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THE INFLUENCE OF ORGANIC FERTILIZERS ON THE GROWTH AND YIELD OF BROCCOLI (*Brassica oleracea* L. var. *italica*)

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Abstract

The experiment was conducted in order to determine the influence of organic fertilizers on the growth dynamics and yield of broccoli grown in the open field. The variety Verdija F1 cultivated in Skopje region during one year (2018) was used in the experiment. The treatments were as follows: Ø control - no use of organic fertilizer, V-1 - foliar treatment with Biohumus, V-2 - foliar treatment with Orgalife, V-3 - foliar treatment with Bio – Vital. The treatments were conducted every 10 days, starting on 19.08.2018, three times during vegetation period. The following traits were examine: dynamics of growth and broccoli yield. According to the results, the V-2 foliar treatment with the organic fertilizer Orgalife resulted in considerable higher yield on the central flower (6.98 t/ha) as compared to the control treatment (5.41 t/ha), proven with statistically significant difference, at the level of 0.05 with the LSD test. The results obtained for the average height of the plants in the three treatments showed that there are highly statistically significant differences at the level of 0.01 between the V-2 treatment (55.6 cm) and the control (48.7 cm). According to the overall results of the experiment, it can be concluded that the V-2 foliar treatment has given the best results in both traits as the plant height and the yield obtained.

***Key words**: growth dynamics, Biohumus, Orgalife, Bio – Vital*

INTRODUCTION

Broccolis belong to the group of leafy vegetables from the family Brassicaceae; they are an important vegetable crop with high nutritional and good commercial value (Yoldas et al., 2008). They are food with a low concentration of salts, without fats and calories, rich in vitamin C and a good source of vitamin A, vitamin B2 and calcium (Decoteau, 2000). According to Apahidean (2011), the broccoli inflorescences (flowers) have great therapeutic value in the battle against cancerous diseases. Today, broccolis attract more attention because of their variety of uses and excellent nutritional value (Salunkhe and Kadam, 1998; Talalay and Fahey, 2001; Rangkadilok et al., 2002;). The broccoli production, along with the application of organic fertilizers, could serve as an alternative to mineral fertilizers (Gupta et al., 1988; Wong et al., 1999; Yoldas et al., 2008; Farahzety and Siti Aishah, 2013) as well as to improve the soil structure (Bin, 1983;) and microbiological biomass (Suresh et al., 2004). However, it has been shown that liquid organic fertilizer as compost tea contains nitrogen mainly in an inorganic form such as ammonia (Price and Duddles, 1984; Gross et al., 2007) and make the nutrients immediately available to the plants. Bio-fertilizers play a multifunctional role, not only in the soil improvement process with microorganisms, but also as nutrients, stabilizers, hormones and isolates (Mohapatra et al., 2013). The application of organic (bio) fertilizers in the production of vegetables leads to higher plant productivity, quality improvement, early fruit growth and greater fruit durability.

MATERIAL AND METHODS

The experiment was set up near Skopje, in the village of Jurumleri, on alluvium soil type, during the cultivation season in 2018. Broccoli (*Brassica oleracea* L. var. *italica*), hybrid Verdia F1 was used as research material. The broccoli was cultivated from seedlings produced in cold beds, transplanted on open field. During the vegetation, the plants were treated with organic fertilizers Biohumus - organic fertilizers made from California worms in liquid (V-1 treatment), Orgalife – organic fertilizers made from California worms in liquid (V-2 treatment) and Bio - Vital microbiological fertilizer which contains bacteria in its composition (nitrifying microorganisms, phosphate-solubilizing microorganisms and cellulolytic microorganisms) (V-3 treatment). All fertilizers were used in concentration of 1% solution.

The treatments were set in three replications in the following order:

1. Ø control – no use of organic fertilizer,
2. V-1 – foliar treatment with Biohumus,
3. V-2 – foliar treatment with Orgalife,
4. V-3 – foliar treatment with Bio – Vital.

Each treatment was applied every 10 days. The beginning of the treatments started on 19.08, the second application of fertilizers was on 29.08 and the third application was performed on 09.09.

During the vegetation, dynamics of plant growth and yield were monitored. The dynamics of plant growth were monitored by measuring the height of the plants before each treatment.

The plant height was determined using a metro and the height was measured from the base to the top of plant. The height measurement was performed before each application of the organic fertilizers.

The yield per plant was determined only by the central inflorescence, by measuring them on an analytical scale and determining the arithmetic mean.

An analysis of - variance (ANOVA) for the two factors, the application timing and the fertilizer type for plant height and a single yield factor, was performed to determine the data obtained, and the smallest significant data ratios were determined by the LSD test at the level of $p = 0.05$ and $p = 0.01$.

RESULTS AND DISCUSSION

Plant height

It is widely known that the broccoli height is usually from 50 to 100 cm with spirally arranged leaves with an elongated shape, in the base more or less cut off depending on the type. In general, the plant is permeable, and the inflorescence is formed at the tip of the elongated trunk. In the generational phase, the broccoli tree grows from 50 to 90 cm (Lešić et al., 2002).

