EFFECT OF BIOHUMUS THROUGH FERTIGATION ON THE YIELDING IN A STRAWBERRY PLANTATION, THE "MARMOLADA" VARIETY, UNDER FIELD CONDITIONS

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Abstract
Strawberries are the first fruits to appear on store shelves and are highly appreciated by consumers. The fertilization of strawberry plantations has a high contribution to the size of the crops, and the tendency of farmers is to reduce the application of chemical fertilizers and to turn to organic, green fertilizers, both for economic reasons and for the care of the environment. The experiment was replicated 3 times with one soil bed per replication. A number of 6 fertilization variants resulted: T1 – control – unfertilised, T2 –200kg DAP ha^{-1} (36 kg/ha N-NH_4^+ + 92kg/ha P_2O_5 active ingredient), T3 - 300kg/ha DAP (54 kg·ha^{-1} N - NH_4^+ + 138kg·ha^{-1} P_2O_5 active ingredient), T4 – Biohumussol 4L/ha, T5 - 200kg/ha DAP + Biohumussol 4L/ha, T6 - 300kg/ha DAP + Biohumussol 4L/ha. The average fruit weight was between 13.3 and 18.7g, the maximum weight being found at fertilization with 300kg/ha DAP (T3), followed by T6 - 300kg/ha DAP + Biohumussol 4L/ha, with an average fruit weight of 18.3g. All other variants of fertilization had increases of the yield, with a maximum yield in T6 – 776.9g/plant, reaching the productivity of the variety. The increased of the yield compared to T1 – control is 207%.

Key words: Biohumussol, DAP, strawberries, yield

Strawberries are the first fruits to appear on store shelves and are highly appreciated by consumers. The Marmolada variety of strawberry is a variety cultivated predominantly in the Republic of Moldova and Russia, but also in Romania. It is highly appreciated for its tasty fruits and the high productions it can achieve in optimal growing conditions. The plants of this variety are tall, vigorous, with an intense flowering when the proper temperatures are achieved.

The fertilization of strawberry plantations has a high contribution to the size of the crops, and the tendency of farmers is to reduce the application of chemical fertilizers and to turn to organic, green fertilizers, both for economic reasons and for the care of the environment. The application of high doses of chemical fertilizers, especially those with nitrogen, lead to soil, water and air pollution.

Biohumus is usually obtained with the help of earthworms, also called vermicompost, and represents an input of organic matter in the soil, from materials without economic value, residues from various industries, that improve the physical and chemical properties of soils dedicated to agriculture (Arancon Z. *et al*, 2006). Applying vermicompost on saline sodic soils, an increase in wheat production was noted, by reducing the negative effects of sodium (Ding *et al*, 2021)

It can partially replace chemical fertilization, with a supply of nutrients, yet best results were observed when it is used in combination with fertilizers.

The use of biohumus comes with a number of advantages:

- accelerates the development of plants,
- increases resistance to diseases and pests,
- increases the resistance of plants to toxicity,
- improves flowering,
- helps the healthy growth of fruits (Sinha *et al*, 2009).

When applying 10t/ha of vermicompost, higher productions were obtained with larger fruits but with a dry substance of the plants similar to the control variant. By combining it with NPK (85/55/125kg/ha active ingredient) positive results were obtained in: dry shoot area, leaf areas, more number of flowers and growth of microbial flora (Arancon N.Q. *et al*,2004).

In a study carried out with two doses of biohumus 5 and 10 t/ha, Arancon noted that there are no significant influences, but with significant increases in production when it is combined with NPK (Arancon N.Q. *et al*,2004).

The aim of this study was to evaluate the effect of Biohumussol, applied singular and in combination with diammonium phosphate, to

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increase the fertility of the soil and the yield in a plantation of strawberries, Iasi county.

MATERIAL AND METHOD

The establishment of the strawberry plantation was done in September 2020, on raised layers, with a drip irrigation system and foliated with mulch. The planting distances are 30 cm between plants and 30 between rows, with a zig-zag arrangement, the distance between soil beds is 60 cm.

The experiment was replicated 3 times with one soil bed per replication. Following the soil analysis, 2 types of fertilizers were chosen, applied singly and in combination: DAP (diammonium phosphate) with a content of 18% N-N_4^+ and 46% P_2O_5 in two doses and fertigation with Biohumussol.

