University of Novi Sad

Faculty of Agriculture

ПОЉОПРИВРЕДНИ ФАКУЛТЕТ
УНИВЕРЗИТЕТ У НОВОМ САДУ

Field test of commercial products ekolive biostimulants

1. Basic info

Requestor and producer:	Test executor:
Ekolive S.R.O. Americka trieda 3 Košice 040 13 Slovakia (CEO: Ing. Darina Štyriaková, PhD.)	University of Novi Sad Faculty of Agriculture Laboratory for microbiology Trg Dositeja Obradovića 8 21000 Novi Sad, Serbia (prof. dr Timea Hajnal Jafari)

Objective of the trial was to determine the effect of two biostimulants on cabbage production in field conditions. *ekofertile® plant* and *microfertile® plant* were applied separately or combined in concentration of 5 and 10%.

2. Methodology

2.1. Experimental site and conditions of the trial

The trial was conducted in Gospođinci, province of Vojvodina, Serbia, at 80 m above the sea level (45°403957" N latitude and 19°969406" longitude) in 2024. Total size of experimental plot was around 1000m^2 (50m x 20m). All treatments were evaluated at the same location, therefore weather and soil conditions were the same. Meteorological parameters such as temperature and rainfall during 2024 were obtained from Republic Hydrometeorological Service of Serbia (RHZS) and presented in Figure 1. August was characterised as very dry with an average 1.2mm of rainfall and high temperatures (average 27.5°C). On the other hand, September was extremely rainy, with measured 130 mm of rainfall. Temperatures remained high (average 19.5°C), with three tropical nights recorded. Soil type was chernozem. The previous crop on the field was onion. During its vegetation season EURIFERTIL TOP 51 NPF (500kg/ha) and ELIXIR

SUPREME 12:12:17 (600kg/ha) mineral fertilisers were applied. After onion harvest, residues were shredded with disc plough and incorporated into the soil.

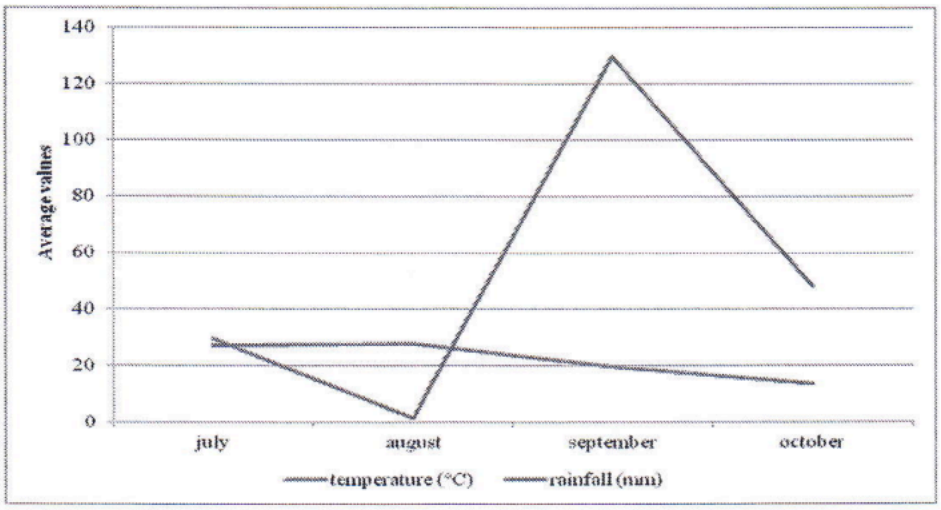

Figure 1. Meteorological data in 2024

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2.2. Experimental design

The experiment was set up as a randomised block design with 45 m plot per variant (15 m replicated three times). The study included 10 treatments: two biostimulants (*ekofertile® plant* and *microfertile® plant*) in two concentrations (5 and 10%) applied separately or combined. Control treatment included only application of water (Table 1). Mineral fertilisation was not applied (see the comment about fertilisation of previous crop in crop rotation). Each treatment had three biological replicates. The foliar application was performed with a "Womax" (16l) sprayer.

