

357 mm,
352 mm.

0 – 60 cm,
3,7 3,9 mm.

5,5 mm,
5,4 mm,
5,3 mm.

()
()

(1972), Vitkov

263-346 mm
0-60 cm.

4,6-5,9 mm
Delibaltov Sarkizov (1974)

236,3-354,1 mm
(279,3 mm).

(2002), Matzenauer et al.
8

337

384 mm,

irrigation, drip irrigation was 357 mm, and furrows 352 mm. The daily average evapotranspiration for the layer 0-0,60m without irrigation occur during phase "full blossoming" and range in 3,7 to 3,9 depending on the year. Irrigation shifted maximum two to three weeks in phase "formation of bean" as the difference between techniques practically gone. The average maximum daily average ET in irrigation furrows is 5,5 mm, with drip irrigation is 5,4 mm, and for sprinkler systems – 5,3 mm.

Key words: green been, drip irrigation, sprinkler irrigation, gravity irrigation, furrows, evapotranspiration

INTRODUCTION

The evapotranspiration (ET) of each culture (including bean) is a basic costly element in water balance equation for active soil layer and is one of the main determinants of irrigation parameters.

Since it is a time-consuming indicator, its study and knowledge would help to refine irrigation and increase its efficiency.

For the conditions of our country, ET of beans was studied for the regions of Rouse and Pazardzhik. According to Vitkov (1972), the beetle cultivated as a spring crop on the degraded chernozems of the Ruse irrigation system under optimal irrigation is 263-346 mm for the layer 0-60 cm. The maximum is during the "buttoning - mass flowering" period when it reaches 4.6-5.9 mm per day. According to Delibaltov and Sarkizov (1974), the cumulative values of the bean evapotranspiration in the Pazardzhik region in the non-irrigation conditions ranged between 236.3 and 354.1 mm (279.3 mm on average).

According to Matzenauer et al. (2002), based on 8 annual results, the optimum irrigation waterfall ranges from 337 to 384 mm, regardless of the sowing

Muñoz-Perea et al. (2007),
 384 432 mm,
 – 268 309
 mm.
 Sezen et al. (2005; 2008)
 ,
 ,
 ,
 276-365 mm,
 30 mm
 60 mm ()
 ”), 400-472 mm,
 15 mm
 15 mm.
 , Köksal et
 al. (2008)
 ,
 – 580 mm.
 ()
 –
 (Topak et al., 2009).
 412-623 mm,
 420 627 mm.

time. Similar are data from Muñoz-Perea et al. (2007), according to which the total ET for optimum irrigation of beans varies from 384 to 432 mm and in non-irrigating conditions from 268 to 309 mm.

Sezen et al. (2005; 2008) conducted a large-scale study on ET and irrigation regime in drip irrigation of garden beans. According to the authors, for the Mediterranean part of Turkey, the cumulative ET varies from 276 to 365 mm when the irrigation is 30 mm in size and is set at 60 mm evaporation (vaporizer "A" class) to 400-472 mm for irrigation based on 15 mm evaporation and full irrigation of 15 mm. Based on research conducted in the semi-desert area of Turkey, Köksal et al. (2008) reported extremely high ET values for garden beans, drip irrigated – 580 mm. Very high cumulative values of ET are found in the Konya region (Turkey) in maintaining high soil moisture and two ways of irrigation – sprinkling and dripping (Topak et al., 2009). During spraying, ET is in the range 412-623 mm, and in drip irrigation – from 420 to 627 mm.

E
 2013-2015 . -
 -
 , “ ”.
 .
 20 m²,
 – 10 m²
 – 50 5 cm (20 1
).
 : 1)
 ; 2)
 3) ; 4)
 .
 80 %
 ,

MATERIAL AND METHODS

The experiment was carried out during the period 2013-2015 in the educational-experimental base of the Agricultural University of Plovdiv on the alluvial-meadow former muddy soil. Garden beans, Strike variety, have been tested. The experience is based on the long plots method in four iterations. The size of the experimental plots is 20 m², and the harvest - 10 m² in the sowing scheme - 50 x 5 cm (20 plants per 1 meter). To determine the impact of different ways of irrigation on the ET of the test beet variety, the following options were tested: 1) without irrigation; 2) gravitational irrigation; 3) drip irrigation; And (4) irrigation. The floodplains were built at a pre-humidity level of 80% of field capacity in all irrigation variants and the

0-60 cm.