The results for the average plant height after applied treatments are given in Table 1. According to the results, the average plant height ranged from 32.4 cm in V-3 treatment at the first measurement to 67.6 cm, in V-2 treatment at the third measurement. The difference between the control (no use of organic fertilizer) and the treatments ranged from 6.9 cm (V-2 treatment) to 0.7 cm (V-3 treatment). The absolute dispersion was the highest in the control treatment and V-3 treatment, while the lowest was found for the V-1 treatment. The relative placement of treatment data was the highest for the V-2 treatment with the highest plants (8%) and the lowest for the control treatment.

Statistical significance at the level of p=0.01 was obtained only in the V-2 treatment. While insignificant differences between the treatments were obtained in V-1 in terms of control and the V-3 variant, while the V-2 secondary variant varies considerably with all variants (V-2 and V-1) and control. The V-3 treatment did not show any significance regarding the treated, and the data was closest to the control variant.

The average height of plants ranged from 48.7 cm in control, at a V-3 height of 49.4 cm, at a V-1 height of 49.7 cm, and the highest average height had plants in V-2 of 55.6 cm.

The results obtained for average plant height from all three treatments showed high statistically significant differences of 0.01 between control and V-2.

Table 1. Average plant height (cm) after three applications of different treatments.

Treatments		Ø	V-1	V-2	V-3
Application	I	32.8	33.7	39.7	32.4
	II	49.6	53.3	59.5	52.6
	III	63.7	62.2	67.6	63.3
±		48.7a	49.7ab	55.6c**	49.4a
+ - од Ø		Ø	1.0	6.9	0.7
SD		15.5	13.6	14.3	15.7
CV (%)		7.5	6.9	8.0	7.7
LSD 0.05		2.82			
0.01		4.27			

SD – standard deviation; CV – coeficinet of variation
*Significant differences at level *p=0.05, **p=0.01, for treatment and a, b, c for applications.*

The differences on plant height between the treatments and the control are shown in Figure 1. The plants in treatment V-2 were averagely 14% higher as compared to the plants in the control, 11% of treatment V-1 and 13% of the V-3 treatments. Treatments V-1 showed 3% higher plants than the control and 2% of the treatments V-3, while plants of treatments V-3 were 1% higher than the control.

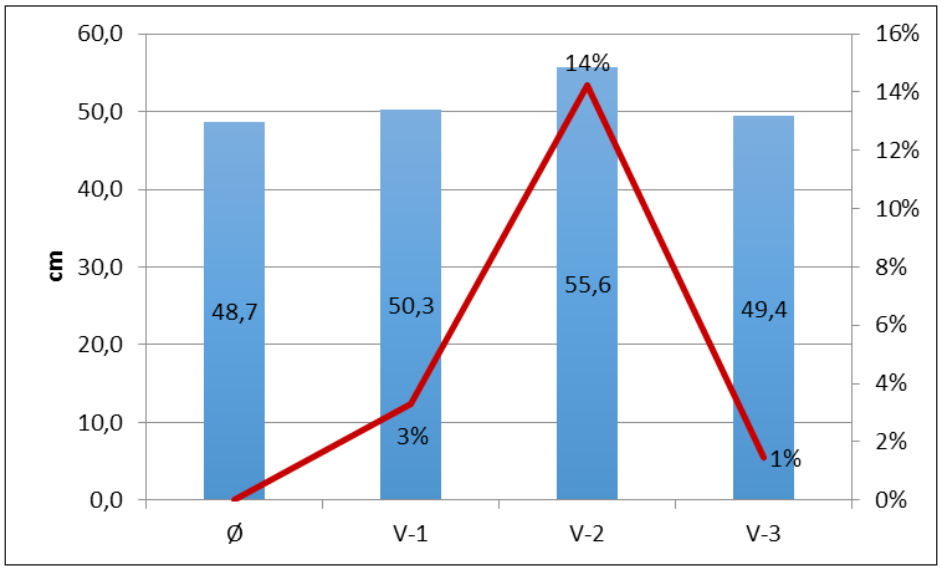

Figure 1. Average plant height (cm) and percentage of difference among different treatments.

Yield of central inflorescence in broccolis

Adding organic matter enhanced the soil structure conditions, creates conducive conditions for good root development (Arisha et al., 2003; Togun- and Akanbi, 2003) and mineralization by microorganisms. Hence, plants are able to get nutrients for higher yield (Radwan et al., 1993; El-Mansi et al., 1999; Wong et al., 1999; Abdelrazzag 2002; Al-Nasir 2002; Togun & Akanbi, 2003) upon application of organic fertilizers.

The harvesting of the inflorescences of the broccoli should be done before the inflorescences begin to open. Harvesting can be one-off or multiple. According to Đurovka et al. (2008), the yield can range from 15 to 30 t/ha, including main and lateral inflorescence.

According to the results from our research regarding the central inflorescence yield, the highest average yield was obtained in V-2 treatment (6.98 t/ha) which was 1.57 t/ha higher yield as compared to the control. The lowest yield was recorded in V3 treatment (5.18 t/ha) and it was 0.23 t/ha lower than control. The standard deviation in all treatments was low, while the relative distribution was the highest in control (13.82%) and the lowest in V-3 treatment (7.54%).

