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EFFECTS OF DIFFERENT SUBSTRATES ON BASIL SEEDLINGS QUALITY (*Ocimum basilicum* L.)

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Abstract: In this study five different substrates were used, such as: compost; mixture of compost, Lumbrikus H and garden soil; mixture of compost and Lumbrikus H; mixture of compost, Lumbrikus H and peat Galicina and Seedling Klassman substrate. Basil seedling was produced in containers according to "speeding" system. The studies have shown that the best quality of basil seedling of variaties Genovese and Lattuga is achieved when the mixture of substrates Compost, Lumbrikus H and Galicina peat are applied in the volume proportion of 50% : 30% : 20%.

Key words: basil seedling, variety, substrates, container production.

Introduction

Basil belongs to the group of aromatic multipurpose plant species of special significance for the Mediterranean region (Putievsky, 2001). In our climatic conditions basil is grown in open field, from the first decaded of May to the end of September (Jelačić, 1995).

Basil production in a protected area, with additional warming is possible during the entire year. That is why special attention is paid to the production of quality and healthy basil seedlings as one of the most significant moments in the technology of production.

Container production of seedlings, with the use of different substrates, has a number of advantages in comparison to classical production and it found its

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application in the vegetable and fruit growing production a long time ago (Marković et al., 1992; Hanić, 2000). In our country medicinal, aromatic and seasoning herbs seedlings are still produced in a classical way - the so-called bare root (plants with unprotected root system) in cold and warm seedbeds. Garden soil is most frequently used as a substrate, and in this kind of production plants suffer from stress during transplantation, and as a result take longer time for rooting and continuation of growth and development.

Contemporary production of medicinal species of herbs in the world is conducted in different containers according to the system of protected root system, with the use of different growing substrates (McGinnis et al., 2004; Atiyeh et al., 2000; Fernandes et al, 2004; Tesi et al., 1995). The selection of suitable substrate is highly significant for the production of seedlings (Bures et al., 1993).

The purpose of this study is to find the most favourable substrate for container production of basil.

Material and Methods

Two varieties of basil "Genovese" and "Latuga" and five different substrates, i.e. soil mixtures were used in the following volume proportions:

A. Compost (100%) – disinfected compost of warm seedbeds
B. Compost, Lumbrikus H and garden soil (50% : 30% : 20%)
C. Compost and Lumbrikus H (70% : 30%)
D. Compost, Lumbrikus and Galicina peat (50% : 30% : 20%)
E. Seedling Klasmann substrate (100%)

The following components for mixture were used: Lumbrikus H - concentrated humus of the chemical composition 1% N, 1.29% P_2O_5, 0.70% K_2O, 2.10% Ca, 0.50% Mg, organic substance 20.5%, mineral substance 19.8 and pH 7.5., Galicina peat of the composition (2.27% N, 32.40 mg/100g P_2O_5, 50.00 mg/100g K_2O, 1.60% Ca, 0.21% Mg, organic substance 75.27%, mineral substance 24.73% and pH 4.8-5.0) and Seedling Klasmann substrate (1.034% N, 0.94% P_2O_5, 0.64% K_2O pH 5.88).

The experiment was conducted in the green-house of the Faculty of Agriculture of Belgrade during 2005. The basil seedling was produced in containers according to "Speeding" system in three repetitions. Containers made of styrofoam, 53 cm x 31 cm x 5,5 cm in size, with 40 cells each were used. The volume of one cell is 76 cm^3. On the surface of 1 m^2 there are 148 cells.

Sowing basil seeds in containers, previously filled with disinfected, substrates was conducted on March 26, 2005 with two seeds in each cell. After

cropping one plant was left in each cell. During the experiment normal measures of seedling care were applied: watering, shading and ventilation.

Seedling production lasted 56 days when the plants were in the phase of 3-4 pairs of leaves.

Prior to the analysis (measuring), the plants underwent the procedure of "tempering". By random sampling method, 32 plants were selected from each variant of substrates. In analyzed plants height (cm), fresh and dry root (g) and root volume (cm^3) were measured by the method of submerging root into a measuring cup with water.

The analysis of experimental results was conducted by means of descriptive and analytical statistics with statistical package STATISTICA.

