Bulgarian Journal of Agricultural Science, 27 (Suppl. 1) 2021
Agricultural Academy

Influence of pruning on growth and productivity of glasshouse eggplant in biological fertilization

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Abstract

Filipov, S., Kostadinov, K. & Valcheva, V. (2021). Influence of pruning on growth and productivity of glasshouse eggplant in biological fertilization. *Bulg. J. Agric. Sci., 27 (Suppl. 1)*, 125–129

A field experiment to establish the influence of training on the growth and the level of productivity of greenhouse eggplant, cv. Traviata, in conditions of biological fertilization was carried out in 2013-2014 at the experimental glasshouses of Agricultural University – Plovdiv. Several variants have been tested: 1.Control- mineral fertilization and two-form formation; 2. Biological fertilization Naturale + StimAK and two-stemmed formation; 3. Biological fertilization Naturale + StimAK and three- stemmed formation. It was recorded the following indexes: phenology indicators: plant morphology/:morphology of fruit: productivity as early and average yield. Best of reported indicators is Naturale + StimAK with two stems, with highest early yield – 955 kg.da^{-1} and total yield – 4062.7 kg.da^{-1} and which by mass fruiting in excess of the control is with 29.59% for fresh mass of the whole plant, with 44.73% for dry mass of the whole plant.. The results obtained showed that the Naturale + StimAK (fertigation) with two stems is the most suitable for biological production of greenhouse eggplant.

Keywords: greenhouse eggplant; pruning; biological fertilization; growth, productivity

Introduction

Over the past 15 years, the interest of farmers in the organic production system has grown in Bulgaria. Although this production is slower and smaller, this production also goes into greenhouse production. In Bulgaria there is a lack of scientific research in organic production of eggplant in greenhouses. Prior-take cultures (tomatoes, cucumbers and pepper) have been carried out many studies all over the world. It is significantly limited, where by greenhouse monitoring is carried out as bio-production.

Ambroszczyk et al. (2008) investigates the influence on light conditions and vegetative development of aubergine under greenhouse conditions. Early spring – summer production in heated steel – glasshouses is cultivated Tania F1. The following pruning systems are examined: 1st variant – branching, leaving 1, 2 or 3 leaves after each 2nd fruit; 2nd variant – growing with 2 stalks and leaving 1 fruit on each branch. They find that by leaving a larger number of leaves and tying more fruits the branching of plant habitats decreases. The value of the places depends on the way of pruning. Enhanced photosynthetic activity under stronger pruning was obtained by the large leaf area and the large thickness of the mesophilic tissues.

The influence of the biological fertilization and the variety on the growth, productivity and quality of the aubergine grown in polyethylene greenhouses is studied (Becherescu Alexandra et al., 2016). They establish the highest total yield of 84.2 tons / hectare in the variety Madonna fertilizer with organic fertilizer 1. (cow manure 60 tons / hectare) and 87.8 tons / hectare for the same variety with organ fodder manure 2. (chicken manure 60 tons / hectare) in combination with foliar treatment of PGR Vifarex 2%.

The impact of pruning on yield and quality of greenhouse eggplant fruit is the subject of a study by the same authors (Ambroszczyk et al., 2007). After the applied pruning anal-

ogous to that of the previous quote, the intensive pruning does not reduce the yield. The early market yield was 4.04 kg/m^2 without a statistical difference between the different variants. A total yield of 9.41 kg/m^2 was obtained, and was slightly influenced by the type of pruning applied.

A similar study to determine the impact of the growing scheme and the type of pruning on eggplant productivity is conducted by (Ferratto, & Rotondo, 2003). They study two variants of line orientation (row, row and two-line). Apply two types of pruning: 1. two stems; 2. four stalks; 3. – the control without pruning. They found that yields were higher for pruning options. The two-row tape overtakes the one-line in terms of productivity.

Raksoy & Akll (1993) conducted a pruning study in a 7- eggplant varieties: Dusky, Vittorta, Valentina, Indra, Sicilia, Palmira, Imperial. They are trying to use two types of pruning: 1. Two-stem pruning; 2. Three-stalk pruning; 3. Control – without pruning. They find out that both pruning methods significantly increase the main side branches and the first quality fruit. The total yield did not affect the type of pruning.

Research on the effect of pruning on lateral branches on the growth and yield of greenhouse eggplants is conducted by (Cebula, 2005). Bets a 1, 2, 3, and 4-leaf pruning experience in a combination of 1, 2, 3, and 4 fruit of the Liona side branches. It establishes that the length and mass of the leaves are greatest in pruning with 1 fruit and 2 leaves after it.