1 m.

20 cm

m.

$= W_{\text{basic}} - W_{\text{end}} + M_N + M_M$ (mm),

mm;

W ; W -

mm;

mm;

mm.

irrigation rate was calculated to wet the soil layer 0 - 60 cm. The irrigation of the experimental parcels in the irrigation variants is carried out by using different techniques for irrigation water distribution, respectively by furrows, by a dripping system and by micro projection, the water quantity delivered in each variant being measured by a water meter.

The dynamics of actual soil moisture is established in 5-7 days by the weighting method. For this purpose soil samples were taken over 10 cm at a depth of up to 1 m. Evapotranspiration is calculated layer by layer by variants, through a consistent balance of the water supply in the soil, through 20 cm to a depth of up to 1 m. For this purpose, the formula is used:

$ET = W_{\text{basic}} - W_{\text{end}} + M_N + M_M$ (mm), where
 ET - Evapotranspiration for the reporting period, mm;
 W_{basic} ; W_{end} - water stock at beginning and end of period, mm;
 M_N - total of usable precipitation, mm;
 M_M - usable irrigation rate, mm.

RESULTS AND DISCUSSION

Evapotranspiration of each agricultural crop is influenced by abiotic factors of the environment, agro-technology and irrigation techniques used in irrigated crops. For this purpose, a meteorological characteristic of the experimental years has been made with regard to the total rainfall and the average daily air temperature for the period V - VIII. Table 1 presents the values of the relevant indicators and their provision.

1. **V-VII (2013-2015)**
Table 1. Climate characteristics for periods V-VII (2013 to 2015)

Years	Magnitude	N		T	
		(mm)	P (%)	°C	P (%)
2013		176,2	31,8	1996,1	21,9
2014		235,5	20,0	1892,1	55,4
2015		151,1	55,2	2018,1	14,3

N - rainfall in mm; **T** - sum of the average daily air temperature in C°; **P** - provision in%

(2013)

2

(

2014 .

(235,5 mm)

3

(2015)

2013 .

2015 .

- 5,

The first experimental (2013) year is characterised as average wet and moderate, with May rainfall practically missing. In this period due to their small size and relatively low average daily air temperatures, the plants have little water consumption, which is satisfied with the available water supply. During this experimental year, the precipitations were concentrated in the period from the first decade of June to the first of July, due to which two floodplains were carried out during the fructose period (end of July).

In the wet 2014 Precipitation (235.5 mm) is relatively evenly distributed, which is significantly higher than the average for a multiannual period, with the most significant being the deviation in the second ten days of June - more than 3 times. In the first phase, the only watering season for the season was made to compensate for the drought that started in the third decade of June and rainfall in the second ten days of July and then continue to provide enough water for the plants to the end of the harvest.

In the last experiment (2015), the sum of the precipitated rainfall is identical to the one in 2013. In terms of precipitation, it is characterised as average, and in terms of average daily air temperature is warm. This year the rainfall is mainly concentrated in the first two decades of May, when the needs of the plants are mainly satisfied by the available water supply, and in the second and third decades of June.

The distribution of precipitations in decades during the first and last experimental year determines the realisation of a radically different number of irrigation, and in 2015 the irrigation season starts one month earlier. The largest number of irrigations - 5, the first being realised during the vegetative period of the development of the bean. The second irrigation is realised at the

2.