Of the central tendency indices arithmetical mean ($\bar{X}$) and mediane (M_e) were calculated. Data variability was quantified through interval of variation (I_v), standard deviation (S), standard error ($S_{\bar{x}}$) and coefficient of variation (C_v).

With the aim of rendering objective conclusions on the influence of applied substrates on the quality of basil seedlings, homogenity of variances analyzed treatments was tested with Levene's test as well as the congruence of data distribution with the normal distribution model with Kolmogorov-Smirnov's, Lilliefors' and Shapiro-Wilks' test.

Testing the differences between the treatments was conducted by analysis of variance (ANOVA), lsd-test, t-test, Kruskal-Wallis' and Mann-Whitney's test.

Since the quality of the substrates was observed through the effects on six characteristics, discrimination effect was used to determine synthetical rank, expressed by I-distance.

Results and Discusion

Based on the presented results through the main statistical indices in Tab. 1, the lowest average values for all analyzed parameters of the quality of basil seedling, variety Genovese, were obtained on Compost (substrate A). The greatest effect was shown in average values of the tested parameters with the use of Compost + Lumbrikus H + Galisina peat (substrate D).

Similar results were obtained by Tesi et al. (1995) by growing basil on the substrate of Cultural F of dark peat, with the use of different treatments, densities and doses of fertilizers.

The obtained average values for analyzed parameters: dry plant mass and dry root mass were in accordance with the studies of McGinnis et al. (2004) who experimented with different doses of fertilizers and the share of vermincompost in substrates.

Coefficients of variation (C_v) for all substrates and all analyzed indices have values less than 30%, which means that empirical series contain homogenous data.

T a b. 1. - Results of descriptive statistics for variety Genovese

Characteristics	Substrates	$\overline{X}$	M_e	I_V	S	$S_{\bar{x}}$	C_v (%)
Plant height (cm)	A	19.406	19.20	17.200-21.800	1.252	0.221	6.45
	B	21.134	20.75	19.200-23.400	1.328	0.235	6.28
	C	21.259	21.35	19.300-23.000	1.145	0.202	5.39
	D	22.978	23.20	21.600-23.900	0.7795	0.138	3.39
	E	22.028	22.15	20.200-24.000	0.973	0.172	4.42
Fresh plant mass (g)	A	3.003	3.00	2.410-3.796	0.322	0.057	10.73
	B	3.375	3.42	2.524-3.917	0.341	0.060	10.10
	C	3.536	3.56	2.735-4.387	0.441	0.078	12.47
	D	4.035	4.06	3.303-4.867	0.319	0.056	7.91
	E	3.816	3.83	3.400-4.190	0.211	0.037	5.53
Dry plant mass (g)	A	0.297	0.29	0.226-0.376	0.037	0.006	12.39
	B	0.307	0.31	0.237-0.369	0.033	0.006	10.84
	C	0.318	0.31	0.242-0.384	0.039	0.007	12.26
	D	0.375	0.37	0.320-0.432	0.035	0.006	9.47
	E	0.356	0.35	0.320-0.392	0.022	0.004	6.18
Fresh root mass (g)	A	1.936	1.95	1.291-2.643	0.352	0.062	18.18
	B	2.223	2.26	1.509-2.985	0.396	0.070	17.84
	C	2.261	2.27	1.229-2.971	0.445	0.079	19.68
	D	2.502	2.54	1.895-3.038	0.331	0.058	13.23
	E	2.378	2.33	2.102-2.811	0.169	0.030	7.11
Dry root mass (g)	A	0.106	0.11	0.099-0.119	0.004	0.001	3.96
	B	0.109	0.11	0.103-0.120	0.004	0.001	3.76
	C	0.113	0.11	0.106-0.122	0.005	0.001	4.16
	D	0.122	0.12	0.117-0.128	0.003	0.0006	2.62
	E	0.118	0.12	0.110-0.129	0.005	0.001	4.20
Root volume (cm^3)	A	1.546	1.60	1.000-2.200	0.308	0.006	19.92
	B	1.750	1.65	1.200-2.600	0.410	0.084	23.41
	C	1.929	1.90	1.300-2.600	0.372	0.076	19.28
	D	2.444	2.40	2.100-2.900	0.284	0.059	11.63
	E	2.279	2.30	2.000-2.6000	0.213	0.043	9.35

Distribution of extreme values coefficients of variation for characteristics and varieties is shown in tables 3 and 4.

