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EFFECTS OF ORGANIC FERTILIZERS ON GROWTH AND DEVELOPMENT OF SCARLET SAGE (*Salvia splendens* (L.) Ker.-Gawl.)

BISTRA ATANASOVA*, DENICHKA MANOLOVA

Institute of Ornamental and Medicinal Plants – Sofia, Agricultural Academy, Bulgaria
**Corresponding author: iop_sofia@abv.bg*

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Abstract: During 2018, in the glasshouse of the Institute of Ornamental and Medicinal Plants - Sofia, a research was carried out to study the influence of fertilizers Masterblend, Kompovet and Kokovet on the growth and development of Scarlet sage (*Salvia splendens*). Root manuring of plants with organic fertilizers revealed a positive effect in the course of the phenophases. Flowering began with 4 to 6 days earlier. The duration of the flowering period compared to those of non-treated plants also increased with 4 to 6 days. When fertilized with Kompovet and Kokovet, plants had higher values of height and diameter than those of untreated plants. The best effect was achieved with Kokovet, where plants had better habitus - 29.4% higher and 19.0% larger.

INTRODUCTION

For nature conservation and human health, as a result of active research work in recent years, new environmentally friendly and biologically active fertilizers were marketed. The remains of these fertilizers do not accumulate in crop production and the environment (Malinova, 2007; Sengalevich, 2007; Petkova and Kutev, 2017). For introduction into breeding scheme new mineral and organic fertilizers must be pre-tested for a number of agricultural crops.

For their development, flowers require balanced and rational systems of feeding with suitable biomineral and organic fertilizers, corresponding to modern growing technologies (Ivanova *et al.,* 2005). An advantage of organic fertilizers is that they do not contain harmful impurities that can lead to plant damage or to the accumulation of residues in the soil and production. Furthermore, organic

fertilizers are convenient to use because they can be imported with irrigations in root fertilization or in combination with plant protection products in leaf treatment.

Studies in this field with flowers were carried out mainly in the Institute of Ornamental and Medicinal Plants. Organic fertilizers Biostim, Humustim, Baikal, Lumbrickol and Plantagra in cultures of cut flowers and pot plants (pot carnation, mini carnation, chrysanthemum, petunia, impatiens, gypsophila, etc.) had proven positive effects on the growth and development of plants (Kotopanova *et al.,* 2006; Atanassova *et al.,* 2007; Atanassova, 2012; Atanassova and Nencheva, 2012; Atanasova and Zapryanova, 2013).

The aim of the study was to determine the effect of organic fertilizers Kompovet and Kokovet on the growth and development of *Salvia splendens* (L.) Ker.-Gawl.

MATERIALS AND METHODS

To test the effect of fertilizers - Kompovet and Kokovet, a pot experiment was per formed in glasshouse without heating and uncontrolled conditions - air temperature was from 5°C (at night) to 28°C (during the day) and soil moisture about 70%.

Characteristics of tested fertilizers:

Kompovet - liquid concentrated extract of bio-fertilizer from Californian red worm, which contains 40% organic substance andis with macro elements composition: Nitrate nitrogen (NO_3-N) – 110 mg/l; Ammonium nitrogen (NH_3-N) – 250 mg/l; Diphosphorus Trioxide (P_2O_3) – 1100 mg/l; Potassium oxide (K_2O) – 4200 mg/l; Magnesium oxide (MgO) – 20 mg/l; Calcium oxide (CaO) – 70 mg/l; Iron (Fe) – 10 mg/l and heavy metals under the acceptable norm.

Kokovet - liquid fertilizer produced on the basis of chicken manure, containing 45 % organic substance, Nitrate nitrogen (NO_3-N) – 250 mg/l; Ammonium nitrogen (NH_3-N) – 335 mg/l; Diphosphorus Trioxide (P_2O_3) – 2580 mg/l; Potassium oxide (K_2O) – 7580 mg/l; Magnesium oxide (MgO) – 11 mg/l; Calcium oxide (CaO) – 50 mg/l; Iron (Fe) – 10 mg/l and heavy metals under the acceptable norm.