Table 1. Description of the treatments*

Treatments	Description	Abbreviation
1	*ekofertile® plant* 5% sprayed 3 times	E5/3
2	*ekofertile® plant* 5% sprayed 4 times	E5
3	*ekofertile® plant* + *microfertile® plant* 5% both, sprayed 3 times	EM5/3
4	*ekofertile® plant* + *microfertile® plant* 5% both, sprayed 4 times	EM10
5	*microfertile® plant* 5% sprayed 3 times	M5/3
6	*microfertile® plant* 5% sprayed 4 times	M5
7	*ekofertile® plant* 10% sprayed 4 times	E10

8	*microfertile® plant* 10% sprayed 4 times	M10
9	*ekofertile® plant +microfertile® plant* 10% both sprayed 4 times	EM10
10	Control	C
*Treatments 2, 4, 6-9 were altogether sprayed 4 times, respectively instead of planned 5 due to unfavorable weather conditions in August (high temperatures and no rain) and September (large number of rainy days)		

Figure 2. Cabbage trial (20.09.2024) (Gospođinci, Serbia)

2.3. Cabbage cultivation management

The cabbage variety used in the field trial was hybrid B1 Bravo (Figure 2). One of the most popular cabbage hybrids mainly used for late summer and autumn production. Bravo F1 is a cabbage that is intended primarily for pickling, of course, it is also used for consumption as fresh salads. The heads are bluish-green in color, with an average weight of 2.5-3.5 kg. It can also be used in storage up to 35-45 days. Due to its very stocky mass, this cabbage grows up to 5 kg. To the eye it has an average head, but due to its very compact leaves, it has a lot of weight. The growing season is 90-95 days after transplanting.

The agronomic treatments such as planting, application of pesticides, application of biostimulants, times of harvest were time-wise identical for all treatments, respectively. Pesticides used during cabbage production were standard for integrated management of cabbage production and are listed below:

1. Stomp® aqua (herbicide): In cabbage production, it is applied once as a soil herbicide, with incorporation, before the cabbage is transplanted and before the emergence of weeds. Recommended dosage: 2.5 – 3.0 l/ha.
2. Coragen®20SC (insecticide): every 14 days during vegetation period. Recommended dosage: 0.14 – 0.20%.

2.4.Determination of cabbage plant growth and yield

Harvest started in October, 85 days after planting (Table 3). Cabbage heads were taken for physical analysis of diameter (cm) using a sliding ruler and the weight (kg) by a scale (Figure 3).

Average cabbage yield per hectare was calculated by measuring freshly harvested heads (kg) and average number of planted cabbage plants per hectare (33.300). The harvest lasted one day.

Table 3. Timeline of the trial*(see the explanation in table 1)

Timing	**Activity**
29. 07. 2024.	Cabbage planting
30. 08. 2024.	1st biostimulant application
20. 09. 2024.	2nd biostimulant application
02. 10. 2024.	3rd biostimulant application; 1st measurement of head diameter
15. 10. 2024.	4th biostimulant application
22. 10. 2024.	Cabbage harvest; 2nd measurement of head diameter

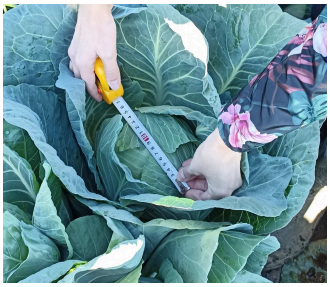

Figure 3. Measurement of cabbage head diameter (cm)

3. Results

Effect of the two biostimulants on cabbage production was investigated in field conditions. Results show that the application of biostimulants, in average, lead to increase of cabbage head diameter and weight. The highest increase in head diameter, in relation to the control was achieved with *microfertile® plant* 5% and *ekofertile® plant* 10% when applied 4 times, respectively (Table 4). Treated cabbage heads had increased diameter and weight compared to control, resulting in nicely formed, compacted, and regularly shaped heads (Figure 4).

Figure 4. Cabbage heads

Table 4. Effect of biostimulants on vegetative growth of cabbage

Treatments	**Head diameter (cm) 1st measurement**	**Head diameter (cm) 2nd measurement**
ekofertile® plant 5% (3 times)	18.27**	20.27
ekofertile® plant 5% (4 times)	18.23	20.65
ekofertile® plant + *microfertile® plant* 5% both, (3 times)	19.10	20.60
ekofertile® plant + *microfertile® plant* 5% both, (4 times)	19.17	20.73
microfertile® plant 5% (3 times)	17.47	19.30
microfertile® plant 5% (4 times)	20.43	20.77
ekofertile® plant 10% (4 times)	19.90	21.40
microfertile® plant 10% (4 times)	19.27	20.73
ekofertile® plant+*microfertile® plant* 10% both (4 times)	19.63	20.63
Control	17.40	20.13

