Journal of Agricultural Sciences
Vol. 52, No 2, 2007
Pages 105-113

UDC: 653.918
Original scientific paper

EFFECT OF APPLING DIFFERENT RATES OF SLOW - DISINTEGRATING FERTILIZER ON THE QUALITY OF MARIGOLD (*Tagetes patula* L.) AND SCARLET SAGE SEEDLINGS (*Salvia splendens* L.)

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Abstract: The paper investigates the effect of applying different rate of slow disintegrating fertilizer *Scotts* (*Osmocot Exact*) with the formula 15:9:9:MgO+Me to the quality of seedlings of marigold and scarlet sage. The marigold and scarlet sage seedlings were grown in poly-propylene containers (*speedling system*) and poly-propylene pots (*pot system).* Slow disintegrating fertilizer rate have been applied to the seedlings in the course of their growing (0, 1, 2, 3, i 4 g/l). The obtained data show that the 4g/l substrate rate of slow disintegrating fertilizer has significant effects on the studied parameters of seedlings quality of studied species.

Key words: slow disintegrating fertilizer, marigold, scarlet sage, seedlings.

Introduction

Flower seedlings growing in this country is still carried out in a traditional manner, by growing plants with the unprotected root system (so-called “bare roots” system) (Hanić, 2000). During the production, the producers often use inadequate substrates, unfit for the grown species and development phase, so different problems arise during the production, and low quality seedlings as a result (Beatović et al., 2006, Vujošević et al., 2007).

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Project TR-6900B: "Application of slow disintegrating fertilizers and natural biostimulators in the commercial production of flowers, medicinal, aromatic and seasoning herbs seedlings". The realization of the project was financed by the Ministry of Science of the Republic of Serbia

An increasing demand for flower seedlings, (Vujošević, A. 2002) has as a result the need to intensify the seedlings production, and one of the ways to achieve this is to use the container production. The container production, according to Marković et al., (1992), has significant advantages compared to a traditional way of production and is applied in contemporary vegetable, flower and horticultural plant growing. The contemporary flower seedlings production, apart from different systems of container production, (Latimer, 1991), is based on the application of different substrates and different slow decomposing fertilizers (Nelson, P.V. 2003).

The application of slow disintegrating fertilizers in the container production of seedlings (*speedling system*) and pots (*pot system*) has been extensive in the production of horticultural plants and flowers, (Belger and Drach, 1989). Also, local researchers have studied the effect of a slow disintegrating fertilizer on the quality of seedlings of medicinal, aromatic and pot herbs (Beatović et al., 2007 a,b,c). The advantageous use of these fertilizers is fact that a single application of the fertilizer completely satisfies a plant's need for minerals. In a comparatively precise time interval, these fertilizers release biogenetic elements. In this way at the very moment of fertilizer's application, and/or at the moment of planting, their complete activation is avoided, which usually happens when applying simple mineral fertilizers. A high concentration of salts in the substrate is avoided in this way, which in case of producing seedlings in containers and pots usually accounts for plants' deterioration (Hanić, 2000).

Marigold (*Tagetes patula* L.) and scarlet sage (*Salvia splendens* L) are annual flowering plants which, due to their decorative features, represent irreplaceable materials for decorating public greens, house lots, gardens, balconies, flower-stands, (Ferrante et al., 2006, Vujošević et al., 2007b). Both species are characterized by a long period of blossoming, starting in May and ending in late autumn, and therefore they are produced more extensively in the planned seasonal production portfolio of local producers of flower seedlings. In order to provide a continuous and extensive blossoming, it is necessary that both flower species have enough food during the whole vegetation period.

This paper aims at studying the effects of applying different rates of slow disintegrating fertilizers to the quality of seedlings of African marigold and Scarlet sage.

Materials and Methods

The researches were conducted during 2007 in the greenhouse of the Faculty of Agriculture in Belgrade. Annual flower species, marigold of series *Bonanza* and scarlet sage of series *Scarlet Queen* werw used for the experiment. The experiment was conducted in two phases. During the first phase the seeds were sown in poly-propylene containers with 144 combs (870 plants/m^2). A commercial substrate for sowing seeds and seedlings production, consisting of white peat (70%) and black peat (30%) with salt contents of about 0.5 – 1.1g/l and pH value between 5.2 and 6.0, was used. The sowing of seeds was carried out on 11 February 2007.