Table 2. Total evapotranspiration of garden beans depending on the way of irrigation by variants and years

Variants		(evapotranspiration)				
		(mm)	compared to Var. 1	compared to Var. 2	compared to Var. 3	compared to Var. 4
			%			
2013						
1	Not irrigated	235,5	100,0	75,9	76,9	77,1
2	On furrows	310,2	131,7	100,0	101,3	101,6
3	Drip irrigation	306,1	130,0	98,7	100,0	100,3
4	Spring /	305,3	129,6	98,4	99,7	100,0
2014						
1	Not irrigated	221,6	100,0	71,1	75,9	75,9
2	On furrows	311,6	140,6	100,0	106,7	106,7
3	Drip irrigation	291,9	131,7	93,7	100,0	99,9
4	Spring /	292,1	131,8	93,7	100,1	100,0
2015						
1	Not irrigated	226,0	100,0	52,1	47,7	49,6
2	On furrows	433,8	191,9	100,0	91,6	95,3
3	Drip irrigation	473,7	209,6	109,2	100,0	104,1
4	Spring /	455,2	201,4	104,9	96,1	100,0

The method of irrigation does not have a significant impact on the aggregate values of ET, and in 2013 the differences between the different techniques are below 2%. In the second and third experimental years, the difference between techniques is below 10% and is not one-sided.

Average data are presented in Table 3. According to them, in non-irrigation conditions, the water flow is 228 mm, which is by over 55% less than that of the irrigation variants. Generally, the differences between the irrigation variants are not significant, and are below 2% for the whole of the experimental period. The

- irrigation method does not have a significant impact on the total water consumption values.

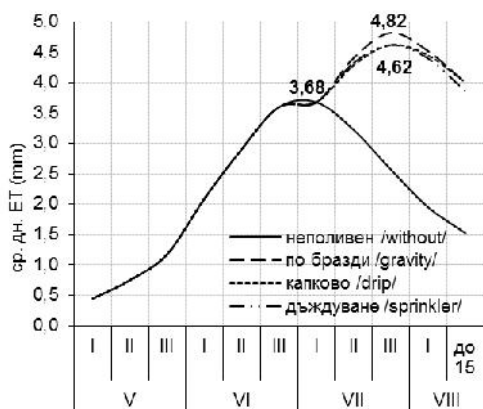
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Table 3. Total evapotranspiration of garden beans depending on the way of irrigation by variants on average over the period

Variants	(evapotranspiration)				
	(mm)	compared to Var. 1	compared to Var. 2	compared to Var. 3	compared to Var. 4
		%			
1 Not irrigated	227,7	100,0	64,7	63,7	64,9
2 On furrows	351,9	154,5	100,0	98,5	100,3
3 Drip irrigation	357,2	156,9	101,5	100,0	101,8
4 Spring	350,9	154,1	99,7	98,2	100,0

1, 2 3

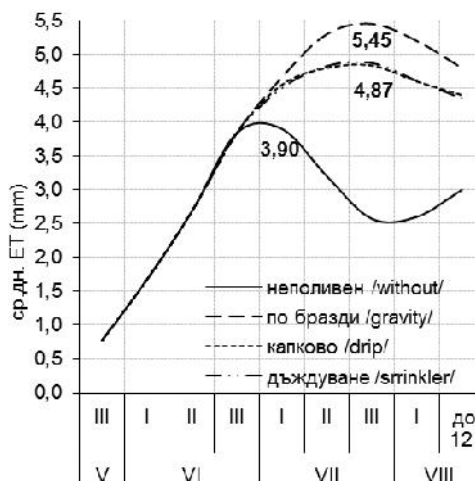
- For irrigation purposes, it is of particular importance to trace water scarcity during the different periods of culture development, therefore setting its daily average values. Figures 1, 2 and 3 represent the yearly ET daily rotation in non-irrigating conditions and in irrigation, drip and sprinkling.



1.

2013

1. Average diurnal course of by variants for 2013



2.