**Results represent mean values (n=3)

In Table 5, the results show the effect of biostimulants application on cabbage head weight (kg), total yield (t/ha) and percentage of yield increase (%). It can be noted that all tested treatments led to higher yield formation compared to control with the maximum value of 42,60% (*ekofertile® plant* 10% applied 4 times). The data also show that the treatments with the same biostimulator type and concentration, but with different number of application (treatments 1 and 2; 3 and 4 as well as 5 and 6, respectively), had significant variation in yields. It was much lower when applied 3 times compared to the same treatment with 4 times application. Only one more treatment led to considerable yield increase. That leads to the conclusion that the number of product(s) application during cabbage vegetation season does matter. According to the result of this trial the number of applications should not be lower than 4.

Table 5. Effect of biostimulants on cabbage yield/plant (% of increase)

No.	Treatments	Cabbage head weight (kg)	Cabbage yield (t/ha)	% of yield increase
1	*ekofertile® plant* 5% (3 times)	2.08**	69.13	5.82
2	*ekofertile® plant* 5% (4 times)	**2.35**	**78.34**	**19.91**
3	*ekofertile® plant* + *microfertile® plant*5% both, (3 times)	2.14	71.18	8.95
4	*ekofertile® plant* + *microfertile® plant* 5% both,(4 times)	**2.63**	**87.48**	**33.90**
5	*microfertile® plant* 5% (3 times)	1.99	66.13	1.22
6	*microfertile® plant* 5% (4 times)	2.28	75.88	**16.15**
7	*ekofertile® plant* 10% (4 times)	***2.80***	***93.16***	***42.60***
8	*microfertile® plant* 10% (4 times)	2.37	78.88	20.74
9	*ekofertile® plant*+ *microfertile® plant* 10% both, (4 times)	2.57	85.70	31.18
10	Control	1.96	65.33	

**Results represent mean values (n=3)

4. Discussion

The increase of cabbage head diameter and weight in all treatments could be associated with primary and secondary metabolites produced by microorganisms in biostimulants. This trial lasted one vegetation season with challenging meteorological conditions. It was set on fertile soil, no mineral fertilisers were added, the plants were not irrigated but organic residues were incorporated in soil prior to planting. However, excellent results were obtained (presented in Tables 4 and 5) even with the shortened vegetation period (85 days). It is important to highlight that the number of biostimulants application proved to be a significant factor in cabbage yield formation. According to Bejarano-Herrera et al. (2024), cabbage plants that were treated with biofertiliser showed considerably greater sizes. Also, they found that microbial inoculation (consortium of *Azospirillum brasilense* D7, *Herbaspirillum* sp. AP21, and *Rhizobium leguminosarum* T88) significantly influenced cabbage crop yield, resulting in a 9-ton increase in yield per hectare. Increased head diameter, weight and ultimately yield could be attributed to the composition and metabolic activity of the microorganisms in the tested biostimulants. Improved nutrients and water availability resulted in increased vigor of cabbage plants (Hajnal Jafari et al., 2019).

5. Conclusion

Results of the large-scale field trial highlighted the positive effect of applied biostimulants on vegetative growth parameters as well as on cabbage yield.

- ✓ ***ekofertile® plant* ® 10% and the combination of *microfertile® plant* 5%+*ekofertile® plant* 5% increased cabbage yield more than 30% in relation to the control when applied 4 times by spraying.**
- ✓ **Plants in all treatments showed faster growth, improved plant vigor compared to the control.**
- ✓ **The recommended number of applications should be 4 (or more).**
- ✓ **These data strongly suggest that the overall improvements of cabbage production can be attributed to the tested biostimulants.**

In order to get more reliable and accurate information of biostimulants efficiency in cabbage production, the same trail (or similar) should be performed including different levels and combinations of mineral fertilisers. Moreover, it is strongly advisable to set up trials in various agro-ecological conditions during longer period of time.

Cited literature:

Bejarano-Herrera, W.F.; Marcillo-Paguay, C.A.; Rojas-Tapias, D.F.; Estrada-Bonilla, G.A. Effect of Mineral (2024). Fertilization and Microbial Inoculation on Cabbage Yield and Nutrition: A Field Experiment. *Agronomy 14*, 210. https://doi.org/10.3390/agronomy14010210

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Novi Sad, 12th November 2024