After first two pair of leaves had appeared, the plants were moved to poly-propylene pots of 9 cm in a ready commercial substrate (*Floragard*), and the second phase of the experiment was initiated in which the effect of slow disintegrating fertilizer was studied in accordance with the application of the following rates:

1. 0 (control)
2. 1g/l of substrate
3. 2g/l of substrate
4. 3g/l of substrate
5. 4g/l of substrate

Slow disintegrating fertilizer *Scotts* (*Osmocot Exact*) with the formulation 15:9:9:MgO+Me was used in the experiment. The fertilizer was applied to the plants after they had been transplanted, in the phase when they had two pairs of permanent leaves. The seedlings production was carried out in optimal and everyday monitored conditions, which was a necessary precondition for a successful production (optimal day – night temperature, optimal relative air humidity, substrate humidity). During the seedlings production, standard measures of attending the seedlings were used: watering, shading and aeration. The seedling production lasted until May 2007. The random sample method was used and 30 plants of each series were taken for further analysis.

The following parameters of seedlings quality were analyzed: plants' height (cm), above-ground mass (g), number of side arms, number of flowers - inflorescence, length of inflorescence (cm).

In accordance with the research, the statistic analysis of the obtained results was conducted by using parameter and non-parameter tests. The results of the research were reflected in descriptive statistics basic indicators (variation interval, arithmetic mean and its standard error, Mediana test and variation ratio). With respect to the objective of the study, the equality of variants of analyzed treatments has been tested by means of applying the *Levene* test and in accordance with the obtained results, the statistical significance of differences between average values for each studied parameter was studied by applying the variant analysis (ANOVA), *Kruskal-Wallis* test and Mediana test. Individual comparisons of two means were conducted by using the test of minimal significant difference and Mann-Whithey U test (Hadživuković,1977).

Results and Discussion

The highest average values in respect of plant's height in marigold (Table 1) were obtained by applying the rate of 3g/l slow disintegrating fertilizer (20.21 cm) and minimum in control (13.51 cm). The variation ratios for the analyzed parameter ranged between 11.92 – 16.08% . The rate of 4g/l mostly influenced the average number of side arms on the marigold plant (7.4) and the rate of 3g/l in scarlet sage (5.8) (Table 1 and 2).

The greatest average mass of plants was obtained by applying the greatest rate of fertilizer to both studied – 18.95 g in marigold and 12.31g in scarlet sage (Table 1 and 2). The largest average number of flowers in marigold (3.66) was influenced by fertilizer dose of 2g/l, while the average number of inflorescence (4.23) was mostly influenced by fertilizer rate of 4g/l.

T a b. 1. - Key descriptive statistics indicators for the tested parameters of *African marigold* seedling quality with the use of slow disintegrating fertilizers and critical values of LSD test

Parameters	Rate of slow-disintegrating fertilizers	Iv Interval of variation	$\overline{X} \mp S_{\bar{x}}$ Arithmetical mean ∓ Standard error	M_e Median	Cv (%) Coefficient of variation
Plant height (cm)	0 (test)	10.2 - 19.2	13.51 ∓ 0.397	13.45	16.08
	1 g/l	12.6 – 19.3	16.07 ∓ 0.350	16.00	11.92
	2 g/l	12.8 – 23.7	17.58 ∓ 0.453	17.35	14.12
	3 g/l	14.4 – 27.1	20.21 ∓ 0.591	20.2	16.01
	4 g/l	13.0- 24.6	19.45 ∓ 0.471	19.85	13.25
LSD 0.05 1.274 0.01 1.677					
Number of lateral branches	0 (test)	4 - 8	5.20 ∓ 0.182	5	19.16
	1 g/l	5 - 9	6.63 ∓ 0.200	7	16.55
	2 g/l	5 - 8	6.03 ∓ 0.176	6	15.98
	3 g/l	4 - 10	7.10 ∓ 0.255	7	19.69
	4 g/l	5 - 10	7.48 ∓ 0.243	7.5	17.84
LSD 0.05 0.593 0.01 0.780					
Plant weight (g)	0 (test)	3.19 – 13.68	8.43 ∓ 0.353	8.71	22.96
	1 g/l	5.14 – 16.837	9.83 ∓ 0.408	9.76	22.70
	2 g/l	7.39 – 27.14	13.03 ∓ 0.673	12.64	28.29
	3 g/l	4.55 – 21.46	16.22 ∓ 0.639	16.70	21.57
	4 g/l	14.06 – 24.09	18.95 ∓ 0.474	18.54	13.69
LSD 0.05 1.455 0.01 1.915					
Number of flowers	0 (test)	1-5	2.97 ∓ 0.189	3	34.83
	1 g/l	1-7	3.27 ∓ 0.283	3	47.51
	2 g/l	2-5	3.67 ∓ 0.168	4	25.15
	3 g/l	0-5	2.98 ∓ 0.227	3	41.97
	4 g/l	0-5	2.58 ∓ 0.207	2.5	44.22
LSD 0.05 0.606 0.01 0.798					