The experiment was set on April 15 in 4 variants with 20 plants each. Two controls were used – non-treated plants (C_1) and plants, fertilized with 0.03% solution of Masterblend (C_2).

Variants:

I – non-treated plants (C_1);

II – 0.03% solution of Masterblend (C_2);

III – 2.0% solution of Kompovet;

IV – 0.5% solution of Kokovet.

For root fertilization of plants with Kompovet and Kokovet, doses recommended by the company "Agrobiovet" LTD - Sofia were used and for Masterblend – 0.03% solution, which is widely applied in practice. Masterblend is an universal fertilizer, containing nitrogen (N) – 20%, Nitrate – 6.22%, Ammoniacal – 3.88%, Ureen - 9.90%, soluble phosphorus (P_2O_5) – 20%, soluble potassium (K_2O) 20% and microelements, which provide a high yield and quality production in all crops and ornamental plants.

Plants in variants with fertilizer were irrigated with 100 ml of solution, and those of control (C_1) non-treated plants with 100 ml of water. Three fertilizations were performed: the first one 15 days after planting (April, 15), the second - two weeks later and the last after two weeks.

During vegetation the following phenophases were observed - budding and flowering, 10% were accepted for the beginning of the phase and 60% for full stage. For the end of the experiment, the date was set at which 60% of the plants were with one overblowing blossom.

The following biometric data were measured: plant height and diameter in the widest part of the plants. The first measurement was in the beginning of the trial and the others in every 15 days. At the end of the experiment, the growth of the two parameters was calculated, representing the difference between the initial and last measurement of the height and diameter of the plants, in cm and %.

The statistical processing of the data was analyzed by ANOVA test. The significant differences between the control and variants were presented as

* ($P<0.05$), ** ($P<0.01$),

*** ($P<0.001$) and the non-significant – ns.

RESULTS AND DISCUSSION

When fertilizing the plants with organic fertilizers Kompovet and Kokovet and complex mineral fertilizer Masterblend the phenophases budding and flowering started earlier as compared to non-treated plants (Table 1).

Beginning of flowering for plants, nourished by Kompovet and Kokovet is accelerated by 4 to 6 days respectively, compared to non-treated plants (C_1) and 5 days for mineral fertilizer Masterblend (C_2).

Table 1. Phenological observations of *Salvia splendens* when fertilizing with organic fertilizers

Variant	Budding		Flowering		Overblowing		Duration of flowering period
	/Date/		/Date/		/Date/		/number of days/
	Start	Full	Start	Full	Start	Full	
Scarlet sage							
I – non-treated plants (K)	19.04.	25.04.	02.05.	08.05.	16.05.	28.05.	26
II – 0.03% Masterblend	15.04.	18.04.	27.04.	02.05.	18.05.	28.05.	31
III – 2.0% Kompovet	15.04.	19.04.	28.04.	03.05.	19.05.	28.05.	30
IV – 0.5% Kokovet	14.04.	19.04.	26.04.	30.04.	18.05.	28.05.	32

The full flowering of plants, fertilized with organic fertilizers also started with 5 to 8 days earlier compared to those of the control plants (C_1), whereas with the use of Masterblend (C_2) the full flowering was reported 6 days earlier (**Figures 1 and 2**).

Fig.1. Full flowering in plants treated with Kokovet

Fig.2. Full flowering in non-treated plants treated with Kokovet

The duration of the flowering period of plants, nourished by organic fertilizers and mineral fertilizer was greater than those of the control plants (C_1) – 4 days for Kompovet, 5 days for Masterblend and 6 days for Kokovet. The balanced ratio of the macro and microelements, contained in the composition of the tested fertilizers are the cause of the early beginning of flowering and prolongation of the flowering period.

The results obtained from the current study showed that organic and mineral fertilizers, used as a control - C_2 had positive influence on the height of plants, as compared to non-fertilizer plants (C_1) percentage of growth increased with 9.2% (Kompovet) to 29.4% (Kokovet) – Table 2. The height of plants, treated with Masterblend was 1.2 cm higher than those of non-treated plants.