The foliage and thickness are greatest when pruning 1 sheet and 1 fruit. The total yield is highest for pruning 4th leaf and 3 fetuses.

Certain studies, however, do not indicate pruning as a better option. When tested with 3rd variety: Diva, Anet and Orion, two variants are applied with and without pruning; 1. Without pruning when planting with two stems; 2. Pruning with two stalks and reduction of lateral branches after the beginning of flowering. Both variants give good quality fruit, do not slow down fruit harvesting. Without pruning, the yield is low.

Research on these crops using plant regulation and succumbing practices is quite limited worldwide. Under bio-production conditions, they are even more limited.

In Bulgaria such research is lacking in organic growing eggplant.

The present experiment aims to study the pruning of greenhouse aubergine in unheated glasshouses.

Material and Methods

Establishment of experiment and study materials

The experiment was held during the period 2013-2014 in the glass-greenhouse of the Department of Horticulture as early spring-summer production. Seeds of the variety Traviata F_1 were used. A two-factor experiment with effects of the technological components fertilization and pruning is covered.

The following variants have been studied:

- Control – mineral fertilization and two-form formation.
- Biological fertilization Naturale + StimAK and two-stemmed formation.
- Biological fertilization Naturale + StimAK and three- stemmed formation.

The cultivation scheme is as follows:

1. N_{24}: P_{12}: K_{12}; Formulation-two-stems, 1887 plants/da, Intermediate distance 0.5 m.
2. Naturale + StimAK ; Formulation two-stems, 1887 plants/da, Intermediate distance: 0.5 m
3. Natural + StimAK Formulation three-stem 1887 plants/da, Intermediate distance: 0.5 m.

The fertilizers for basic fertilization were introduced with the last treatment of the soil at norms: Naturale 100 kg.da^{-1}, P_2O_5 – 12 kg.da^{-1} and K_2O – 12 kg.da^{-1}. Nitrogen was introduced in equal parts as a fourfold feed from a phenophase beginning of fruiting through 15 days via the fertigation system. Fertilization with StimAK (hydrolyzed plants proteins) for dose 8 liters/da) was carried out as a fourfold feed from the beginning of the fruiting in intervals of 15 days via the fertigation system.

Seedlings are grown by standard technology in a heated glasshouse. The attempt was made in four replicates with 20 plants each. Seedlings in the 5-6 leaf stage were planted in the second half of March under the relevant scheme – 55+105+105+55/50 cm. Plants were grown under controlled temperature conditions, with minimum temperatures not falling below 14-15 degrees, and the maximum were controlled by ventilation and shading. For the control of diseases and pests, only biofuel authorized. The following biological fertilizers were used:

Naturale NPK 8-8-6 contains organic nitrogen 8%; P_2O_5 – 8%; K_2O – 6%; MgO – 2%; Organ. Biocarbon – 30. It is a high quality organic fertilizer, both in terms of raw materials used and in terms of its extremely low humidity level. It is obtained as a result of the exclusive use of organic substances of vegetable origin, bone meal and organic products, which is why it manages to ensure a gradual and continuous supply of nitrogen, thus providing the plants with nutrients throughout the cultivation cycle. Immediate over dosage with nitrogen, leading to strong vegetative growth and weakening of plants, is avoided. It is used in the form of pellets with sizes ranging from 3-4 mm in diameter and 8-10 mm length and humidity not exceeding 10%. The pellets produced in this

way are excellent for spreading with all types of fertilizer spreaders and, after being in the soil, quickly disintegrate due to the fact that they absorb up to 4 times more water than their own weight.

StimAK is a multicomponent, amino acid fertilizer derived from hydrolyzed vegetable and yeast proteins with 30% dry matter. Used as a biostimulator for plants to promote their growth and sustainability. It contains a dry matter of not less than – 44%, of which: Org. substance – 82% and Amino acids – 35% Total nitrogen – N-3.8%, Total phosphorus – P_2O_5 – 4%, K – (K_2O) – 4.4% Trace elements (mg/kg): zinc – 75, copper – 4, manganese – 24, boron – 38, calcium – 350, magnesium – 2200, iron – 50.

Indicators and methods of the study

Phenological indicators

Through regular observations the beginning and mass appearance of phenophases was found: germination, crossing, flowering and fruiting.

Morphology of plant. The values of the indicators were determined fresh and dry vegetative mass of the whole plants (g) , height of the stem (cm) and diameter of the stem (mm), fresh and dry mass of the stem (g), number of the leaves, fresh and dry mass of the leaves (g).

Fruit quality and morphology.

The following fruit characteristics were determined:

Average weight of fruit; length – cm; diameter of the fruit in the cup and in the widest part – cm; shape, color of the skin (surface), gloss, color of the meat, number of chambers; consistency; number of fruits without seeds.