2014

2. Average diurnal course of by variants for 2014

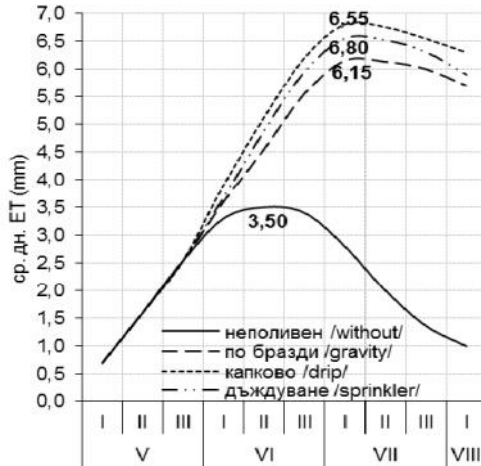


Fig. 3. Average diurnal course of by variants for 2015

For experimental conditions, the maximum values of day-to-day ET in non-irrigating conditions are reached during the first decade of July during the first two experimental years, with the peak in 2013 being in the first-stage phase and in 2014 in phase "Mass flowering". For the layer 0 - 60 cm the maximum average daily temperature is 3.7 mm in 2013. And 3.9 mm in 2014. In the third experimental year, the maximum is pulled one decade earlier (during the flowering period) and is 3.5 mm per day, but due to drought in the second half of the vegetation, the values begin to decrease rapidly.

During the first two years under irrigation conditions, the maximum values of the mid-day ET are reached in the period of beans growth in the third decade of July. For gravity irrigation the maximum for the layer 0-60 cm in 2013 and 2014. Is respectively 4.8 mm and 5.5 mm. Due to the specificity of meteorological factors, the peak (6,2 mm) of the ET in the third year was withdrawn earlier but kept its high values (5,5-6,0mm) almost until the end of the harvest period.

With drip irrigation, a smaller part of the surface of the soil is moistened, and there is no surface

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With drip irrigation, a smaller part of the surface of the soil is moistened, and there is no surface

runoff in comparison with gravity irrigation. Nevertheless, the values (including the maximum) of day-to-day ET are commensurate with gravity irrigation. One way in this sense is the sprinkling data, which once again confirms the view expressed in the present work that the irrigation method has no significant impact on the garden bean ET and its intensity. Furthermore, there are no significant differences between the tested irrigation techniques at the midnight cycle within a given vegetation.

mm. 222 mm 236
30-35%
10 %
351 mm 357
mm, 352 mm.
0-60 cm,
" 3,7 3,9 mm.
" "
5,5 mm,
5,4 mm, - 5,3
mm.

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CONCLUSIONS

The cumulative SP of non-irrigated garden beans in the Plovdiv region for experimental conditions ranges from 222 mm to 236 mm. Irrigation significantly increases the water flow from 30-35% to more than twice. The difference in values for individual irrigation techniques is below 10%. The average aggregate ET is 351 mm for sprinkling, 357 mm for drip irrigation, and 352 mm for irrigation.

Under non-irrigating conditions, the maximum daily average values of ET for the 0-60 cm layer occur during the "mass flowering" phase and vary by year from 3.7 to 3.9 mm. Irrigation shifts the maximum by two to three decades in the "bean" phase, as there is no difference between the different techniques. The average maximum daily average EW for furrow irrigation is 5.5 mm, with drip irrigation 5.4 mm and 5.3 mm with microdilution.

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(Spray carnation)

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Biometric evaluation of the implementation of new, environmental friendly products at mini carnation (Spray carnation) production using cluster analysis

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SUMMARY

The Institute of Ornamental Plants - Sofia has studied the impact of five new, environmentally friendly product on the productivity of cuttings in propagation of mini carnation: TeraSorb Foliar – growth promoter (0,1%; 0,2% and 0,5%); HortiGrow – universal fertilizer (0,2% and 0,3%); Lumbrikol – extract of red Californian worm (0,5%; 0,8%; 1%); Baykal – organic fertilizer (0,1%; 0,3%; 0,5%) and Plantagra Foliar – biomineral fertilizer (0,1%; 0,14%; 0,18%). The experiments were carried out in pot trials under greenhouse conditions with eight Bulgarian mini carnation varieties – Ira, Yanita, Regina, Biljana, Elmaz, Feya, Russalka and Naslada, created at the Institute of Ornamental Plants - Sofia.