DAP is a fertilizer with a high concentration of phosphorus, to supplement the very low reserves of it in the experimental plot. It was applied in the fall before planting when preparing the soil beds, to be incorporated homogeneously in the soil, closer to the root area.

Biohumussol is an organic fertilizer compatible with organic fertilization, authorized product and made in accordance with the SR EN ISO 9001:2015 quality management system. Its composition contains 60% organic matter, 5% amino acids, microorganisms, humic and fulvic acids, macro and micro elements. It has been applied weekly, for four weeks, through irrigation during the flowering and fruiting period.

A number of 6 fertilization variants resulted:

T1 – control – unfertilised

T2 –200kg DAP ha^{-1} (36 kg/ha N-NH_4^+ + 92kg/ha P_2O_5 active ingredient),

T3 - 300kg/ha DAP (54 kg·ha^{-1} N - NH_4^+ + 138kg·ha^{-1} P_2O_5 active ingredient),

T4 – Biohumussol 4L/ha,

T5 - 200kg/ha DAP + Biohumussol 4L/ha

T6 - 300kg/ha DAP + Biohumussol 4L/ha

In the second year from planting (2022) only Biohumussol has been applied through irrigation.

In order to determine the influence of fertilizer application on strawberry growth and productivity, a series of measurements were made, on a number of 10 plants from each fertilization variant:

- the number of inflorescences,
- the number of flowers per plant,
- average fruit weight,
- the number of fruits weighing more than 30g.

The works carried out in the plantation after establishment were: manual removal of weeds, watering depending on the soil moisture and removing the inflorescences that appear in autumn with the aim of favoring the growth of the plant.

Before setting up the experiment, soil samples were sent to the agrochemical analysis laboratory and analyzed to determine soil fertility. The analysis report indicates a very weak supply of the soil with ammoniacal nitrogen – 5ppm, phosphorus – 1.25ppm, but high concentrations of nitric nitrogen – 80ppm, chlorine – 150ppm, sodium 315ppm, calcium 299ppm and magnesium – 102ppm. The reaction of the soil is neutral with a pH of 7.14 and EC = 0.86 explained by the high content in cations.

RESULTS AND DISCUSSIONS

Following the measurements carried out in the first year of experimentation, a significant difference can be observed between the number of inflorescences per plant in the control variant (4.8) compared to the fertilized variants, hence the small number of flowers per plant - 27. The big difference in the number of inflorescences between the control and the other variants can be explained by the poor supply of soil with phosphorus at T1, phosphorus having a role in flowering and fruiting. The fertilization variant T6 – 300kg DAP supplemented with Biohumussol, has the largest number of inflorescences with an average number of 8.1 inflorescences and a number of 45 flowers per plant (Table1).

The average production was calculated for a number of 10 plants, and by extrapolation it can be related to the number of plants per hectare. The Marmolada strawberry is a very productive variety recording productions of 700-1500g/plant under optimal conditions. Without fertilization, in the conditions of a poor supply of nutrients, the plants from T1 variant reached 375 g/plant fresh fruits.

All other variants of fertilization had increases of the yield, with a maximum yield in T6 – 776.9g/plant, reaching the productivity of the variety. The increased of the yield compared to T1 – control is 207%. The treatments T3- 300Kg DAP an T5 - 200kg/ha DAP + Biohumussol had good results with 638g/ plant, respective 675,7g/plant (Table1).

The average fruit weight was between 13.3 and 18.7g, the maximum weight being found at fertilization with 300kg/ha DAP (T3), followed by T6 - 300kg/ha DAP + Biohumussol 4L/ha, with an average fruit weight of 18.3g.

The largest number of fruits that exceed the weight of 30 grams can be found when fertilizing with Biohumussol, 7 strawberries, while in the unfertilized version the fruits did not reach this weight. The other variants have close values, approximately a number of 4 fruits/ for the analyzed plants (*table 1*).