The effect of applying slow disintegrating fertilizers and positive effect of different rates has been shown in researches of seedlings production of medicinal herbs *Jelačić et al.*, 2006, 2007, *Beatović et al.,* 2007 a,b,c

T a b. 2. - Key descriptive statistics indicators for the tested parameters of S*carlet sage* seedling quality with the use of slow disintegrating fertilizers and critical values of LSD test

Parameters	Rates of slow-disintegrating fertilizers	Iv Interval of variation	$\bar{X} \mp S_{\bar{x}}$ Arithmetical mean ∓ Standard error	M_e dian	Cv (%) Coefficient of variation
Plant weight (g)	0 (test)	3.92-6.32	4.86 ∓ 0.117	4.70	13.16
	1 g/l	5.14-10.82	7.35 ∓ 0.276	7.16	20.51
	2 g/l	6.29-13.13	8.42 ∓ 0.250	8.04	16.27
	3 g/l	8.07-16.83	11.70 ∓ 0.349	11.51	16.35
	4 g/l	9.11-15.13	12.31 ∓ 0.300	12.17	13.32
LSD 0.05			0.748		
0.01			0.985		
Number of lateral branches	0 (test)	2 - 5	3.13 ∓ 0.115	3	20.06
	1 g/l	3 - 10	4.60 ∓ 0.302	5	35.92
	2 g/l	3 - 8	4.63 ∓ 0.176	5	20.81
	3 g/l	4 - 10	5.80 ∓ 0.264	5	24.96
	4 g/l	4 - 8	5.60 ∓ 0.218	5.5	21.28
LSD 0.05			0.408		
0.01			0.537		
Number of flowerlet	0 (test)	2 – 3	2.93 ∓ 0.046	3	8.64
	1 g/l	2 – 8	3.60 ∓ 0.252	3	38.32
	2 g/l	2 – 7	3.50 ∓ 0.171	3	26.79
	3 g/l	2 – 8	3.70 ∓ 0.199	3.5	29.39
	4 g/l	3 - 6	4.23 ∓ 0.124	4	16.03
LSD 0.05			0.480		
0.01			0.631		
Length of flowerlet (cm)	0 (test)	6.6 – 12.5	8.89 ∓ 0.239	8.75	14.70
	1 g/l	8.2 – 20.2	13.38 ∓ 0.590	12.6	24.15
	2 g/l	9.2 – 22.2	14.17 ∓ 0.551	13.65	21.30
	3 g/l	8.4 – 23.3	15.26 ∓ 0.545	15.35	19.56
	4 g/l	5.6 – 22.3	15.74 ∓ 0.617	16.2	21.46
LSD 0.05			1.460		
0.01			1.922		

The results of *Levene* test (Table 3) show that variants are homogenous for all studied features in marigold, therefore the significance of average values has been tested by parameter model analysis of a variant (ANOVA).

The values regarding the feature - number of flowers are not homogenous in samples (Cv>30%), therefore the testing of the hypothesis has been conducted by using non-parameter tests, Kruskal Wallis test and mediana test (Table 3).

The increase of rates of slow disintegrating fertilizer in marigold (Table 1) statistically increases to a great extent the average values of above-ground mass, height, number of side arms, while the number of flowers has been significantly reduced. The application of rates greater than 2g/l, the average number of flowers is statistically significantly (3g/l), and/or very significantly (4g/l) reduced (Table 1).