In the variety Lattuga, the highest average values (tab. 2) were obtained with the mixture: Compost + Lumbrikus H + Galicina peat (substrate D), while the lowest values were obtained on Compost (substrate A).

In comparison to the results of research of T e s i et al. 1995. somewhat higher average values were obtained for the tested parameters.

Also, in the variety Genovese, coefficients of variation (C_v) for all substrates and all analyzed indices have values less than 30%, which means that the empirical series contain homogenous data. The distribution of extreme values of coefficients of variation for characteristics and varieties is shown in tables 3 and 4.

Objective conclusions on the effect of substrates on the quality of basil seedlings can be drawn based on the results of testing hypotheses on the equality of average values of characteristics, through which their quality is shown. The established hypotheses can be tested with parametrical and non-parametrical tests.

T a b. 2. - Results of descriptive statistics for the variety Lattuga

Characteristics	Substrates	$\overline{X}$	M_e	I_V	S	$S_{\bar{x}}$	C_v (%)
Plant height (cm)	A	20.281	20.20	18.500-22.400	1.157	0.204	5.70
	B	21.709	22.05	20.000-23.100	1.016	0.180	4.68
	C	22.359	22.25	20.800-23.800	0.758	0.134	3.39
	D	24.119	24.15	22.400-26.600	1.110	0.196	4.60
	E	23.775	23.85	21.400-25.200	0.981	0.173	4.13
Fresh plant mass (g)	A	4.925	4.85	4.034-5.957	0.500	0.088	10.14
	B	5.326	5.21	4.340-6.572	0.554	0.098	10.40
	C	5.629	5.71	4.908-6.509	0.373	0.007	6.62
	D	6.223	6.27	5.419-6.991	0.387	0.068	6.22
	E	5.952	5.94	5.525-6.606	0.236	0.042	3.97
Dry plant mass (g)	A	0.556	0.56	0.436-0.669	0.061	0.011	10.97
	B	0.601	0.59	0.419-0.953	0.100	0.018	16.70
	C	0.318	0.31	0.242-0.384	0.039	0.007	12.34
	D	0.656	0.65	0.574-0.786	0.048	0.009	7.39
	E	0.652	0.64	0.507-0.791	0.0723	0.013	11.09
Fresh root mass (g)	A	2.058	2.00	1.628-2.804	0.222	0.039	10.78
	B	2.140	2.12	1.863-2.610	0.189	0.033	8.84
	C	2.194	2.12	1.962-2.875	0.240	0.042	10.95
	D	2.443	2.41	1.863-3.121	2.252	0.044	10.31
	E	1.806	1.80	0.968-2.411	0.517	0.092	28.65
Dry root mass (g)	A	0.112	0.11	0.081-0.131	0.012	0.002	11.06
	B	0.120	0.12	0.110-0.140	0.006	0.001	5.08
	C	0.124	0.13	0.099-0.152	0.013	0.002	10.74
	D	0.138	0.14	0.123-0.157	0.007	0.001	4.85
	E	0.129	0.13	0.120-0.141	0.005	0.001	3.89
Root volume (cm^3)	A	1.608	1.60	1.000-1.800	0.200	0.041	12.42
	B	1.817	1.80	1.200-2.400	0.368	0.075	20.25
	C	1.888	1.80	1.400-2.400	0.268	0.055	14.17
	D	2.242	2.20	1.800-2.600	0.236	0.048	10.52
	E	2.050	2.00	1.800-2.400	0.159	0.032	7.75

The assumption for the application of the statistical method of analysis of variance (ANOVA) that each subset must be normally distributed was tested with Kolmogorov-Smirnov's, Lilliefors' and Shapiro-Wilks' test. The test results show that this prerequisite was not fulfilled in all cases.

Another assumption that the samples derive from the main sets with equal variances was tested with Levene's test.

The obtained results (tab. 3 and 4) show that the variances are non-homogenous for all tested characteristics, except for the plant height of the basil of variety Lattuga and dry root mass in the plants of variety Genovese. Therefore, the assumptions of parametrical methods of testing were disrupted.