Table 1

Effect of fertilization on the growth and productivity of "Marmolada" strawberry, in the experimental field, 2021

Treatment	Number of inflorescences /plant	Number of flowers/plant	Mean Yield (g/10 plants)	Yield (%)	Mean fruit weight (g)	Number of big fruits (more than 30 grams)/10 plants
T1 – control – unfertilised	4.8	27	3750	100.00	13.3	0
T2 –200kg/ha DAP	6.7	34	4580	122.13	15.3	4
T3 - 300kg/ha DAP	7.1	38.2	6382	170.19	18.7	4
T4 – Biohumussol	7.5	33	4853	129.41	16.1	7
T5 - 200kg/ha DAP + Biohumussol	7.2	43.4	6757	180.19	17.2	3
T6 - 300kg/ha DAP + Biohumussol	8.1	45	7769	207.17	18.3	5

Table 2

Effect of fertilization on the growth and productivity of "Marmolada" strawberry, in the experimental field, 2022

Treatment	Number of inflorescences per plant	Number of flowers per plant	Mean Yield (g/10 plants)	Yield (%)	Mean fruit weight (g)	Number of big fruits (more than 30 grams)/10 plants
T1 – control – unfertilised	5.3	36	3660	100.00	12.2	0
T2 –200kg/ha DAP	7.2	43.8	6632	181.20	15.5	4
T3 - 300kg/ha DAP	8.3	47.2	8421	230.08	19.8	6
T4 – Biohumussol	6.8	38	5643	154.18	16.3	8
T5 - 200kg/ha DAP + Biohumussol	7.6	48.5	7954	217.32	17.8	11
T6 - 300kg/ha DAP + Biohumussol	8.6	51.2	8836	241.42	19.5	10

In the second year of experiment, all the monitored production indicators increased due to the development of the plant and the accumulation of nutrient reserves in the soil. The coefficient of use of phosphorus in the first year after application is low, then in the second year it increases to 50-60%.

It can be seen that the number of inflorescences per plant increased in all experimental variants, including the non-fertilized plot, from 4.8 in the first year to 5.3 in the second year, with a number of flowers per plant of 36. With all these increases, the production recorded a slight decrease in T1 due to the decrease in the average weight of the fruits as well as the percentage of the binding of the flowers (*table 2*).

The maximum number of inflorescences was found in the fertilization options T3 and T6 - fertilization with 300Kg DAP, 8.3 and 8.6 inflorescences, followed by the T4 variant with Biohumussol, 7.6 inflorescences. The increase in the number of inflorescences also led to the increase in the number of flowers on the plant. The maximum number of counted flowers were found on plants from T6 - 300kg/ha DAP + Biohumussol, 51.2 flowers per plant, followed by T5 and T3 with 48.5 and 47.2 flowers per plant. The plants from the version fertilized with Biohumussol had approximately the same number of flowers as the control variant (Table 2).

Compared to the first year, in the second year the productions were higher, for all the fertilized variants by up to 241% in T6, with an average of 883.6g fruits/plant, followed by T3 with a production of 842.1g fruits/plant and T5 with 795.4g fruit/plant. The lowest yield, 564.3g of strawberries/plant, was observed when exclusively fertilized with Biohumussol (*table 2*).

The average weight of the fruits was between 12.2g in T1 and 19.3g in T3, values similar to the previous year. There is an increase in the number of strawberries that exceed 30 grams, with maximum values of 10-11 strawberries when fertilized with DAP and Biohumussol - T5 and T6. In the unfertilized version, no fruit was found that exceeded 30 grams (Table 2).

The Marmolada variety has an average fruit weight of 20-25g, and large fruits of 30-40 grams, being common in the culture.

However, this variety raises problems for marketing, having a short shelf life, the fruits have a dark red color and the shape of the large fruits is flattened and toothed on the tip.

CONCLUSIONS

In order to obtain high yields in the strawberry culture, the requirements related to nutrition must be met. There is a clear difference between the unfertilized variant and the other experimental variants. Even if the flowering seems to improve in the second year, the plants have nothing to grow the fruits with, so they remain small and so does the production per hectare.

Good results were obtained with the fertilization options with DAP in combination with Biohumussol, but also with the application of DAP in a dose of 300 kg/ha.

The exclusive application of organic fertilizer in liquid form once with irrigation water leads to increased production but does not approach the genetic potential of the variety.

In order to make the application of fertilizers more efficient, it's mandatory to know the balance of the nutritive elements in the soil. The application of organic fertilizers will be done in addition to chemical fertilizers, so as to create an optimal nutritional environment for strawberry cultivation.

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