T a b. 3. - The results of Levene's variance homogenity test, ANOVA, Kruskal-Wallis test and median tests for the use of slow-disintegrating fertilizers African marigold

Parameters	Levene-ov test		ANOVA		Kruskal-Wallis –ov test		Median test	
	F	p	F	p	H	p	χ^2	p
Plant height (cm)	2.05	0.090	34.35	0.000	-	-	-	-
Number of lateral branches	1.52	0.198	17.60	0.000	-	-	-	-
Plant weight (g)	2109	0.083	69.32	0.000	-	-	-	-
Number of flowers	1.543	0.193	3.49	0.009	14.183	0.07	10.971	0.027

p<0,05 (*) the difference is significant
p<0,0 1 (**) the difference is highly significant

The results of *Levene* test (Table 4) show that in scarlet sage the variable treatments are not homogenous in relation to studied features, therefore the hypothesis of equality of average values of studied indicators after the application of different doses of slow disintegrating fertilizers has been tested by non-parameter models (Kruskal-Wallis test and Mediana test). Used i.e. studied rates of slow decomposing fertilizer cause statistically very significant differences in average values of all studied parameters of seedlings quality of scarlet sage, meaning that the increase of fertilizer doses results in the increase of average values of studied parameters.

T a b. 4. - The results of Levene's variance homogenity test, and non-parametric tests Kruska-Wallis and median test for the use of slow-disintegrating fertilizer Scarlet sage

Parameters	Levene-ov test		Kruskal-Wallis-ov test		Median test	
	F	p	H	p	χ^2	p
Plant weight (g)	5.384	0.000	120.882	0.000	97.06	0.000
Number of lateral branches	5.960	0.000	69.02	0.000	36.52	0.000
Number of flowerlet (g)	6.346	0.000	46.595	0.000	53.42	0.000
Length of flowerlet (cm)	3.832	0.005	66.32	0.000	53.79	0.000

p<0,05 (*) the difference is significant
p<0,0 1(**) the difference is highly significant

The application of the smallest rate of fertilizer (1g/l) in scarlet sage statistically very significantly all studied parameters increase compared to the control variant (Table 4). Also, the application of the greatest rate of 4g/l of slow disintegrating fertilizer results in the increase of average values of all studied parameters. The rate of 4 g/l statistically influences to a great extent the increase of number of inflorescence.

The obtained results are in accordance with previous studies of a medicinal sage (*Salvia officinalis*), Jelačić et al., 2006. Similar results were obtained in studies of Van Lerselet al., 1998, of scarlet sage and other flower species.

Conclusion

The results of studies show a significant, positive and justified effect of applying different rates of slow disintegrating fertilizer in production of marigold and scarlet sage seedlings. The application of these fertilizers results in good quality seedlings, therefore their application is justified, which was the objective of the research.

The application of 4g/l rate of slow disintegrating fertilizer during production gives the best results in relation to the increase of above-ground mass of studied species. Also, the application of 4g/l rate of in scarlet sage significantly increases the average number of inflorescences comparised to smaller rates, therefore such dose can be recommended as the best rate in this case.

The application of 3g/l rate prodaces has great results in production of seedlings of both species compared to the application of 4 g/l, since the results show quality differences in favour of a greater rate, however these are not significant for the studied parameters of height, number of side arms and number of inflorescence in marigold, and/or above-ground mass, number of side arms and length of inflorescence in scarlet sage. The study results show that this new approach in the production of seedlings of marigold and scarlet sage with the application of slow disintegrating fertilizers significantly improve the production technology to-date.

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Received December 11, 2007
Accepted December 31, 2007

UTICAJ RAZLIČITIH DOZA SPORORAZLAGAJUĆEG ĐUBRIVA NA KVALITET RASADA KADIFICE (*Tagetes patula* L.) I UKRASNE ŽALFIJE (*Salvia splendens* L.)

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R e z i m e

U radu je ispitivan uticaj različitih doza spororazlagajućeg đubriva *Scotts* (*Osmocot Exact*) formulacije 15:9:9:MgO+Me na kvalitet rasada kadifice i ukrasne žalfije. Rasad kadifice i ukrasne žalfije je proizveden u polipropilenskim kontejnerima (*speedling system*) i polipropilenskim saksijama (*pot system)*. U toku proizvodnje rasada dodavano je spororazlagajuće đubrivo u dozama (0, 1, 2, 3, i 4 g/l). Dobijeni rezultati ukazuju da doza spororazlagajućeg đubriva od 4g/l supstrata značajno utiče na ispitivane parametre kvaliteta rasada ispitivanih vrsta.

Primljeno 11. decembra 2007.
Odobreno 31. decembra 2007.

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Projekat TR-6900B:"Primena spororazlagajućih đubriva i prirodnih biostimulatora u komercijalnoj proizvodnji rasada cveća, lekovitog, aromatičnog i začinskog bilja". Sredstva za realizaciju projekta obezbedilo Ministarstvo nauke Republike Srbije.