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STUDYING THE INFLUENCE OF BIOLOGICAL FERTILIZATION ON RADISHES IN UNHEATED POLYETHYLENE GREENHOUSES

Stoyan FILIPOV[1], Kostadin KOSTADINOV[1], Radoslav CHIPINSKI[2], Nadejda SHOPOVA[3]

[1]Agricultural University - Plovdiv, AU, 12 Mendeleev Blvd, 4000, Plovdiv, Bulgaria
[2]Institute of Plant Genetic Resources "K. Malkov", 2 Drujba Str., 4122, Sadovo, Bulgaria
[3]Climate, Atmosphere and Water Research Institute at Bulgarian Academy of Sciences (CAWRI-BAS), 66, Blvd Tzarigradsko chaussee, 1784, Sofia, Bulgaria

Corresponding author email: stoyanf@aqbv.bg

Abstract

In an experiment with greenhouse radishes grown according to biological production technology during the period 2018-2020, the influence of the variety, the cultivation scheme, the method of sowing and the applied biological fertilizers on the morphological characteristics and productivity of the crop was evaluated.In scattered sowing, the mass of the whole plant, the mass and the diameter of the root crop were positively affected by the applied biological fertilizers. The yield of ties per unit area has increased to a greater extent in the Edri red variety compared to the Saxa variety. On the other hand, the Large Reds variety has from 12.9% to 23.7% higher average yield in all fertilizing options compared to the control, and in the Saxa variety from 7.3% to 13.2%. In scattered sowing, the highest yield was reported when fertilizing with Italpolina of 8718 connections/dec in the Large Reds variety and 6918 connections/dec in the Saxa variety. The influence of biological fertilization in row sowing is more pronounced and has been proven statistically in both varieties and in all fertilization options. Row sowing gave a higher yield with 11.3% in both varieties. As with scattered sowing, the Edri red variety has a 15.9% to 24.9% higher yield with all fertilization options. The highest productivity was obtained for variant fertilizing with Italpolina in the Large Reds variety 9950 bunch/ha-1 and in the Saxa variety 8906 bunch/ha-1.Organic fertilizers did not lead to the accumulation of excessive amounts of nitrates in both varieties, but varietal differentiation was confirmed. In scattered sowing, they were from 1118.4 mg/kg to 1407.3 mg/kg in the Saxa variety and in Large Reds from 1023.7 mg/kg to 1131.4 mg/kg. Nitrates in row sowing are lower and vary from 969.7 mg/kg to 1051.8 mg/kg for Large Reds variety and for Saxa from 1118.4 mg/kg to 1407.3 mg/kg

Key words*: radishes, greenhouses, organic fertilization, nitrate.*

INTRODUCTION

The concern for the protection of human health is directly related to the production of clean and healthy food. Vegetables occupy an important place in a healthy diet. They are especially valuable during the winter season, when some are grown in greenhouses. In addition to the main vegetables, some cold-resistant crops such as radishes are grown in the autumn-winter and winter-spring period. The product part of them develops in the soil and is strongly influenced by mineral nutrition.

There are a number of studies on the influence of mineral fertilization on the growth, yield and quality of this crop. Under greenhouse conditions, the influence of different forms of nitrogen NH4-N and NO3-N on some parameters of radishes is determined. At the beginning of the growing season, the yield increases with increasing NO3-N in the soil. As NH4-N increases, the yield decreases. Nitrates are the highest when fertilized with NO3-N (Kováčik, P., at all 2004). In similar studies, the influence of nitrogen fertilization was monitored at three doses of 0; 15 and 30 kg N ha^{-1}. The best values for the monitored biological and morphological indicators were found at 15 kg N ha^{-1} (Pedó T. et al., 2014) When vermicompost was used as a source of N, the radish yield was more strongly affected by NO3-N compared to NH4-N. At the higher doses, with an increase in nitrate nitrogen, the content of free nitrates in root crops increases and vitamin C decreases (Kováčik P. et al., 2021). Studies have also been conducted to

establish the influence of different forms of K on the quality of root crops. The influence of different sources of K on the quality of root crops when fertilizing with potassium chloride, potassium nitrate and potassium phosphate is evaluated. They established a good response of radishes to K regardless of the source of fertilization. (Maia P. de M. E. et al., 2011) Similar studies with three doses of nitrogen 0.3, 0.6 and 0.9 $g.dm^{-3}$ and two types of potassium fertilizer KCL and K_2SO_4 were carried out in two varieties of radish Carmen and Sinieźka. A differentiated reaction of the varieties was established. Weight and yield in Carmen decreased with increasing nitrogen doses, while in Sinieźka it increased with the higher dose. The form of potassium does not affect the indicators, but when fertilizing with K_2SO_4 there are lower nitrates in the root crops (Nurzyńska-Wierdak, R. et al., 2013). The reaction of greenhouse radishes to the shortage of N.P.K and S was also investigated. The strongest adverse effect is the deficiency of N. (Kováčik, P. and Jančovič, J., 2001).