With a cluster analysis was found a presence of comparable effect between the fertilizer on the growth and development of plants, the number of

branches and the number of cuttings. In the accelerated cuttings production of the examined mini carnation varieties it is necessary to know that there is a genotypic dependence on the applied biofertilizer. To increase the efficiency of mini carnation cuttings, it is necessary to use the appropriate product applied in an optimal dose for each variety.

Key words: mini carnation (*Spray carnation*), feeding, growth, productivity, cluster analysis

INTRODUCTION

In recent years, the use of various organic products, biofertilizers, growth stimulants and others as an alternative to chemistry in plant growing is increasingly used in flower production. This required detailed testing of their effects on plants and the establishment of optimal doses, duration of treatment and methods of application in different flower crops.

At the Institute of Ornamental Plants - Sofia, experiments with mini-carnation have been conducted to study the impact of various ecologically clean products such as Humustim (Atanassova et al., 2007), Lumbrikol (Atanassova, 2011a), TeraSorb (Atanassova, 2011b), Baykal (Atanassova, 2012a), HortiGrow (Atanassova, 2012b) and Plantagra (Atanassova, 2015).

Experiments are also carried out with other ornamental crops for cutting flower with the same and other ecological products: *chrysanthemum* (Atanasova, et al 2008b), *aster* (Atanassova and Zapryanova, 2009), *calendula* (Zapryanova and Atanasova, 2009a), *gypsophila* (Zapryanova and Atanasova, 2009b; Atanassova, 2013), in potted plats as *cyclamen* (Sapundzhieva et al., 2001), potted *chrysanthemum* (Kotopanova and Nencheva, 2008), *petunia* (Atanassova et al., 2008a and Zapryanova and Atanassova, 2013) and others.

- The purpose of this study is to summarize data from studies with different cultivars of mini carnation to stimulate growth in cuttings by applying a cluster analysis and to assess whether there are similar dependencies in the change of the growth indicators when plants were treated with different ecologically pure products.

MATERIAL AND METHODS

- The Institute for Ornamental Plants - Sofia has carried out vascular experiments for six consecutive years (2009-2014). Five different products (Plantagra, TeraSorb, HortiGrow, Baykal and Lumbikol) were included in the methodological set-up of the experiment. Eight Bulgarian mini carnation cultivars (Regina, Yanita, Rusalka, Naslada, Feya, Elmaz, Bilyana and Ira), as the plant material, were used to determine the effect and optimal concentration of each product on the growth and productivity of cuttings of maternal plants.

- Plantagra – a biomineral humic fertilizer of company “ROMB”, with immobilized enzyme systems and live mushroom cells useful for plants, bacteria and other microorganisms. The fertilizer is a well-balanced microorganic composition of organic substances with a mineral base. It was applied to cvs Rusalka and Naslada in concentrations of 0.1%, 0.14% and 0.18%.

- TeraSorb foilar – growth promoter of company BIOIBERICA, based on 18 amino acids, obtained by the enzymatic hydrolysis method, enriched with 7 macroelements and trace elements. It was tested in two varieties – Regina and Yanita, in concentrations of 0.1%, 0.2% and 0.3%.

- HortiGrow – a mineral universal, high quality fertilizer, product of Dutch company HortiLand. It had a balanced formula of all the necessary macro and trace elements. Microelements are encapsulated in a special substance for

(2009-2014).

(,)

(,)

0,18% , 0,1%, 0,14%

– BIOIBERICA, 18

7

– 0,1%, 0,2% 0,3%

–

“HortiLand”,

0,2% 0,3%.

60

0,1%, 0,3% 0,5%.

16

0,5%, 0,8% 1%.

in vitro

(2007, 2011ab, 2012ab 2015).

JMP-7.

(*Spray carnation*)

more complete absorption by plants. The treated varieties are Feya, Elmaz and Ira in concentrations of fertilizer 0,2% and 0,3%.

Baykal – microbiological fertilizer created by the company "EM-Center Ukraine". The fertilizer contained 60 strains of microorganisms, forming a sustainable symbiosis, which lasts for a long time in the soil. It was applied to cvs Bilyana and Ira with concentrations of 0.1%, 0.3% and 0.5%.

