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INFLUENCE OF SEEDLING QUALITY ON THE BIOLOGICAL MANIFESTATIONS AND PRODUCTIVITY OF GREENHOUSE SALAD

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Abstract

The characteristics of seedlings to a great extent determine the quality and describe the success of production after planting. In an experiment carried out with winter-spring planting in an unheated glasshouse the influence of seedlings mixture on the main characteristics and the productivity of leaf lettuce variety Malvine.Four variants of nurseries grown with different seedlings mixtures have been set up as follow: 1.Peat -100% (control); 2.Peat 88% +Perlite 12%; 3.Peat 80% + Perlite 10% + Pine shavings Peat 79.85% + Perlite 10.52% + Pine shavings 10.53%. The aggregated results show that Peat 79.85% + Perlite 10.52% + Pine shavings 10.53% is with the highest vegetative growth and development, as exceeded the control for all indicators: 2% - 3% for the whole plant, 8% for the leaves, and 1% -2 % by diameter of the rosette. This study gives us reason to recommend as a hopeful for salad planting winter-spring season in unheated glasshouse mixture: Peat 79.85% + Perlite 10.52% + Pine shavings 10.53%.

Key words*: correlations, greenhouse, growth and productivity, nurseries mixture, salad (lettuce).*

INTRODUCTION

Salad is a widely cultivated field and greenhouse crop. A significant part of the production during the autumn-winter and the winter-spring period takes place in steel-glass greenhouses, in order to the yearly supply of the population. Salad is a rich source of vitamins, polyphenols, minerals, organic acids and other nutrients during the winter and early spring period.

Getting high earnings was and will be a major factor in the development of the sub-sector, regardless of the country in which the production takes place. High incomes are based above all on the sharp increase in yields per unit area in the cultivation equipment compared to outside area. The competitive surroundings in which greenhouse salad growers work imposes the need for continuous improvement of the economic results and technological upgrading of the manufacture in order to reduce the cost price of the production.

The main way for salad production in Bulgaria is by growing seedlings containers. An important point for obtaining quality seedlings is the choice of a mixture that has appropriate water-physical properties and provides nutrients necessary for the growth of the young plants. On the other hand, substrates in the mixture must be of low-cost materials to reduce manufacturing costs.

A number of authors point out that the alternative substrates can increase salad yield by producing higher quality seedlings, some of which also reduce the time of seedlings production and produce earlier crops (Xiumin et al., 2002; Möller et al., 1998; Bilalis et al., 2009; Carmona et al.,2012; Fincheira et al., 2016; Castoldi et al., 2014; Costa et al., 2001; Moraiset al., 2018; Luz et al., 2004; Bustamantea et al, 2008;Güla et al., 2005).

The aim of the study was through correlation and regression dependencies between some biometric indicators of the plant to establish a suitable mixture for growth of salad seedlings for planting during the winter-spring period in unheated polythene greenhouses.

MATERIALS AND METHODS

For the needs of the experimental work in 2014-2015, in the heated steel-glass greenhouses of LLC, seedlings of variety Melvine were grown.

The experiment was set in unheated steel-glass greenhouses at the Agricultural University - Plovdiv. To determine the influence of the

seedlings mixture on the plant growths, 4 variants with different composition of the mixture were tested. The main substrate for the preparation of the mixtures was peat. The used peat Durpeta had the following composition: 250.0 mg/l nitrogen, 250.0 mg/l phosphorus, 270.0 mg/l potassium and 1.2 mg/l Fe, Cu, Mn, Mo, B and Zn. The salt concentration measured in microsymens was 1.2 and pH was 6.5-7. The contained pinewood substrate in the mixture contains: pH (H_2O) - 5.28, P_2O_5 9.41mg/kg, K_2O 904.78 mg/kg, CaO-1086.89mg/kg, MgO-223.27mg/kg, Na_2O- 62.87mg/kg, S-4.82mg/kg, total N- 0.06%, organic C - 48.23%, C/N 803.83.

The following variants have been studied:

1. Peat 100% - control
2. Peat 88.24 : Perlite 11.76
3. Peat 79.85 : Perlite 10.52 + Pine shavings 10.53
4. Peat 71.43 : Perlite 9.52 : Pine shavings 19.05

The chemical composition of the used mixtures is shown in Table 1.