The subject of research is organic and organo-mineral fertilization. The impact of different types of manure alone or in combination on growth, yield and quality was investigated. (Kowalski, A., Kaniszewski, S 2017); (,Singh, V.,at all 2016); (Bodkhe, V. A., at all 2010); (Mahorkar, V. K., at all 2007); and (Costa, C. C., at all 2006) . Very good results were obtained after fertilization FYM50% +PM50%. High yield was obtained after application of vermicompost. A strong stimulating effect on vegetative growth was found in the combined use of vermicompost in combination with California worm extract.(Araújo, R. at all 2020) The influence of cow manure 20,30, 40 t/ha and poultry manure 10,15,20 t/ha and qualitative and quantitative indicators were tracked. The effect of various sources of organic matter (cattle manure, pig manure, aviary bed) on lettuce cultivation was monitored under greenhouse conditions. No knock-on effect has been found in growing radishes.(Bonela, G. D., at all 2017) When using vermicompost alone, the best results were obtained at a concentration of 40% and 60%. Similar results were obtained by other authors with a combination of peat with vermicompost. (Alsiņa, I.,at all 2013) Comparing mineral and organic fertilization in growing radishes is also the subject of research. The highest values for growth and yield were obtained after fertilization with NPK followed by the organic fertilizers PM, GM, SS, FYM (Mehwish Kiran et al., 2016) In an experiment with three varieties of radish and five types of fertilizers, the best results were obtained with PM and with a combination of PM + NPK. There are similar results with FYM (Subedi S., 2018) Integrated fertilization with organic and mineral fertilizers has shown the best results on growth and yield with increasing levels of fertilization (Verma U. K., et al., 2017) Studies have been conducted with some microbial fertilizers involving *Penicillium* sp. and *Aspergillus* sp. related to phosphorus nutrition. It was found that there were no major differences in phosphorus uptake between treated and untreated plants (Narloch C., 2002) A comparison was made between microbial and organic fertilizers: FYM, phosphobacter Azospirillium, vermicompost, humus acid and NPK. The best root crops in terms of size and weight were recorded when fertilizing with vermicompost (Vijayakumari B. et al., 2012)

Special attention in research is also devoted to the question of the accumulation of nitrates in the root crops of radishes. In an experiment with 10 varieties grown outdoors and in a greenhouse, the tendency to accumulate nitrates was evaluated. The Cortund variety shows the lowest accumulation of nitrates 1158.7 ppm and the highest in Helios 1876.7 ppm. In polyethylene greenhouses, the nitrate content is higher than outdoors by 20-30% (30). In another study, 5 varieties are studied. It is indicated that nitrates are below the MPC of 600 ppm in the Rudolf variety - 293 ppm, Soro - 326 ppm, Hellex - 407 ppm. Above the permissible norms are Altex - 614 ppm, Mirabeu - 689 ppm(Soare R. et al., 2010).

Dates, schemes and methods of sowing are also the subject of research (Bleyaert P., 1990); (Kobryń J., 1987). 3 sowing dates 1, 15 and 30 October and 3 distances 5 cm, 7.5 cm and 10 cm /3 cm ensuring a density of 666 were studied; 444 and 333 ras./m2. The best results were obtained with sowing 1.10 and scheme 10 cm /3 cm. 3 types of seed drills were tested in glasshouse and PE greenhouse conditions: mechanical single-row: 5-row with perforated

discs and 15-row pneumatic. The experiment was carried out with two varieties in glasshouse and one variety in PE. It has been established that the pneumatic seeder gives 2 times more yield than the others.