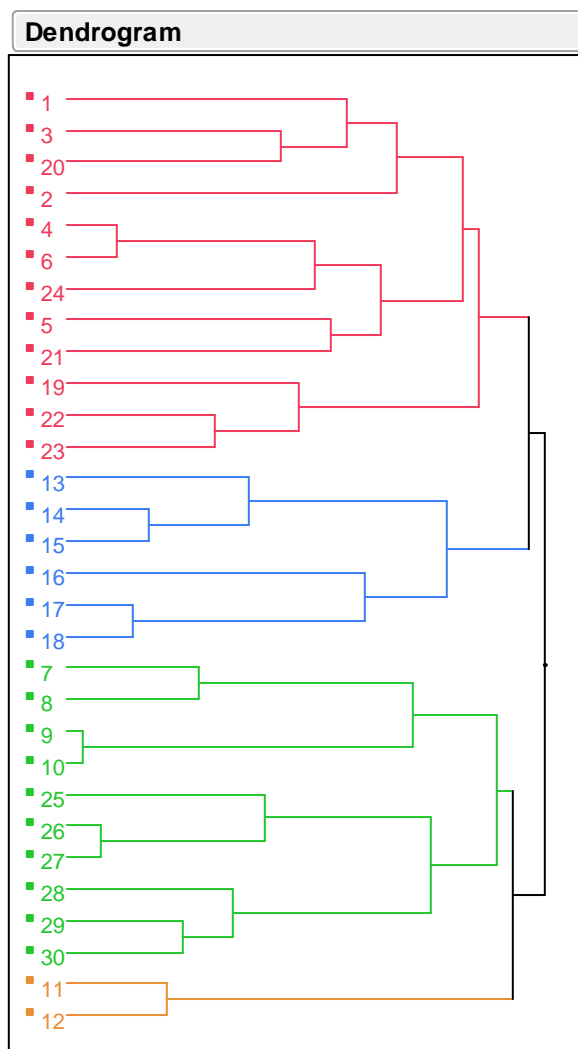
Lumbrikol is a redworm biofuel extract by the company "Ecopherma", which is especially valuable with the content of humic acids, which is a reserve of nutrients and soil structure improvement. It contains in a concentrated form all 16 chemical elements required by plants, biologically active stimulants, vitamins, amino acids and hormones that are in an easily digestible form, gradually releasing to the needs of the plants. Used in cvs Regina and Yanita in concentrations of 0.5%, 0.8% and 1%.

The experiments are carried out with adapted *in vitro* plants, and all plant requirements were met during vegetation. The betting, treatment and reporting methods for each product are detailed in previous publications of Prof. Atanassova (2007, 2011ab, 2012ab and 2015).

The data obtained were processed with the statistical package JMP-7. The cluster analysis was performed using the Ward method.

RESULTS AND DISCUSSION

The information obtained from the Spray carnation conducted during the years was summarized using cluster analysis. The studied varieties are divided into clusters based on their productive elements – plant height, number of branches and number of cuttings (Figure 1).



. 1.

(*Spray carnation*) (2009-2014 .),

Fig. 1. Dendrogram of productivity and growth indicators of cvs mini carnation (*Spray carnation*) (2009-2014), treated with mineral and organic products

: / Legend:

- 1 ÷ 6 (0,1%,0,2%, 0,3%)
- 7 ÷ 12 (0,2%, 0,3%)
- 13 ÷ 18 (0,1%,0,2%, 0,3%)
- 19 ÷ 24 (0,5%, 0,8%, 1%)
- 25 ÷ 30 (0,1%,0,3%, 0,5%)

variants 1 ÷ 6 **TeraSorb** (0,1%,0,2%, 0,3%) for cvs Regina Yanita

variants 7 ÷ 12 **HortiGrow** (0,2%, 0,3%) for cvs Feya, Elmaz Ira

variants 13 ÷ 18 **Plantagra** (0,1%,0,2%, 0,3%) for cvs Russalka Naslada

variants 19 ÷ 24 **Lumbricol** (0,5%, 0,8%, 1%) for cvs Regina Yanita

variants 25 ÷ 30 **Baykal** (0,1%,0,3%, 0,5%) for cvs Bilyana Ira

12

10 27 (0,3% - 0,5%

() < 0,001%.

