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Post Effect of Organic and Mineral Nutrition in Growth, Yield and Quality of Spinach (Spinacia Oleracea).

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ABSTRACT

Cultivating spinach during autumn, as a sealing crop, has important economic and agro-ecological significance both through the yields achieved and by the more complete and rational utilization of the residual nutrients in the soil after harvesting the previous main crop. A field experiment with spinach variety Matador is conducted on the alluvial-meadow soil. The soil reaction (pH) is slightly acidic, humus content is low (1.33 %). The availability of mobile forms of N, P and K variants of an experiment in post-harvest predecessor are low mineral nitrogen and high P_2O_5 and K_2O. The study aimed to assess the post-effect of organic, mineral and mixed manure and mineral nutrition in the predecessor previous crop early potato with many treatments. Control variant without nutrition (T1), with organic (manure) (T2), with mineral (T3), and with mixed 50% manure-50% mineral nutrition (T4). The effect of treatments on growth, yield, quality of production and quality parameters in autumn growing Spinach (Spinacia oleracea Linn) has studied. The experiment is a completely randomized design. The results indicate that the highest yield of spinach is obtained from the plants with post effect of the mineral nutrition. Plants are grown after mineral nutrition has higher nitrogen, chlorophyll and nitrates contents. The dry matter content and total sugars are highest in the production of spinach after the previous crop fertilized with manure.

Keywords: *Organic, mineral nutrition, spinach, quality parameters.*

INTRODUCTION

A major challenge for modern horticulture is to reconcile productivity and sustainability of production systems and nutritional quality of food products. Nutritional quality is a highly complex trait due to both (i) the large number of individual properties which determine crop quality (i.e., concentration and bioavailability of essential and potentially toxic minerals, organic nutrients and accessory health factors) and (ii) the various factors which control them (i.e., genetic and exogenous factors, the latter either natural or man-made) Wiesler, F. 2015.

Provision of a sustainable environment in the soil by amending with organic inputs can improve the quality and acceptability of crop. Jaya Sharmaand Sunita Agarwal 2014

Autumn-winter crops can be an important reserve for compensation and increase the income of farmers. For optimum crop rotation schemes according to the requirements of good agricultural practice (GAP), using of leafy vegetable crops with short duration is recommended. Adequate crop for that is spinach, which can use as an indicator who expressed nutritional status of the soil. Leafy vegetables consist from huge diversity, Spinach (Spinacea oleracea Linn) a member of the chenopodiaceae family. Usually spinach plant used as test crop in many agrochemical and ecological studies. (Botev 2006, Dinev and Mitova, 2011, Mitova, et all 2005 and Mitova and Stancheva, 2003).Vegetative organs react quickly and appropriately to various biotic and abiotic effects.

The objectives of this research are to determine post-effect of organic manures and chemical fertilizer on the growth, yield and quality of spinach.

MATERIAL AND METHODS

Experiment is laid in experimental open field of IPAZR "N. Poushkarov " located in –Tsalapitsa village on alluvial meadow soil. Initial values of soil reaction (pH) (pH H_2O- 6.8; pH kcl- 6.0) and humus content (1.33%) characterized as slightly acidic soil with low humus content.

By using of spinach cvs."Matador" sowing date in mid-September, after harvesting of early potato production. The production wasfinished on 10 November. An experiment was laid in Completely Randomized Design the options with 4 replications with the size of the experimental plot- 30 m^2.

For the main crop (potatoes) in variants with 100% mineral fertilizer wasadd 20 kgN.da^{-1}as ammonium nitrate, 12 kg P da^{-1}-as triple superphosphate and 18 kg kaliy.da^{-1} as potassium sulphate.

By using manure which contain of 1.2% total nitrogen. Manure norm 20 kgN.da^{-1} was add with 1667 kg.da^{-1} manure.

In variant, four were added ½ of mineral fertilizer norms and manure. For experiment with spinach did not used any fertilizers. To understand the post effect of fertilization of the previous crop.

Variants of using fertilizers with soil reaction, and the content of nutrients after harvest the potatoes are present in Table 1.

Table 1. *Soil agrochemical analysis in depth 0- 30 cm after harvesting of potatoes*

Treatments	pH_{kcl}	NH_4-N	NO_3-N	P_2O_5	K_2O
(T1)without nutrition	6.5	10.63	5.70	17.63	24.32
(T2)100% manure	6.9	12.19	0.52	77.50	38.30
(T3)100% mineral fertilizer	6.7	7.52	13.48	21.91	33.35
(T4)with mixed 50% manure-50% mineral fertilization	6.9	4.41	3.63	30.72	28.50

The fresh weight of plants is determined by weight in kilograms per hectare. From the plant samples, after drying at 65˚C with a preliminary fixation, the dry substance (absolute dry matter%) was determined by weight. The total sugar content is determined refractometrically - (%) (Digital refractometer - 32 145).