From the literature review, it is clear that different types of fertilizer have different effects on the quality and yield of radishes. The variety has a decisive influence, also the type of fertilizer and the rate of fertilization. The sowing scheme and the density have an influence. The results obtained, even with similar fertilization, vary and are strongly influenced by the variety and growing conditions. This motivated us to experiment with PO with local and adapted radish varieties. In this regard, we set ourselves the goal of exploring different organic fertilizers and seeding schemes suitable for organic production.

MATERIALS AND METHODS

The experiment was conducted in the Educational-experimental field of the Department of Horticulture at the Agrarian University - Plovdiv during the period 2018/2020. A field experiment was conducted with radish culture in an unheated polyethylene greenhouse on the block method in four repetitions with a reporting plot size of 1.4 m^2. Two varieties of radishes Saxa and Large Reds were used. Sowing was done at the beginning of November at a seeding rate of 1.5 g/m^2. The preparation of the soil was carried out in the autumn, and the entire quantity of the tested biological fertilizers was brought in with the pre-sowing preparation of the soil. The following biological fertilizers were tested: Biosol, Italpolina, Vita organic and were applied in the recommended rates. Two methods of sowing were studied: manual - scattered and row sowing with a single-row seeder. The following options were chosen: 1- control (unfertilized); 2 - Biosol 100 kg/ha^{-1}; 3 - Italpolina 25 kg/ha^{-1}; 4 - Vita organic 100 kg/ha^{-1}. Harvesting began when about 10% of the plants formed standard root crops. The harvests were initially carried out once a week and after the second week twice a week. Biometry was done three times to determine the morphological indicators of the plants during the harvesting period. The following indicators were determined: mass of the whole plant, average mass of the root crop, number of leaves per plant, diameter of the root crop. Only the standard yield from plants with standard roots that were healthy and not cracked was counted. The yield was determined as the sum from all bunches during the harvest period. Nitrates in the root crops were counted once, and one bunch was taken for each variant of the four replicates. Standard cultivation technology was applied, but without the use of chemicals. Watering is done by rain.

The obtained results were subjected to statistical processing using the ANOVA statistical software product. Nitrates were determined in the certified chemical laboratory of AU - Plovdiv.

RESULTS AND DISCUSSIONS

One of the tasks we set ourselves was to follow the influence of the studied factors (biofertilizers and sowing method) on basic morphological indicators in relation to productivity and quality. We tested the reaction of two local radish varieties and the possibility of growing them as organic production.In the experiment with applied row sowing with a seeder, very good values were obtained for all biometric indicators. For the Saxa variety, the plants fertilized with Italpolina have the greatest mass, both in the first and in the second year and on average for the study with statistical evidence of differences in GD 5%. (Table 1). The applied fertilization did not have a significant impact on the number of leaves. In the fertilized variants, the plants formed between 10.04 and 10.42 leaves against 10.05 for the control and the differences were not statistically proven. The obtained results correspond to the notion that the leaves are varietal sign and their number is slightly affected by fertilizing. A good effect is obtained from biological fertilizing on the product part. The largest root crops, both in diameter and according to mass, were obtained after fertilizing with Italpolina and Biosol, and the differences were mathematically proven. In the other variety Large Reds results are similar. (Table 2). The mass of the plants is the largest when fertilized with Italpolina, as the

difference compared to the control and it was proven at GD5%. The number of leaves was also slightly affected by fertilization, but the differences compared to the control were not proven. Very good results were found for the average mass and diameter of the root crop. The largest root crops were obtained after fertilizing with Vita organic and the difference was proven at GD 1%.

With manual scattered sowing, lower values are obtained for most of the studied indicators.

The Saxa variety forms plants with a smaller average mass compared to row sowing. (Table 3)

Table 1. Biometric characteristics of the Saxa variety under row sowing by year and average for the study period

Option	Weight of 1 plant, g			Average root mass, g			Number of leaves per plant			Root diameter, mm		
	2018-19	2019-20	Average	2018-19	2019-20	Average	2018-19	2019-20	Average	2018-19	2019-20	Average
K	30.11	35.45	**32.78**	12.39	16.64	**14.51**	10.12	9.98	**10.05**	31.64	27.14	**29.39**
1	31.31	36.22	**33.76**	13.50	18.44	**15.97**	10.63	10.22	**10.42**	33.27	27.66	**30.46***
2	34.68	39.15	**36.91**	13.11	19.61	**16.36**	10.13	9.96	**10.04**	33.80	27.07	**30.43***
3	30.30	36.35	**33.32**	11.67	16.66	**14.16**	10.39	10.02	**10.20**	31.96	26.67	**29.31**
	GD	5%	2.27	GD	5%	1.46	GD	5%	0.49	GD	5%	1.04
	GD	1%	4.29	GD	1%	2.40	GD	1%	0.68	GD	1%	1.51
	GD	0.1%	6.08	GD	0.1%	3.70	GD	0.1%	0.94	GD	0.1%	2.08