Table 1. The chemical composition of nurseries mixtures

Variant	pH (H_2O)	P_2O_5, mg/kg	K_2O, mg/kg	CaO, mg/kg	MgO, mg/kg	Na_2O, mg/kg	S, mg/kg	Total N, %	Organic C, %	C/N
1. 100% T–Control variant	6.17	560.07	869.16	17583.80	1390.65	352.88	472.35	0.88	44.12	50.14
2. T 88.24 : P 11.76	6.01	541.79	753.44	16212.11	1311.77	263.18	373.81	0.81	40.76	50.32
3. T 79.85 : P 10.52+ BS 10.53	6.26	413.29	775.72	12766.75	906.10	155.50	365.92	0.72	41.41	57.51
4. T 71.43 : P 9.52 : BS 19.05	6.28	312.34	722.89	11086.44	1074.88	140.33	341.56	0.64	42.69	66.70

The sowing of the seeds was done on November 1 in a styrofoam trays. The plants were planted on Fluvisols on December 18, by scheme 30 x 30 cm, and grown by the standard technology for before winter planting (Aleksiev 1982). The experiment was set by the block method in 4 repeats with the experimental plot size of 10 m^2 with 20 plants in repeat (Barov 1982).

Indicators and methods of study:

Before planting, biometric measurements of 8 seedling plants of each variant were performed. The values of the indicators were determined: stem diameter (mm), number of leaves, fresh mass of the leaf (g), fresh weight of the root system (g), fresh weight of the whole plant (g).

After planting, to determine the influence of seedling mixtures on the plant growths, biometric measurements were performed three times from 1 March in 7 days. The values of the indicators were determined of 8 seedling plants of each variant: fresh stem weight (g), leaf (number), diameter of the rosette (mm), fresh weight of the whole plant (g).

The evaluation of the correlation dependencies in the tested variants was based on the following biometric indicators: stem - x_1; leaves – x_2; diameter of the rosette – x_3; the fresh weight of the whole plant – x_4.

Correlation and regression dependencies are a product of mathematical and statistical processing (Genchev et al., 1975). Processing was done through the SPSS statistical program.

The main aims of the processing are: to evaluate the correlation between certain biometric indicators, typical for the salad, which are changed under the influence of the applied fertilizers, by means of correlation analysis; to find a suitable linear regression model between the mass of the whole plant and the diameter of the rosette.

RESULTS AND DISCUSSIONS

Before planting, the variants did not differ significantly in the diameter indicator of the stem (Table 2). With a larger diameter of the stem compared to the control variant was only the variant grown in

a mixture of Peat 79.85: Perlite 10.52 + Pine shavings 10.53, the rise was 0.7%.

Table 2. Vegetative manifestation of the salad seedlings - average for the period 2014-2015

Variants	Stem diameter		Leaves	Leaf rosette weight		Root system weight		Whole plant weight	
	cm	%	number	g	%	g	%	g	%
1. Peat 100% - control variant	1.44	100.00	4.00	0.71	100.00	0.13	100.00	0.84	100.00
2. Peat 88.24 : Perlite 11.76	1.39	96.53	4.00	0.61	86.60	0.14	105.30	0.75	89.30
3. Peat 79.85 : Perlite 10.52 : Pine shavings 10.53	1.45	100.69	4.00	0.54	76.30	0.13	97.00	0.67	79.67
4. Peat 71.43 : Perlite 9.52 : Pine shavings 19.05	1.33	92.36	4.00	0.44	62.06	0.12	93.10	0.56	67.06

The mass of the leaf rosette was the highest again in the control variant (100 Peat). The differences compared to the control variant ranged from 0.01 to 0.27 g, with the highest value reported for Peat 88.24 : Perlite 11.76. During this period, the plants of the variants with the pine shavings were less developed, as in the variants with the higher percentage of pine shavings the values of the indicators were lower. The mass of the root system had the highest value in the Peat + Perlite variant. The value obtained in this variant exceeds the control variant by 5.3%.

The fresh weight of the whole plant was greatest at the control variant - 0.84g.

The results of the study showed, that after planting, the variants did not differ by the stem weight indicator (Table 3). Only in Peat 71.43: Perlite 9.52: Pine shavings 19.05.the reported value was insignificantly lower - by 0.25g. The number of leaves for the individual variants varies from 32.25 to 35.75.with the highest for Peak 79.85: Perlite 10.52+ Pine shavings 10.53.where the exceed compared to the control variant was 10.9%.

