegetation period of 90-95 days. The inflorescence has an average weight of 1.8-2.5 kg and leaves offer a good inflorescence protection. During summer, blossoms are not sensitive to direct sunlight. Third hybrid was 'Charlot' F₁. It is a new hybrid that gives great results in autumn cultures. The vegetation period is between 75 and 85 days, with an average inflorescence weight of 2-2.5 kg. Leaves protect the inflorescences very well.

Organic fertilizer Fuleț (3 N - 6 P₂O₅ - 12 K₂O + 4 MgO) was used for this experiment. Content of this fertilizer is total nitrogen (N) 3%, phosphorus pentoxide (P₂O₅) 6%, potassium oxide (K₂O)

12%, magnesium oxide soluble in water (MgO) 4%, calcium oxide (CaO) 3.3%, micro-elements 0.5%, organic carbon (C) 30%, humidity 7, organic substances 51%, pH 7 (<http://www.klastorf.ro>).

Fertilization was applied in different ways, some variants weren't fertilized, others were fertilized once with 1 t/ha of Fuleț and the other variants were fertilized twice with 1 t/ha of Fuleț.

By combining the two experimental factors, a number of nine variants were obtained which were located in three repetitions.

V1 – hybrid Casper F1, fertilizer not applied;

V2 – hybrid Casper F1, fertilized once with 1 t/ha of Fuleț;

V3 – hybrid Casper F1, fertilized twice with 1 t/ha Fuleț;

V4 – hybrid Cercy F1, fertilizer not applied;

V5 – hybrid Cercy F1, fertilized once with 1 t/ha Fuleț;

V6 – hybrid Cercy F1, fertilized twice with 1 t/ha Fuleț;

V7 – hybrid Charlot F1, fertilizer not applied;

V8 – hybrid Charlot F1, fertilized once with 1 t/ha Fuleț;

V9 – hybrid Charlot F1, fertilized twice with 1 t/ha Fuleț.

Research was established in 2016, near Cluj-Napoca, in Apahida village, 46° 48' 28" N latitude and 23° 44' 24" E longitude. Situated along Someș riverbed, soil is loamy, good for vegetable growing. In that area the soil is very suitable for vegetable growing. In order to obtain the seedling, seeding was done in the middle of June in alveolar trays. The substrate used was made only of peat TS3. The seedlings were planted in 19.07.2016. Planting was done mechanized, at a distance of 50 cm between plants and 70 cm between rows. The resulting density was 28 000 pl/ha.

During the vegetation period observations set in the experimental protocol, were made and the specific technology for autumn grown cauliflower in open field was applied.

Harvesting began on October 5 and it was done by hand.

RESULTS AND DISCUSSIONS

Growth and development of cauliflower plants were influenced by the studied factors. Regarding stem diameter, it was between 25 mm and 31.5 mm (Tab. 1). Low stem diameter was recorded at

Tab. 1. Plant growth and development before harvesting (averages)

Variant	Stem diameter (mm)	Rosette diameter (cm)	Leaf number	Plant height (cm)	Inflorescence Diameter (cm)
V1	25.0	14.0	12	35.0	16.0
V2	27.0	16.0	14	36.5	18.0
V3	28.5	18.0	14	38.0	19.0
V4	26.0	15.0	13	36.0	15.5
V5	28.5	17.5	14	37.5	17.0
V6	30.0	19.5	15	38.5	19.5
V7	26.5	15.5	14	36.5	17.0
V8	29.6	18.6	15	38.5	19.5
V9	31.5	19.5	16	40.0	21.0

Fig. 1. Average weight of cauliflower inflorescence (kg)

'Casper' F₁, unfertilized (V1) and the larger stem diameter was at 'Charlot' F₁, fertilized twice (V9).

In terms of leaves rosette diameter, the lowest value was achieved at 'Casper' F₁, unfertilized (V1), and the highest values were recorded at 'Charlot' F₁ (V9), and 'Cerci' F₁ (V6), that were fertilized twice.

In terms of the number of leaves found on plant, 'Casper' F₁, unfertilized (V1), had the lowest number of leaves, 12. On the other hand 'Charlot' F₁, fertilized twice (V9) had a highest number of leaves, 16. These values are similar to those obtained by Bianco *et al.* (2015) at autumn cauliflower varieties. Number of leafs also increased under different fertilizations options and it was between 13 cm at the unfertilized variant and 16 cm at the fertilized variant. Plant height varied between 31,2 at the unfertilized variant and 37,5 cm at the fertilized variant (Bianco *et al.*, 2015).

Regarding plant height, it varies between 35 cm at 'Casper' F₁, unfertilized (V1) and the highest value 40 cm, was recorded at 'Charlot' F₁ fertilized twice (V9).

Cauliflower cultivars showed significant variation in inflorescences diameter. Inflorescence diameter was influenced by the experimental factors, thus the largest diameter was 21 cm at 'Charlot' F₁, fertilized twice (V9) and the smallest diameter, of 15,5 cm was obtained at 'Cerci' F₁, unfertilized. Also a small inflorescence diameter was recorded at 'Casper' F₁, unfertilized, of 16 cm. Similar inflorescences diameter values (between 18 cm and 21,5) were obtained by Filho *et al.* (2015) in an experiment where they fertilized autumn cauliflower crops with doses of 244 and 320 kg/ha of P₂O₅.