Table 2. Biometric characteristics of the variety Large reds in regular sowing by year and average for the period of the study

Option	Weight of 1 plant, g			Average root mass, g			Number of leaves per plant			Root diameter, mm		
	2018-19	2019-20	Average	2018-19	2019-20	Average	2018-19	2019-20	Average	2018-19	2019-20	Average
K	29.73	35.45	**32.59**	14.93	16.05	**15.49**	9.58	9.70	**9.64**	30.59	29.46	**30.02**
1	29.72	37.29	**33.50**	15.83	16.06	**15.94**	9.29	10.00	**9.64**	30.99	29.36	**30.17**
2	29.03	40.54	**34.78**	17.24	16.70	**16.97**	9.39	10.24	**9.81**	30.88	29.42	**30.15**
3	27.67	40.07	**33.87**	16.51	17.77	**17.14**	9.57	9.98	**9.77**	31.43	30.33	**30.88**
	GD	5%	2.18	GD	5%	1.42	GD	5%	0.40	GD	5%	1.36
	GD	1%	4.81	GD	1%	2.38	GD	1%	0.56	GD	1%	2.26
	GD	0.1%	7.65	GD	0.1%	3.28	GD	0.1%	0.77	GD	0.1%	3.51

Table 3. Biometric characteristics of Saxa variety in scattered sowing by year and average for the study period

Option	Weight of 1 plant, g			Average root mass, g			Number of leaves per plant			Root diameter mm		
	2018-19	2019-20	Average	2018-19	2019-20	Average	2018-19	2019-20	Average	2018-19	2019-20	Average
K	28.31	27.44	27.88	11.70	13.09	12.39	9.68	9.38	9.53	26.17	27.13	26.65
1	29.71	31.07	30.39	12.51	13.29	12.90	9.82	9.95	9.89	26.90	27.78	27.34
2	30.15	32.57	31.33	12.47	13.74	13.10	9.74	9.91	9.83	26.84	28.96	27.90
3	28.31	29.44	28.87	12.68	14.61	13.64	9.77	9.78	9.78	27.20	27.89	27.55
	GD	5%	2.35	GD	5%	1.11	GD	5%	0.50	GD	5%	1.36
	GD	1%	4.02	GD	1%	1.53	GD	1%	0.70	GD	1%	1.89
	GD	0.1%	7.32	GD	0.1%	2.11	GD	0.1%	0.96	GD	0.1%	2.61

The plants are the largest after fertilization with Italpolina and the difference compared to the control is statistically proven at GD 5%.

Fertilization had little effect on the number of leaves and the slight superiority of the fertilized variants was not mathematically proven. The applied biological fertilizers stimulated the formation of root crops with greater mass and diameter. The differences have been proven when fertilizing with Italpolina and Vita organic. The Large Reds variety has slightly higher values for most of the monitored indicators. (Table 4) Larger plants were formed, with the highest value when fertilized with Italpolina and the difference compared to the control was proven at GD 1%. The leaves were slightly affected by fertilization and the differences in favor of the variants with biofertilizers were not proven. This variety formed slightly larger root crops compared to the " Saxa " variety. The highest average mass and diameter have the root crops when fertilized with Italpolina and Vita organic and the differences are mathematically proven at GD 5%.

The conducted biometric research gives reason to make the following important findings: Method of sowing has an impact on the morphological characteristics. Row sowing shows an advantage over manual sowing and creates an opportunity for the formation of larger plants and better quality root crops. Biological fertilization has a stimulating effect on the morphological characteristics indicators in both varieties. The best values are obtained when fertilizing with Italpolina and the differences are proven. The stimulating effect is more pronounced with row sowing. The studied varieties respond well to the applied biofertilizers and can be recommended for use in organic production.

Good economic results when growing radishes depend not only on the development of strong plants and quality fruits, but also on the obtained ties per unit area. Yield expressed in terms of ties per hectare was reported for both methods of sowing.