The characteristics of the fruit were determined on 20 fruit samples- 5 in each repetition, at the beginning and mass fruiting.

Productivity. The early yield of the first three harvests kg.da^{-1}; Total yield, kg.da^{-1}.

Results and Discussions

Phenological observations

Sowing was carried out on January, 22 under optimal conditions of 25-26°C and 90-100% maximum humidity in the field. This ensures simultaneous germination without variation between variants. The beginning and mass appearance of the crossover phase are also found in all variants. Differences are observed after planting seedlings in the production area of greenhouses (Table 1).

Flowering occurs earliest in the variant with 2-stem formation + biofertilizer. The trend is maintained in the case of mass flowering, with the difference from the control being two days in favor of option 2. The differences increase in fruit production. The same variant enters at the beginning of fruiting 8 days before the control and 5 days compared to the three-stem formation.

In mass fruiting the differences between variants are reduced, but those with pruning outweigh the control.

Morphology of plant

The productivity of the plant is largely determined by the strength of the growth and the total photosynthetic leaf area (Table 2). The applied plant formation in combination with the fertilization scheme used shows a strong overall stimulating effect on the plants.

Table 1. Aubergine phenology – average for the period 2013-2014

Variants	Sowing	Germination		Crossing (2 real leaf)		Flowering		Fruiting		End of experiment
		beginning	mass	beginning	Mass	beginning	mass	beginning	mass	
1	22.01	26.01	28.01	15.02	25.02	7.05	10.05	31.05	4.06	30.07
2	22.01	26.01	28.01	15.02	25.02	6.05	8.05	23.05	31.05	30.07
3	22.01	26.01	28.01	15.02	25.02	7.05	9.05	28.05	31.05	30.07

Table 2. Biometric indicators average for 2013-2014

Variants	Vegetative mass of the whole plants		Stem				Leaves		
	Fresh,g	Dry,g	height, cm	diameter, mm	mass		number	mass	
					fresh, g	dry, g		Fresh,g	Dry,g
1.	526.55	103.19	116,15	18,00	232.31	44.92	94.12	294.24	58.27
2.	684.45	149.35	131.88	20.77	306.65	68.65	122.66	375.80	80.70
3.	616.00	126.00	129.56	20.23	272.95	58.02	118.00	343.05	67.98
GD 5%	4.5	1.3	0.48	0.45	2.09	0.67	0.86	2.33	0.63
GD 1.0%	6.51	1.88	0.7	0.66	3.03	0.97	1.24	3.37	0.92
GD 0.1%	9.77	2.83	1.05	0.99	4.55	1.45	1.86	5.06	1.38

Variants with bio-fertilizers, regardless of the applied system of formation, exceed the height and diameter of the stem compared to the control from 11.54% to 13.55% in height and from 12.39% to 15.38% for the diameter. The same trend is maintained in fresh and dry mass. The increase is from 25.57% to 40.51% for the fresh mass and for the dry mass from 39.95% to 54.79%. The advantage of the variants with biofertilizers in both two-stem and three-stem formation is preserved in terms of the number of leaves, fresh and dry leaf mass. The two-stage version has the highest values and exceeds the control by 30.32% for the number of leaves, 36.01% for fresh weight and 40.28% for dry weight. The other option also significantly exceeds control. The dry and fresh mass of the whole plant, as summaries also have higher values than the control. The highest fresh and dry mass has the option of two- stem formation + bio-fertilization. It exceeded control by 29.59% and 44.737%, respectively. In conclusion bio-fertilization has stimulated a stronger vegetative growth. The two-stem formation has shown better results in vegetative development than the three-stem variant.

Morphology and fruit quality

The morphological characteristics of the fruits are essential for their market value. These traits, although relatively stable, are affected by the applied effects and change during the harvest period. In order to follow the dynamics, the signs were reported in the beginning and mass fruiting.

In the first observation, although slight differences were observed in most morphological characteristics, biofertilization and pruning options were in favor (Table 3).

For the indicators: the weight, length and diameter with the highest values are the fruits of variant 2 (bio fertilization + two-stem pruning), respectively 326.2 g; 19.4 cm and 5.8 cm (7.56 cm), exceeding the control by 110.7%; 112.1 and 101.3% (110.5%). The other indicators of the fruit: shape, color, gloss, consistency, mesocarp color have not influenced either the type of fertilization (mineral or organic). However, the chamber had little influence, as the fruits of pruning options and organic fertilizer formed less chambers.