Bearing this in mind, testing the differences of treatments was conducted with non-parametrical test, but also with parametrical tests.

The results of ANOVA and the adequate non-parametrical test, Kruskal-Wallis' test, are identical and show that the average values of all tested characteristics of the seedling quality depend highly significantly on the applied substrate. However, in comparison with the results of individual tests (lsd, t and Mann-Whitney) the effects of some substrates on individual characteristics of quality do not differ at all, or differ significantly, but not highly significantly.

Therefore, as shown in table 3, with the use of substrate D and E plants of variety Lattuga are obtained, which do not differ significantly in their height.

Based on the results of lsd-test, we can conclude that with the use of substrate A, the same average mass of fresh root is obtained as with the use of substrate B or C, as well as that the substrates B and C have the same effect on the dry root mass of the variety Lattuga.

The relations of effects of substrates on other tested characteristics are shown in tables 3 and 4.

T a b. 3. - Results of analytical statistics for the variety Genovese

Indices		Characteristics					
		Height	Fresh plant mass	Dry plant mass	Fresh root mass	Dry root mass	Root volume
Min		A	A	A	C	A	A
Max		E	D	C	D	E	D
Arithmetical mean	min	A	A	A	A	A	A
	max	D	D	D	D	D	D
Mediane	Min	A	A	A	A	A	A
	Max	D	D	D	D	D	D
Variation coefficient	Min	D	E	E	E	D	E
	max	A	C	A	C	E	B
Levene's test		XX	XX	XX	XX	NZ	X
ANOVA		XX	XX	XX	XX	XX	XX
Kruskal-Wallis' test		XX	XX	XX	XX	XX	XX
Lsd	no significant	A-C	A-C	B-A,C	B-C,E E-C,D	-	B-C D-E
	significant	-	-	D-E	-	-	A-B
Mann-Whitney	no significant	B-C	B-C	B-A,C	B-C,E C-D,E D-E	-	B-A,C D-E
	significant	-	-	A-C D-E	-	-	-
t-test	no significant	B-C	B-C	B-A,C	B-C D-E	-	B-A,C
	significant	-	-	A-C D-E	E-B,C	--	D-E

no significant $p>0.05$
significant $0.01<p<0.05$

T a b. 4. - Results of analytical statistics of the variety Lattuga

Indices		Characteristics					
		Height	Fresh plant mass	Dry plant mass	Fresh root mass	Dry root mass	Root volume
Min		A	A	C	E	A	A
Max		D	D	B	D	D	D
Arithmetical mean	min	A	A	A	E	A	A
	max	D	D	D	D	D	D
Mediane	Min	A	A	A	E	A	A
	Max	D	D	D	D	D	D
Variation coefficient	Min	B	E	E	B	E	E
	max	A	B	A	E	A	B
Levene's test		nz	XX	XX	XX	XX	XX
ANOVA		XX	XX	XX	XX	XX	XX
Kruskal-Wallis' test		XX	XX	XX	XX	XX	XX
Lsd	no significant	D-E	-	B-C D-E	A-B,C B-C	B-C	A-C
	significant	B-C	D-E	C-D,E	-	C-E	E-C,D
Mann-Whitney	no significant	D-E	-	A-B,C D-E	E-A,B,C	C-E	B-C
	significant	B-C	-	E-B,C	A-B	B-C	B-A,E
t-test	no significant	D-E	-	D-E	B-A,C	C-B,E	B-C
	significant	B-C	-	B-A,E	A-C,E	-	A-B C-E

no significant $p>0.05$
significant $0.01<p<0.05$

The order of the substrates based on average values is not identical for all analyzed quality characteristics, so total discrimination effect was used to determine synthetical rank in the work, expressed with I-distance. The rank determined, based on I-distance, is the same for both varieties.

The best quality of seedlings was achieved with the use of substrate D, followed by E, then C, then B and the lowest quality of seedling was achieved with the use of substrate A.

C o n c l u s i o n

In the production of medicinal, aromatical and seasoning herbs seedlings, the existing technologies are developed and new technologies are discovered.