In case of scattered sowing, the highest yield of "Large Reds" by year and on average for the period was reported for the version fertilized with Italpolina 8718 bunch/ha^{-1} and exceeded the control by 23.7%, and the difference was proven at GD 0.1%. Variants fertilized with Vita organic and Biosol also exceeded the control by 12% and 14% with statistical evidence at GD 0.1%. The variety " Saxa " reacted less well to fertilization with the tested fertilizers. The most connections were obtained after fertilization with Italpolina 6918 bunch/ha^{-1}. All variants with biological fertilizers exceeded the control by 7.28% to 13.19% with evidence of differences.

Yields in row sowing are higher than in scattered sowing with 11.3 % (tab. 6). When fertilizing with Italpolina, the "Large Reds" variety has the most ties by year and on average - 9950 bunch/ha^{-1}. It surpasses the control by 24.9% and the difference has been proven at GD 0.1%. The other variants also exceed the control by 15.89% and 19.89% with a high degree of proof of the differences. The variant with Italpolina is also the most productive with the variety " Saxa " - 8096 bunch/ha^{-1}. and an excess compared to the control 16.54%. Fertilization with the other two fertilizers also helped to harvest more vines by 9.47% and 13.59% respectively over the control, with differences in all evidenced at GD 0.1%

Yield expressed in connections is strongly influenced by the method of sowing. Regular sowing creates good conditions for harvesting more summer/dec. compared to scattered hand seeding. With Large Reds, the connections in row sowing are 917 bunch/ha^{-1} (13%) more than in scattered sowing. The Saxa variety also responded well to row sowing and formed 835 more ties. Fertilization with biofertilizers further contributes to the formation of more ties by creating good conditions for germination, growth and development of seeds and plants. The sowing methods also have a significant impact on the resulting ties seed qualities.

Radishes, as a crop with a product part that is formed in the soil, are strongly influenced by the nutritional regime and are prone to nitrate accumulation. In this regard, we determined the accumulated free nitrates in the individual variants. In row sowing, no significant difference in the accumulation of nitrates was found between the two tested varieties.

Variants fertilized with organic fertilizers have higher values from 1177.4 to 1348.1 for " Saxa " and from 1023.7 to 1131.4 for "Large Reds" compared to the unfertilized control. There is no significant difference in the accumulation of

nitrates when radishes are grown with scattered sowing. The highest values are when fertilizing "Saxa" with Italpolinna -1407.3. In the "Large reds" variety, fertilization with Italpolina also has higher nitrates 1051.8 compared to the control and the other fertilizers. The measured nitrates in all fertilization options are below the MPQ(maximum permissible quantities) for radishes.

The high values in the "Saxa" variety compared to "Large Reds" can be defined as a varietal reaction. The highest values reported after applying Italpolina can be explained by the chicken origin of the fertilizer. The low nitrates obtained in the row sowing can be explained by the most developed plants and the obtained more ties per unit area.

Table 4. Biometric characteristics of the variety Large reds in scattered sowing by year and average for the period of the study

Option	Weight of 1 plant, g			Average root mass, g			Number of leaves per plant			Root diameter mm		
	2018-19	2019-20	Average	2018-19	2019-20	Average	2018-19	2019-20	Average	2018-19	2019-20	Average
K	29.96	30.86	30.41	12.94	13.14	13.04	9.95	10.18	10.07	26.81	28.30	27.55
1	34.01	31.36	32.68	13.10	14.17	13.64	10.25	10.64	10.45	27.35	29.71	28.53
2	35.56	36.06	35.81	13.08	14.87	13.98	10.25	10.46	10.36	27.88	29.49	28.80
3	30.90	34.75	32.85	13.90	14.47	14.19	10.30	10.05	10.18	27.99	29.10	28.55
	GD	5%	2.47	GD	5%	1.06	GD	5%	0.39	GD	5%	1.24
	GD	1%	4.59	GD	1%	2.40	GD	1%	0.62	GD	1%	1.91
	GD	0.1%	6.78	GD	0.1%	3.70	GD	0.1%	1.04	GD	0.1%	2.78

Table 5. Yield with scattered sowing by year and average for the study period - pieces/ha^{-1}