The nitrate content is determined on Merck's RQ flex plus 10 instrument. The content of plaster pigments in the fresh mass (mg.g-1) is determined by the Vernon method, 1960.The content of macroelements in the soil is determined by standard methodologies (Arinushkins, 1970), ammonium and nitrate nitrogen - colorimetric, movable forms of phosphorus and potassium by the method of P. Ivanov (1984).In plants, total nitrogen was determined by the Keldahl method by decomposition with concentrated H_2SO_4 and 30% H_2O_2. The remaining macroelements were determined by "dry" burning in muffle furnaces and subsequent dissolution in 20% HCl, taking into account the atomic absorption spectrophotometer.

The yield data is processed using the Statgraphics / Anova / Multifactor dispersion statistic package.

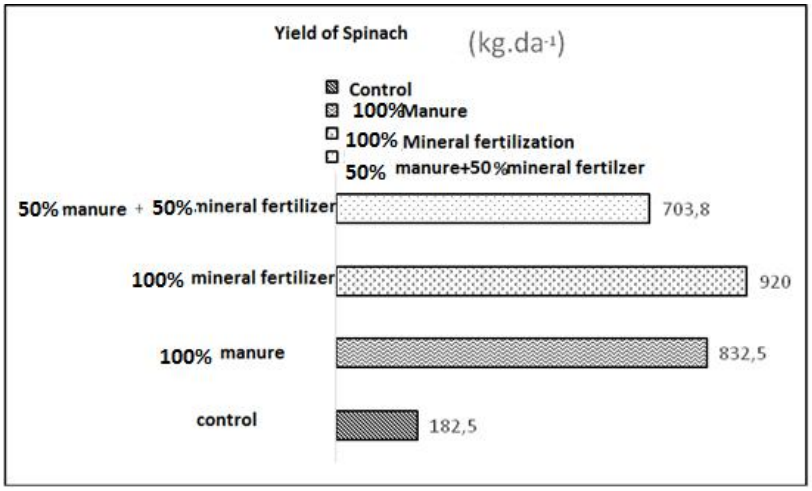

Figure 1. *Yield of spinach after treatments Kg/da*

Results And Discussion

The optimum growth and development of plants depend not only on the balanced absorption of nutrients. Their presence in the soil is readily available in readily accessible and digestible forms. External factors also influence the

vegetation, which in certain situations can compromise production. Spinach is particularly sensitive to high acidity. The optimum soil pH should be 6.2 to 6.9 (Genkova, 2009). It can be seen (Table 1) that soil acidity is appropriate for the development of spinach. In all embodiments, the mineral nitrogen content is low, and in the moveable form of phosphorus and potassium-rich forms. The particularly high content of P_2O_5 and K_2O in the soil is the manure variant with manure.

The yield data shows a significantly lower yield in the control variant compared to the plants suffuring from the effects of using different fertilizers. It can be assumed that the yield from the non-treated plants should be comparable to the other yields. The reason for the low yield of the untreated variant, despite the fact that the nutrient content is close to that of the other variants, could be the highest density of weeds and the attack of diseases that occurred in the cultivation of the previous potato crop. Spinach from the untreated variant develops slowly, the formed leaves are small, and the plants prematurely shoot.(Fig.1)

The yields obtained in the study are significantly lower than those reported in the literature (Boteva Hr .. 2006, Genkova, 2009, Mitova et al., 2005; Rankov et al., 1994) in fertilization with organic and mineral fertilizers. In this experiment its important to take into account the fact that the obtained yields are the result of the effect of the fertilization of the base crop. The highest yield of spinach in the experiment was obtained in the variant with the effect of mineral fertilization - 920 kg / da(35%), followed by manure variants - 832,5 kg / da(31%) and mixed fertilization - 703,8 kg / da(27%). Differences in yields are statistically satisfied.(Fig.2)