Table 2. Broccoli yield (t/ha) after three applications of different treatments.

Variants		Ø	V-1	V-2	V-3
Repetitions	I	6.25	7.05	6.96	4.64
	II	5.54	5.36	7.77	5.56
	III	4.43	6.84	6.19	5.34
±		5.41a	6.42b	6.98c*	5.18a
+ - Ø		Ø	1.01	1.57	-0.23
SD		0.75	0.75	0.65	0.39
CV (%)		13.82	11.75	9.25	7.54
LSD 0.05		1.55			
0.01		2.25			

SD – standard deviation;CV – coeficinet of variation
*Significant differences of level *p=0.05, **p=0.01, for treatment and a, b, c for applications.*

Significant difference (p = 0.05) between the organic fertilizer treatments and control was noted only for V-2 treatment. A significant difference was showed for V-1 treatment in relation to V-3 treatment and the control.

The average yield from all treatments and the control in our research was 6.01 t/ha, higher results showed V-2 (0.97 t/ha) and V-1 (0.41 t/ha), while the V-3 and control showed lower results than the average yield of all treatments (Figure 2).

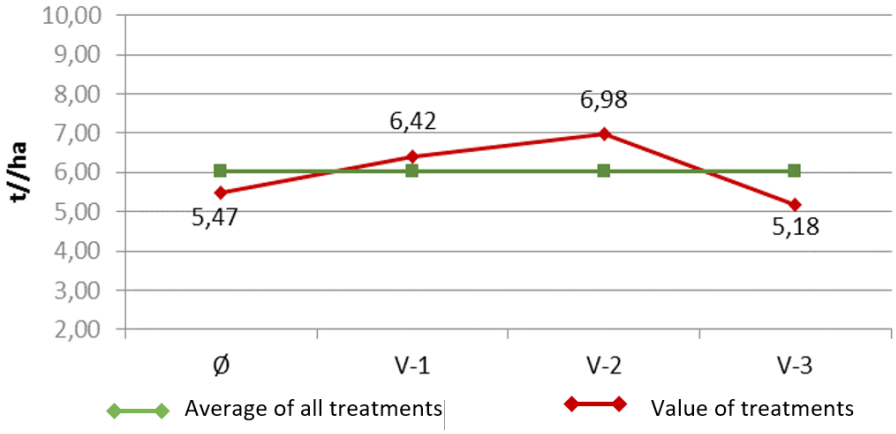

Figure 2. Differences between the average yields in different treatments.

CONCLUSIONS

The application of organic fertilizers in the production of broccoli gave positive results, both for average plant height and yield per hectare. The application of the liquid organic fertilizer based on California worms, Orgalife, gave the best results based on the two examined parameters.

Organic fertilizer treatments gave averagely higher plants up to 14% in V-2, 3% in V-1 and 1% in V-3 as compared to the control plants.

According to the results, it can be concluded that the use of Orgalife contributed to a significantly higher yield on the central flower in treatment V-2 (6.98 t/ha) as compared to control (5.41 t/ha), treatment V-1 (6.42 t/ha) and treatment V-3 (5.18 t/ha). gave the best results based on the two examined parameters.

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ВЛИЈАНИЕТО НА ОРГАНСКИТЕ ЃУБРИВА НА РАСТОТ И ПРИНОСОТ НА БРОКУЛА (*Brassica oleracea* L. var. *italica*)

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Резиме

Експериментот беше спроведен со цел да се утврди влијанието на органските ѓубрива врз динамиката на растот и приносот на брокула одгледувана на отворено. Беше користена сортата *Verdija F1*, која е одгледувана во Скопскиот регион во текот на 2018 година. Беа користени следниве третмани со органски ѓубрива: Ø контрола - без употреба на органско ѓубриво, V-1 - фолијарен третман со Biohumus, V-2 - фолијарен третман со Orgalife, V-3 - фолијарен третман со Bio - Vital. Третирањето е изведувано на секои 10 дена, почнувајќи од 19.8.2018 г. и тоа три пати во текот на вегетацијата. Целта на истражувањата беше да се испита влијанието на соодветните третмани врз динамиката на растот и приносот кај брокулата. Според добиените резултати може да се утврди дека со користење на органски ѓубрива Orgalife е добиен значително повисок принос на централниот цвет со третманот V-2 (6.98 t/ha) во споредба со контролниот третман (5.41 t/ha). Статистички значајна разлика, на ниво од 0,05 со LSD-тест, беше добиена помеѓу V-2 и контролата. Резултатите добиени за просечната висина на растенијата, за време на трите третмани, покажаа дека постои високостатистички значајна разлика на ниво од 0,01 помеѓу V-2 (55.6 cm) и контролата. Според добиените резултати може да се заклучи дека V-2 даде најдобри резултати и во зголемувањето на растот на брокулата и во приносот.

Клучни зборови: *динамика на раст, Biohumus, Orgalife, Bio – Vital.*