Option	Large reds				Saxa			
	2018-19	2019-20	Average	%	2018-19	2019-20	Average	%
K	6575	7523	7049.0	100	5826	6398	6112.0	100
1	7447	8466	7956.5	112.87	6318	6795	6556,5	107.27
2	8129	9307	8718.0	123.67	6621	7216	6918.5	113.19
3	7674	8443	8058.5	114.32	6508	7250	6879.0	112.54
	GD	5%	540				346	
	GD	1%	702				561	
	GD	0.1%	935				752	

Table 6. Yield with regular sowing by year and average for the period of the study - pieces/ha^{-1}

Option	Large reds				Saxa			
	2018-19	2019-20	Average	%	2018-19	2019-20	Average	%
K	7740	8193	7966.5	100	6405	7489	6947.0	100
1	8626	9840	9233.0	115.89	7249	7961	7605.0	109.47
2	9478	10423	9950.0	124.91	7738	8454	8096.0	116.54
3	9163	9940	9551.5	119.89	7591	8191	7891.0	113.59
	GD	5%	623				401	
	GD	1%	836				585	
	GD	0.1%	989				803	

Table 7. Nitrate content in root crops in row sowing - mg/kg

Option	**Saxa**				**Large reds**			
	2018-19	%	2019-20	%	2018-19	%	2019-20	%
K	1218.6	100	1087.4	100	951.7	100	891.3	100
1	1375.3	112.9	1177.6	108.3	1078.5	113.3	969.7	108.8
2	1581.9	129.8	1348.1	123.9	1223.9	128.6	1051.8	118.1
3	1418.1	1116.4	1299.3	119.5	1201.5	126.2	1003.5	112.6

Table 8. Nitrate content in root crops with scattered sowing - mg/kg

Option	Saxa				Large reds			
	2018-19	%	2019-20	%	2018-19	%	2019-20	%
K	1183.5	100	997.1	100	993.1	100	918.5	100
1	1351.7	114.2	1118.4	117.5	1118.3	112.6	1023.7	111.5
2	1615.3	136.5	1407.3	141.1	1293.7	130.2	1131.4	123.2
3	1458.1	123.2	1253.6	125.7	1201.5	119.3	1105.3	120.3

CONCLUSIONS

Fertilization with the organic fertilizers Italpolina, Vita organic and Biosol has a stimulating effect on the morphological indicators and the quality of the root crops in Saxa and Large Reds" . Both varieties can be successfully used in organic production in greenhouse conditions. Row sowing has an advantage over scattered sowing and creates conditions for the formation of better quality root crops and obtaining more bunches per ha^{-1}. The organic fertilizers used do not cause accumulation of nitrates in root crops above maximum permissible amounts of nitrates.(MPA)

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REFERENCES

Alsiņa, I., Dubova, L., Šteinberga, V., Gmizo, G., (2013) The effect of vermicompost on the growth of radish. *Acta Horticulturae* 2013 (No.1013):359-365.

Araújo, R. G. V. de, Lima, J. R. B. de, Silva, A. B. da, Santos, G. T. dos, Silva, J. M. Da,Paes, R. de A., (2020) Development of radish tuber in function off different eartworms humus concentrations. *Ciência Agrícola* 18(3):1-5.

Bleyaert, P., (1990) The effect of the sowing method for radish (Raphanus sativus L. var. radicula Pers.). *Revue de l'Agriculture* 43(6):949-958.

Bodkhe, V. A., Mahorkar, V. K., (2010) Effect of various organic manures on growth, yield and quality of radish. *International Journal of Agricultural Sciences* 6(1):72-73.

Bonela, G. D., Santos, W. P. dos, Alves Sobrinho, E., Gomes, E. J. da C., (2017) Productivity and quality of radish roots cultivated under different residual sources of organic matter, *Revista Brasileira de Agropecuária Sustentável* 7(2):66-74.

Costa, C. C., Oliveira, C. D. de, Silva, C. J. da, Timossi, P. C., Leite, I. C., (2006) Growth, productivity and quality of radish roots cultivated under different sources and doses of organic fertilizers. *Horticultura Brasileira* 24(1):118-122.

Kobryń, J., (1987) The effect of sowing date and density on yield and quality of the radish cultivar Rowa in autumn-winter greenhouse production. *Zeszyty Naukowe Akademii Rolniczej im. Hugona Kołłątaja w Krakowie, Ogrodnictwo* (No.211 (16)):109-127.