Higher inflorescence diameter was recorded (25.64 cm) when a dose of 320 kg/ha of NPK was

Tab. 2. Unilateral influence of fertilization on the production of cauliflower grown in open field

Variant	Production		The difference compared to control (t/ha)	Significance
	(kg/m ²)	(%)		
Unfertilized (control)	3.59	100.0	0.00	-
Fertilized once with 1 t/ha Fulet	3.85	107.2	0.26	**
Fertilized twice with 1 t/ha Fulet	4.12	114.7	0.53	***
LSD (p 5%)		0.15		
LSD (p 1%)		0.24		
LSD (p 0.1 %)		0.45		

Tab. 3. Hybrid influence upon production

Hybrid	Production		The difference compared to control (t/ha)	Significance
	(kg/m ²)	(%)		
Casper F1 (control)	3.86	100.0	0.00	-
Cerci F1	3.82	98.4	-0.06	-
Charlot F1	3.98	111	0.53	***
LSD (p 5%)		0.15		
LSD (p 1%)		0.24		
LSD (p 0.1 %)		0.45		

applied, whereas lower diameter (17.18 cm) was found in control condition, unfertilized (Elahi *et al.* 2015). Increasing curd diameter, higher plant vigor, increased number of leaves and higher production is a result of optimum fertilizer dose application and improved availability of plant nutrients in the soil (Elahi *et al.* 2015).

Surprisingly, the average cauliflower inflorescence weight was under the data provided by the seed producer. Low values regarding the weight of cauliflower inflorescences were recorded at 'Charlot' F₁, unfertilized (V7), with a medium weight of 1.25 kg and 'Cerci' F₁, unfertilized (V4) with a medium weight of 1.28 kg (Fig. 1). Highest values, of 1.54 kg, was obtained at 'Charlot' F₁ (V9), fertilized twice.

Regarding the unilateral influence of fertilization on the production of cauliflower grown in the field, it can be seen from table 2 that the number of fertilizations directly influences production. Production ranged from 3,59 kg/m² at the unfertilized variant and 4.12 kg/m²

recorded when culture was fertilized twice with 1 t/ha Fulet. Inflorescence mass increased with fertilizers doses. The mass in this experiment was similar to that (1,120 g) reported by Monteiro *et al.* (2010) in work with Verona cultivar in an autumn experiment for the observation of cauliflower hybrids. The value obtained in this experiment where, however, larger than that reported by Pôrto *et al.* (2012) (860 g) in an experiment in which the plants were cultivated at the same population density.

Cauliflower productivity was observed to increase linearly with doses of fertilizers in other experiments conducted by other researchers, similar to the results obtained in this experiment.

When fertilizer was not applied, the inflorescence production was 3,35 kg/m², a value representing 79% of the maximum yield (Van Den Boogaard and Thorup-Kristensen, 1997) this value being lower than the one obtained in this experiment, 3,59 kg/m².

Tab. 4. Combined influences of studied factors upon the production of cauliflower

Variant	Production		The difference compared to control (t/ha)	Significance
	(kg/m ²)	(%)		
V1	3.67	100.0	0.00	-
V2	3.87	105.4	0.20	*
V3	4.06	110.6	0.39	**
V4	3.61	100.0	0.00	-
V5	3.88	107.4	0.27	**
V6	3.98	110.2	0.37	**
V7	3.50	100.0	0.00	-
V8	3.81	108.8	0.31	**
V9	4.33	123.7	0.83	***
LSD (p 5%)		0.15		
LSD (p 1%)		0.24		
LSD (p 0.1 %)		0.45		

Differences in production were distinct significant at the variants where one fertilization was done and very significant at the variants where two fertilizations were done, compared to the unfertilized variant, considered control.

Regarding hybrid influence upon production, as seen in table 3, it can be said that the hybrid has a small influence upon production.

Average production had similar values in all hybrids with an increase in production of 11% in 'Charlot' F1.

Only statistically ensured production was obtained in 'Charlot' and it was significant positive compared to control.

Regarding the combined influence of the two factors (hybrid and number of fertilizations) on production it can be seen in table 4, the lowest production of 3,50 kg/m² was obtained at variant V7 ('Charlot' unfertilized) and the highest production of 4,33 kg/m² was obtained at variant V9 ('Charlot' fertilized twice).

Fertilization and fertilization mode directly influences the production of cauliflower, regardless of the hybrid used.

Thus a single fertilization increased the production of all hybrids (V2, V5, V8). Variant V2 achieved a significant positive increase of production, statistically assured compared to control. Variant V5 achieved a distinct significant increase of production and V8 also achieved a distinct significant increase, differences being statistically assured.

Second fertilization application made a higher increase in production (at variants V3, V6, V9) compared to the others variants. Thus V3 and V6, obtained a distinct significant and positive increase in production. Highest production value was obtained at V9 and the increase in production was very distinct positive, differences being statistically assured.

Production obtained at cauliflower crops grown in open field in Apahida, near Cluj-Napoca, is influenced from all points of view by the number of applied fertilizations.

CONCLUSIONS

All hybrids reacted positively to additional fertilization. Vegetative growth was lower at the unfertilized variants and the largest vegetative growths were obtained at variants fertilized twice with 1 t/ha Fulet.

Overall it can be said that 'Charlot' F₁ hybrid is the most vigorous from all of studied hybrids and 'Casper' F₁ is the less vigorous from the three.

In terms of inflorescences diameter, hybrid 'Casper' obtained the lowest value, of 16 cm at V1 and the highest value was obtained at 'Casper' F₁ (V9) and it was of 21 cm.

Regarding average inflorescences weight, the results showed that the hybrid 'Charlot' has obtained the lowest value of 1.25 kg (at V7) but also the highest value of 1.54 kg (at V9).

After this research, it can be recommended for autumn cauliflower crops grown in open field,

hybrid 'Charlot', applying two fertilizations during the vegetation period.

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