Table 3. Characteristics of the salad plants on average for the period 2014-2015

First measurement after planting								
Variant	Stem		Leaves		Diameter of the rosette		Fresh weight of the whole plant	
	weight,g	%	number	%	cm	%	g	%
1. Peat 100% - control variant	5.75	100.00	32.25	100	35.50	100.0	203.75	100.0
2. Peat 88.24 : Perlite 11.76	5.75	100.00	35.25	109.3	37.00	104.2	208.75	102.5
3. Peat 79.85 : Perlite 10.52+ Pine shavings 10.53	5.75	100.00	35.75	110.9	36.25	102.1	198.75	97.5
4. Peat 71.43 : Perlite 9.52 : Pine shavings 19.05	5.50	95.65	34.00	105.4	34.75	97.9	168.75	82.8
Second measurement after planting								
Variant	Stem		Leaves		Diameter of the rosette		Fresh weight of the whole plant	
	weight,g	%	number	%	cm	%	g	%
1. Peat 100% - control variant	10.00	100.00	36.5	100	37.63	100	267.5	100
2. Peat 88.24 : Perlite 11.76	11.25	112.50	39.5	108.2	38	101	281.25	105.1
3. Peat 79.85 : Perlite 10.52+ Pine shavings 10.53	11.25	112.50	39.5	108.2	38.13	101.3	277.5	103.7
4. Peat 71.43 : Perlite 9.52 : Pine shavings 19.05	10.00	100.00	36.75	100.7	37.63	100	233.75	87.4
Third measurement after planting								
Variant	Stem		Leaves		Diameter of the rosette		Fresh weight of the whole plant	
	weight,g	%	number	%	cm	%	g	%
1. Peat 100% - control variant	12.50	100.00	36.5	100	39	100	317.5	100.0
2. Peat 88.24 : Perlite 11.76	11.25	90.00	39.5	108.2	38.25	98.1	290	91.3
3. Peat 79.85 : Perlite 10.52+ Pine shavings 10.53	12.50	100.00	39.5	108.2	39.5	101.3	323.75	102
4. Peat 71.43 : Perlite 9.52 : Pine shavings 19.05	10.00	80.00	36.5	100	36.37	93.3	237.5	74.8

The control variant had least number of leaves - 32.25. The diameter of the leaf rosette varies slightly - from 34.75 for Peat 71.43: Perlite 9.52: Pine shavings 19.05.where the decrease

compared to the control variant was by 2.1% to 37.00 for Peat 88.24: Perlite 11.76.which exceeds the control variant by 4.2%. Regarding the fresh mass of the whole plant, the highest value was recorded for variant Peat + Perlite - 208.75g. The lowest values were recorded for the variants with pine shavings, as the decrease compared to the control was highest for Peat 71.43: Perlite 9.52: Pine shavings 19.05-17.2%, followed by Peat 79.85: Perlite 10.52 + Pine shavings 10.53-2.5%.

During the second reported period, the values obtained for some of the indicators did not show differences between the tested variants (Table 4). In Peat 88.24: Perlite 11.76 and Peat 79.85: Perlite 10.52 + Pine shavings 10.53, the same values for the stem weight were reported and in terms of the leaves number, the difference compared to the control variant is 8.2%.

The diameter of the rosette for peat 100% - control and Peat 71.43: Perlite 9.52: Pine shavings 19.05 was the same- 37.63cm, and the difference between the variants Peat 88.24: Perlite 11.76 and Peat 79.85: Perlite 10.52 + pine shavings 10.53 was 0.13cm, as a higher value of 38.13 cm was reported in the variant Peat 79.85: Perlite 10.52 + Pine shavings 10.53. Significant were the differences between the variants in regard to the fresh weight indicator of the whole plant. The highest value was reported for the variant Peat 88.24: Perlite 11.76- 281.25 followed by the variant Peat 79.85: Perlite 10.52+Pine shavings 10.53 - 277.50g. Lower with 12.6% compared to the control variant was the value reported for Peat 71.43: Perlite 9.52: Pine shavings 19.05.

Biometric measurements during the third period indicate (Table 3), that only for plants of Peat 79.85: Perlite 10.52+Pine shavings 10.53, the reported values for all indicators were higher or equal to those reported in the control variant. The lowest were the values for the variant with higher content of pine shavings Peat 71.43: Perlite 9.52: Pine shavings 19.05. This was probably due to the fact, that at the time of planting of this variant the plants were the least developed.