(0,2% 0,3%) (2012b).

1 3

0,1% 0,3% ()

11 12 (0,2%

0,3%).

It is clear from the dendrogram that the samples are grouped into four clusters. Most numerous is the first cluster in which twelve variants of the Regina and Yanita varieties are combined with all fertilization doses with the growth promoter - TeraSorb and the organic fertilizer - Lumbrikol. In a second cluster with similar results on the studied characteristics are the cvs Rusalka and Naslada, treated only with the biominemal humic fertilizer Plantagra.

In the third cluster, the most varieties have been combined – cvs Feyia, Elmaz and Bilyana, treated with the universal mineral fertilizer HortiGrow and cv Ira, treated with Baykal microbiological fertilizer. In this cluster, variants 10 and 27 are the closest (these are the cv Elmaz, treated with 0.3% HortiGrow and cv Bilyana - with 0.5% Baykal solution), which formed a subgroup with the smallest distance unit. In the Atanassova studies, these two varieties show one of the highest values of the growth characteristics- plant height, number of branches and number of cuttings, and proven differences towards untreated plants (control) with a <0.001% probability.

The fourth cluster is represented only by the cv Ira, treated with the HortiGrow mineral fertilizer. The similar effect of the two applied doses (0.2% and 0.3%) for this variety was also found in Atanassova's trials (2012b).

In the two farthest clusters visible from the dendrogram, two pairs of variants are located. These are variants 1 and 3 of the first cluster (cv Regina treated with 0.1% and 0.3% TeraSorb solution) and variants 11 and 12 of the fourth cluster (cv Ira with 0.2% and 0.3% HortiGrow mineral fertilizer solution). It is entirely possible that these two substrates have a different effect on the growth characteristics of the two mini carnation Regina and Ira.

The cluster analysis have found application in various agrotechnical, plant breeding and social-economic experiments. For example:

- An assessment of impact of different irrigation regime on the soybean growth characteristics (Matev et al., 2014);
- Breeding trials for productive evaluation of various oilseed sunflower hybrids (Kuneva and Tahsin, 2015);
- Determination of biological and economic qualities of perspective samples of spring barley (Neykov, 2014);
- Social-economic research to study the role and living characteristics of small and medium-sized fruit growers (Manolova and Penov, 2014).

There is a wide variety of hierarchical cluster in this method and hence its different application. The most common metric between objects is the Euclidean distance, which is also applied in this study.

CONCLUSIONS

The study aimed to explore and summarize the role of the application of various ecologically pure mineral and organic products for the accelerated propagation of eight mini carnation varieties (Bulgarian selection). From the cluster analysis applied, it was found that the effect of mineral and organic products can be grouped mainly into three clusters: the first one combines cvs Regina and Yanita, treated with TeraSorb and Lumbrikol; the second cluster – Rusalka and Naslada varieties with the bio-mineral fertilizer Plantagra; and the third cluster – a combination of four varieties – Feya, Elmaz, Bilyana and Ira, treated with two products HortiGrow (mineral) and Baykal (organic). The separate fourth cluster was formed of cv Ira, treated with HortiGrow.

In some varieties mini carnation, such as Regina, Yanita, Rusalka, Naslada and Ira, the most suitable for cuttings production was to apply only one product, while for other varieties, Feyta, Elmaz and Bilyana, a positive impact on the propagation potential was to use two of the tested products.

In the accelerated cuttings production of the examined mini carnation varieties it is necessary to know that there is a genotypic dependence on the applied biofertilizer. The study confirms the importance of genotype and cultivar dependence from environmentally friendly, mineral and organic products. The efficiency of mini-carnation cuttings production can be increased by using the appropriate product applied in an optimal dose for each variety.

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