Kováčik, P., Jančovič, J., (2001)Deficiency symptoms of nitrogen, phosphorus, potassium and sulphur in radish plants. *Acta Fytotechnica et Zootechnica* 4(2):38-42. Nitra, Slovakia: Slovenská Polnohospodárska Univerzita v Nitre

Kováčik, P., Vozár, L., Černý, I., Felixová, I., (2004)The influence of ammonium and nitrate nitrogen on radish yield parameters. *Acta Horticulturae et Regiotecturae* 7(Supplement):48-50. 2nd International Horticulture Scientific Conference, Nitra, Slovakia, 16-18 September, 2004

Kováčik, P., Wiśniowska-Kielian, B., Smoleń, S., Škarpa, P., Olšovská, K., Urminská, J., (2021) Dependence of quantitative and qualitative parameters of radish yield on contents of ammonium and nitrate nitrogen in soil substrate. *Journal of Ecological Engineering* 01 May 22(5):68-77.

Kowalski, A., Kaniszewski, S.,(2017) Effect of organic fertilization on the quality and yield of two radish cultivars in greenhouse organic cultivation. *Acta Horticulturae* (No.1164):189-194.

Mahorkar, V. K., Bodkhe, V. A., Ingle, V. G., Jadhao, B. J., Gomase, D. G., (2007) Effect of various organic manures on growth and yield of raddish. *Asian Journal of Horticulture* 2(1):155-157.

Maia, P. de M. E., Aroucha, E. M. M., Silva, O. M. dos P. da, Silva, R. C. P. da, Oliveira, F.A. de,(2011) Development and quality of radish under different sources of potassium. *Revista Verde de Agroecologia e Desenvolvimento Sustentável* 6(1): Artigos 148-153.

Mehwish Kiran, Jilani, M. S., Kashif Waseem, Muhammad Sohail, (2016) Effect of organic manures and inorganic fertilizers on growth and yield of radish (Raphanus sativus L). *Pakistan Journal of Agricultural Research* 29(4):363-372.

Narloch, C., author,Oliveira, V. L. de, Anjos, J. T. dos, Silva Filho, G. N., (2002) Responses of radish culture to phosphate-solubilizing fungi. *Pesquisa Agropecuária Brasileira* 37(6):841-845.

Nurzyńska-Wierdak, R., Dzida, K., Reszka, A., (2013) The yield and chemical composition of radish roots (Raphanus sativus L. var. sativus L.) in relation to the nitrogen and potassium feeding of plants. *Annales Universitatis Mariae Curie-Skłodowska. Sectio EEE, Horticultura* 23(2):11-20.

Pedó, T., Aumonde, T. Z., Martinazzo, E. G., Villela, F. A., Lopes, N. F., Mauch, C. R., (2014) Growth analysis of radish plants subjected to doses of nitrogen. *Bioscience Journal* 30(1):1-7. Uberlândia, Brazil : Universidade Federal de Uberlândia

Singh, V., Naseeruddin, K. H., Rana, D. K.,(2016) Effect of organic manures on growth, yield and quality of radish (Raphanus sativus L.) cv. Pusa Desi. *HortFlora Research Spectrum* 5(2):129-133.

Soare, R., Soare, M., Iancu, P., (2010) Researches concerning the behavior of an radish assortment (Raphanus sativus L. Brassicaceae) for greenhouses. , *Journal of Horticulture, Forestry & Biotechnology* 14(1):202-206.

Strada, J., Truc, J(1994)., Evaluation of some radish (Raphanus sativus L. var. radicula Pers.) cultivars in relation to nitrate accumulating capacity. *Zahradnictví* 21(1):17-25.

Subedi, S., Srivastava, A., Sharma, M. D., Shah, S. C., (2018) Effect of organic and inorganic nutrient sources on growth, yield and quality of radish (Raphanus sativus L.) varieties in Chitwan, Nepal. SAARC. *Journal of Agriculture* 16(1):61-69.

Verma, U. K., Rajeev Kumar, Sanjeev Kumar, Anil Kumar, (2017) Integrated effect of organic manures and inorganic fertilizers on growth, yield and yield attributes of Radish cv. Kalyanpur Safed. *Agriways* 5(1):19-22.

Vijayakumari, B., Sasikala, V., Poornima, C. P., (2012)Effect of organic and inorganic manures on biometric and yield parameters of radish (Raphanus savitus L.) cv. Pusaphepki *International Journal of Plant Sciences* (Muzaffarnagar) 7(1):130-134.