Table 2. Effects of organic fertilizers on plant height in *Salvia splendens*

Variant	Height, cm									Growth	
	15.04. /startig date/	30.04.		15.05.		30.05.		15.06.		cm	% Vs. K
	Cm	cm	%	cm	%	cm	%	cm	%		
Scarlet sage											
I – non-treated (K)	5,2	6,8	100	11,2	100	14	100	17,1	100	11,9	100
II – 0.03% Masterblend	5,2	7	102,9	11,9	106,2	16	114,3	18,3	107	13.1 ***	110,1
III – 2.0% Kompovet	5,2	7,2	105,9	11,9	106,2	15,9	113,6	18,2	106,4	130 ***	109,2
IV – 0.5% Kokovet	5,2	7,1	104,4	14	125	17,4	124,3	20,6	120,5	15.4 ***	129,4

*($P \leq 0.05$), ** ($P \leq 0.01$), *** ($P \leq 0.001$), non-significant – ns.

The differences in height growth of plants, treated with the two organic fertilizers and Masterblend compared to non-treated plants (C_1) demonstrated a very high significance ($p \leq 0.001$). Compared to the mineral fertilizer (C_2), a positive effect was only present in the Kokovet organic fertilizer, which plants exceeded the growth of the control plants by 17.6%.

Concerning the diameter of plants, treated with tested fertilizers, superiorly results were reported again (Table 3). The growth rate of fertilized plants exceeded that of non-fertilized plants (C_1), within 7.1% (Masterblend) to 19.0% (Kokovet). Kokovet organic fertilizer had the most pronounced effect, with differences in diameter growth rate and those of non-treated plants (C_1) being demonstrated at $P \leq 0.05$, and in Kompovet and Masterblend the results were non-significant (ns), as the growth rates were close to those of the control plants.

Compared to the mineral fertilizer Masterblad (C_2), organic fertilizers had a positive effect, exceeding the control plants from 4.4% in Kompovet to 11.1% at Kokovet. The positive results using organic fertilizers was probably due to the

high content of fulvic and humic acids and microelements, which activate the processes of metabolism, providing economic use of moisture. Our survey for the influence of Kompovet and Kokovet confirmed the positive effect of organic fertilizers, used in flower crops (Kotopanova and Nencheva, 2008; Atanassova, 2011; Zapryanova and Atanassova, 2013; Atanassova, 2015; Zapryanova et. al, 2017). In the complex mineral fertilizer Masterblend the positive influence on growth and development of plants could be explained by the optimal ratio of nitrogen, phosphorus and potassium (20%:20%:20%) and the presence of microelements.

Table 3. Effects of organic fertilizers on plant diameters of *Salvia splendens*

Variant	Diameter							Growth	
	15.04. /starting date/	30.04.		15.05.		30.05.		cm	% Vs. K
	Cm	cm	%	cm	%	cm	%		
Scarlet Sage									
I – non-treated (K)	8,3	10,6	100	11,7	100	12,5	100	4,2	100
II – 0.03% Masterblend (K_2)	8,3	10,9	102,8	12,5	106,8	12,8	102,4	4.5 ns	107,1
III – 2.0% Kompovet	8,3	11,8	111,3	12	102,6	13	104	4.7 ns	111,9
IV – 0.5% Kokovet	8,3	11,8	111,3	12,8	109,4	13,3	106,4	5.0 *	119

*(P≤0.05), ** (P≤0.01), *** (P≤0.001), non-significant – ns

The positive results, obtained by fertilizing plants with the two organic fertilizers were probably due to the high content of fulvic and humic acids and the microelements that activate the metabolic processes by providing economical use of moisture.

CONFLICT OF INTEREST: The authors declare no existing conflict of interest.

AUTHOR CONTRIBUTION STATEMENT: BA designed the experiment. BA analyzed the data. BA and DM wrote the manuscript.

CONCLUSIONS

When plants are treated with the tested fertilizers, the beginning of the flowering starts with 4 to 6 days earlier compared to the non-treated plants and the flowering period also increases with 4 to 6 days.

In the root fertilization of plants with Kompovet and Kokovet the values of height and diameter of the plants are bigger than those of non-fertilized plants, as most pronounced effect is obtained with Kokovet, where plants are 29.4% higher and 19.0% larger.

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