In mass fruiting the trend from previous reporting is preserved. Values for most of the fruit indicators are slightly changing (Table 4). Exception makes the weight of the fruit growing in variants 2 and 3. In two-stem pruning + bio fertilization the fruits are the largest – 387.6 g, and in three-stem version 320.2 g. The excess over the control is as follows: 155.9% and 128.8%. Fruit chambers at this stage have lower values since the beginning of fruiting. Variant 2 has the less number of chambers, and variant 3 is close to the control.

Table 3. Morphology of fruit in beginning of fruiting- average for the period 2013-2014

Variants	Weight g.	Length cm	Diameter		Shape	Color	Glantz	Consis-tency	Color of the meat	Chanbers nb	Seedless-fruts
			under the cup, cm	fruit, cm							
1	279.2	17.30	5.72	6.84	elongat-ed-pear-shaped	Deep violet	glossy	Sponge	whitish	4.6	–
2	326.2	19.4	5.8	7.56	elongat-ed-pear-shaped	Deep violet	glossy	sponge	whitish	4.0	–
3	303.2	18.5	5.66	6.84	elongat-ed-pear-shaped	Deep violet	glossy	sponge	whitish	4.2	–
GD 5%	1.33	0.05	0	0.02						0.01	
GD 1.0%	1.93	0.08	0	0.03						0.02	
GD 0.1%	2.9	0.12	0.01	0.05						0.03	

Table 4. Morphology of fruit in mass fruiting- average for the period 2013-2014

Variants	Weight g.	Length, cm	Diameter		Shape	Color	Glantz	Consis-tency	Color of the meat	Chanbers, nb	Seedless-fruts
			under the cup, cm	Fruit, cm							
1	248.6	14.10	5.47	6.94	elongat-ed-pear-shaped	Deep violet	glossy	sponge	whitish	3.6	0
2	387.6	19.16	5.86	7.68	elongat-ed-pear-shaped	Deep violet	glossy	sponge	whitish	3.4	1
3	320.2	18.04	5.44	6.90	elongat-ed-pear-shaped	Deep violet	glossy	sponge	whitish	3.6	2
GD 5%	3.93	0.15	0.01	0.2						0	
GD 1.0%	5.69	0.21	0.01	0.3						0	
GD 0.1%	8.54	0.32	0.02	0.5						0.01	

Table 5. Early and total yield – average for the period 2013-2014

Variant	Early yield, kg.da^{-1}				Total yield, kg.da^{-1}			
	2013	2014	average	%	2013	2014	average	%
1.N24: P12: K12; Formulation-two-stems	686.5	635.5	661.0	100.0	2256.0	2949.3	2602.64	100.0
2. Naturale + StimAK (with fertigation); Formulation-two-stems	920.04	1030.3	955.2	144.0	3832.7	4292.6	4062.7	156.1
3. Naturale + StimAK (with fertigation) Formulation three-stems	324.6	565.1	444.9	67.3	2034.3	2739.5	2386.9	91.7
GD 5%	212.76	174.05			622.08	686.01		
GD 1.0%	298.64	244.31			873.20	962.93		
GD 0.1%	421.62	344.91			1232.75	1359.44		

In summary it can be noted that mineral and organic fertilization and the method of pruning have a more significant effect on the average mass and linear dimensions of the fruit and less affect the other sensory analyzes.

Productivity

The average values confirm the advantage of the formation of two stems + organic fertilizer with an early yield of 955.0 kg.da^{-1}, exceeding the control by 144.0% (Table 5).

The most accurate view of economic productivity gives the total yield. The trend of early yield is maintained at the total yield.

Pruning combined with organic fertilization has had an impact on total productivity expressed in kg.da^{-1}.

The results, both per year and on average for the period define option 2 as the most productive. The total yield of 4062.7 kg.da^{-1} exceeds the control by 156.14%. The second variation grown by three-form formation is closed to the yield of the control.

The results obtained for the early and total yields make it possible to indicate as an optimal variant the provision of 1887 plants in combination to the case of two-stem formation and applied bio fertilizer

Conclusion

The two-stem formation of the plants and the applied organic fertilization influence the appearance of the main phenophases of the plant growth. Formation with two stems + biofertilizers (Naturale+ StimAK) accelerates the beginning of fruit production by 8 days and 4 days in mass fruiting. The early yield from the two-stem formation and organic fertilizer option reached 955.0 kg.da^{-1} and exceeded the control by 44.7%. The total yield in the same variant is 4062.7 kg.da^{-1} and exceeds the control by 56.1%. Pruning has a more significant effect on the average mass and linear dimensions and less on the other sensory parameters of the fruit.

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Received: May, 19, 2021; *Accepted:* June, 25, 2021; *Published:* September, 2021