With the use of natural peat, compost and other materials improved by adding different materials of organic and mineral origin in the form of available nutrients and growth biostimulators.

Based on the research of the effects of different substrates on the parameters of the quality of basil seedling, we can conclude that:

- With the production of basil seedlings in containers according to "speeding" system we obtain quality planting material, ready for transplanation and further production;
- With the use of mixture: Compost + Lumbrikus H + Galicina peat (substrate D) the best results of seedling quality were achieved for both varieties;
- In the variety Lattuga somewhat higher average values of tested parameters were obtained, which can be exploined that this variety reacts better on the applied substrates;
- The consequences of disruption of the assumptions that parametrical testing of average values is based on have not been completely studied yet;
- Evaluations of the sensitivity of method on the failure of the assumptions start from extreme insensitivity to the opinion that insensitivity is simply a myth;
- In the conducted study differences in the form of data distribution and variances heterogenity led to the same conclusions, only with slighly altered probability.

REFERENCES

1. Atiyeh,R.M., Subler, S., Edwards, C.A., Bachman, G., Metzher, J.D., Shuster, W. (2000): Effects of vermicomposts on plant growth in horticultural container media and soil. Pedobiologia. 44:579-590.
2. Beeson, Jr., R. C. (1996): Composted yard waste as a component of container substrates. Journal of Environmental Horticulture 14, 115-121.
3. Bures, S., Pokorny, F.A., Dunavent, M.G. (1993): How to Build Container Media from the Characteristics of their components. Sna Research Conference, Vol.38, p 124-125.
4. Fernandes, P.C., Facanali, R., Teixeira, J.P.F., Furlani, P.R., Marques, M.O.M. (2004): Culture of basil i substrata and hydroponic system under protected environment. Horticultura Brasilera, Vol.22, p.260-264.
5. Gajdos, R. (1997): Effects of two composts and seven commercial cultivation media on germination and yield. Compost Science and Utilization 5, 16-37.
6. Hanić, E. (2000): Significance of substrates, containers and hormones in seedling production, University "Džemal Bijedić" Mostar, Mediteranean culture studio.
7. Jelačić Slavica (1995): The effect of density and method of establishing crops on the yield and quality of basil – *Ocimum basilicum* L. Master's thesis, Faculty of Agriculture, Belgrade.
8. Lakić Nada, Stevanović, S. (2003): Ranking of Vojvodina Municipalites according to multidimensional denominator of livestock production commodities, Journal of Agricultural Sciences, Vol. 48, No.2, p. 217-226, Faculty of Agriculture, Belgrade.
9. Marković, V., Takač, A., Voganjac, L. (1992): Container production of seedlings, Collection of works V Symposium "Intense production of sanitary safe vegetable", Contemporary Agriculture, Vol. 40, number 1-2 (1992), page. 11-14.
10. McGinnis, M.S., Warren, L., and Bilderback, T.E. (2004): Effect of Vermicompost Amended Pine Bark on Basil Production, Container-Grown Plant Production, Sna Research Conference, Vol. 49. p.120-123.

11. Putievsky, E., Dudai, N., Lewinsohn, E., Ravid, U. (2001): Cultivation and production of new species in the mediterranean, World Conference on Medicinal and Aromatic Plant, Abstract-Map Hungary, 57. Budapest
12. Tesi, R., Ghiselli, L., Tallarico (1995): Ricerche sulla coltivazione del basilico in contenitore Colture Protete, N. 12, p.61-66.

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UTICAJ RAZLIČITIH SUPSTRATA NA KVALITET RASADA BOSILJKA (*Ocimum basilicum* L.)

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R e z i m e

U radu je ispitivano pet različitih supstrata kao što su; kompost; mešavina komposta, Lumbrikusa H i baštenske zemlje; mešavina komposta i Lumbrikusa H; mešavina komposta, Lumbrikusa H i treseta Galicine i Seedling Klassman supstrat.

Rasad bosiljka je proizveden u kontejnerima po »speeding« sistemu. Ispitivanja su pokazala da se najbolji kvalitet rasada bosiljka sorata Genovese i Lattuga ostvaruje pri mešavini supstrata Komposta, Lumbrikus H i Galicina treseta u zapreminskom odnosu od 50% : 30% : 20.

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