In such a study Morais at al.(2018) concluded that: pure coconut fiber without fertigation is not feasible for the production of lettuce seedlings; The substrates formulated with 80% coconut fiber + 20% tanned bovine manure and 60% coconut fiber + 40% tanned bovine manure are suitable for production of lettuce seedlings.

Correlation analysis

Positive correlation relationships were found between the structural elements, determining the productivity of the studied variants (Table 4). A high positive value of r = 0.974 was recorded between the stem weight and the whole plant weight at the first measurement after planting.

Table 4. Correlation dependencies on salad at the first measurement after planting on average for 2014-2015

	x_1	x_2	x_3	x_4
x_1	1			
x_2	0.134	1		
x_3	0.775	0.600	1	
x_4	0.974*	0.100	0.826	1

High positive values (Table 5) of r (r = 0.977 ÷ 0.998) were recorded between the stem weight (x_1), the number of leaves (x_2) and the diameter of the rosette (x_3). The well-pronounced positive correlation between these indicators means, that with the increase in the number of the leaves, the plant productivity will potentially increase. This feature can be used as a reliable criterion for the selection of productive variants.

Positive dependence (Table 6) between the indicators stem weight (x_1), rosette diameter and whole plant weight (x_4) and between the indicators plant diameter (x_3) and whole plant weight (x_4) were found.

Table 5. Correlation dependencies on salad at the second measurement after planting on average for 2014-2015

	x_1	x_2	x_3	x_4
x_1	1			
x_2	0.998**	1		
x_3	0.978*	0.977*	1	
x_4	0.768	0.727	0.736	1

Table 6. Correlation dependencies on salad at the third measurement after planting on average for 2014-2015

	x_1	x_2	x_3	x_4
x_1	1			
x_2	0.302	1		
x_3	0.976*	0.500	1	
x_4	0.988*	0.432	0.996**	1

Regression analysis

The correlation coefficient gives a general idea for the degree and the direction of dependence between the studied indicators, but not their quantitative dependence (Figure 1).

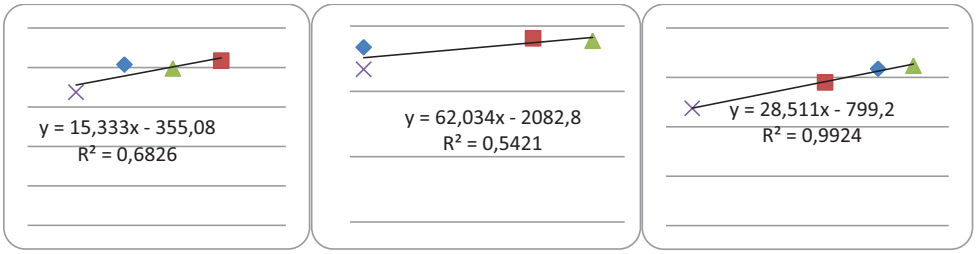

Figure 1. Linear regression model between whole plant weight and the rosette diameter at first, second and third measurement after planting

From the obtained linear equations, the coefficient of determination for each measurement was $R^2 = 0.68$, respectively 68% of the total yield depends on the diameter of the rosette (first measurement), $R^2 = 0.54$, (second measurement) and $R^2 = 0.99$ for the third measurement.

The calculated correlation coefficient, measuring the relationship strength between them was most pronounced in the third measurement, R^2=0.99. Increasing the diameter of the rosette also increased the weight of the whole plant.

Linear regression models, which express the influence of indicator toward the yield per unit area, theoretically determine how and in what direction the change in these indicators contributes to improve the yield.

CONCLUSIONS

The plants grown in the studied mixtures had a significant biological potential to achieve high yield, as their biometric indicators approached the control variant. The closest values to the control variant of the studied variants were plants grown in a mixture of Peat 88.24: Perlite 11.76, which exceeded it with respect to the fresh root system weight by 5.3%.

After planting, the vegetative growth of the plants was most intense in variant 3, which exceed the control variant in terms of the leaves number in the leaf rosette- by 8.2% and the diameter of the rosette- by 1.3%.

This study gives us the reason to recommend, as the most perspective salad seedlings the mixture of Peat 79.85: Perlite 10.52 + Pine shavings 10.53 before winter planting in November in unheated polythene greenhouses.

Correlation and regression dependencies, found in the study can be used purposefully in future work with this plant.

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