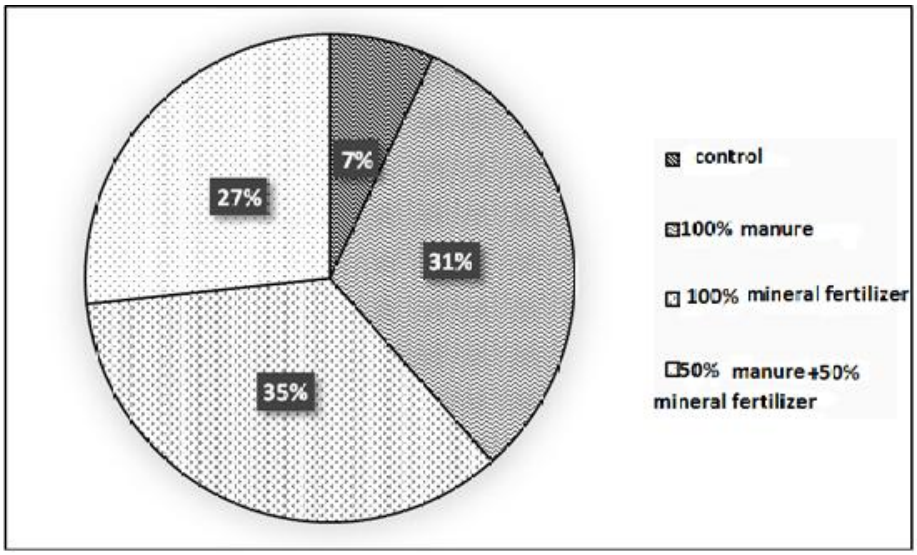

Figure 2. Yield of spinach in percentage%

The differences in yields at both statistical levels between control and fertilizer variants as well as between organic fertilizer plants and mixed and mineral fertilizers are statistically satisfied. Table 2

Table2. *Statistical analyses of yield*

Variants	***1. control***	***2. 100% manure***	***3. 100% mineral fertilizer***	***4. 50%manure+ 50%mineral fertilizer***
Average	703.8	920.0	832.5	182.5
Median	704.4	915.7	831.9	12.5
St Dev	18.11	15.80	17.71	42.5
F-Ratio- 485.37; P- Value- 0.000; (P≥95%)- 48.892; (P≥99%)- 71.142				

The total nitrogen content in the leaf mass varied between (2.0- 3.9%) of the plants (Table 3) follows the yields obtained and is comparable to the cited values in the literature (Rankov et al., 2004; Mitova et al., 2015). High concentrations of phosphorus - 1.13%, potassium - 8.9% and calcium - 1.0% in plants with the effect of manure correspond to the high residual contents –these results showed reverse tendency in the movable forms of these elementsthesoil. The magnesium content in the

leaves (0.11 - 0.63%) of all variants is lower than in other publications (Mitova et al., 2015).

Table 3. *Content of nutrients (%) in leaves of spinach end of the study.*

Treatments	total N	P	K	Ca	Mg
(T1)without nutrition	2.0	0.9	6.1	0.67	0.11
(T2)100% manure	3.3	1.13	8.9	1.00	0.63
(T3)100% mineral fertilizer	3.9	0.95	7.0	0.70	0.12
(T4)with mixed 50% manure-50% mineral fertilization	2.6	0.96	7.5	0.77	0.34

Plastid pigments are involved in photosynthesis and play a role in plant growth and growth processes. The study of the composition and amount of pigments in plants under different conditions of development is of scientific and practical interest. Despite the unfavorable climatic conditions in the autumn-winter period, the applied fertilization (organic, mineral and organo-mineral) has a positive influence on the synthesis of plastid pigments (Table 4) and the content of chlorophylls in treated variants significantly higher values of Ch "a" + Ch "b" compared to the results obtained in other experiments (Mitova et al., 2015, Ratterman, 2006). The highest chlorophyll content in the experiment has plants grown after mineral fertilization - 15.8 mg%. According to some authors (Chinok, 1976), the normal ratio of Ch "a" / Ch "b" should be 3: 1. Bero et al., 2007 consider that the ratio of chlorophylls to 2- 3: 1 is constant and depends on a number of factors. In the present study, the nearest ratio of Ch "a" / Ch "b" to the optimal ratio is the 2.25: 1 ratio obtained after mineral fertilization.

Table 4. *Contents of plastid pigments ins pinach leaves.*

Treatments	**Ch „a”**	**Ch „b”**	**Carotinoudes**	**Ch „a”+Ch „b”**	**Ch „a”/ + Ch „b”**
(T1)without nutrition	4.28	2.57	1.83	6.85	1.68
(T2)100% manure	9.04	5.90	2.88	14.94	1.53
(T3)100% mineral fertilizer	10.94	4.86	3.59	15.80	2.25
(T4)with mixed 50% manure-50% mineral fertilization	7.89	3.57	3.31	11.46	2.21

Leafy vegetables contain relatively low amounts of dry matter, but they are characterized by a high content of vitamins and nitrates (Mitova et al., 2005, Mihov et al., 1980, Shaban et al., 2014). The dry substance is a relatively stable and genetically determined substance. While in fruityvegetable crops its content is lower, in leaf vegetables, in the case of spinach, the dry matter levels are between 11.4 and 12.15% and are comparable to those of other spinach studies (Mitova et al., 2015). The highest levels of absolute dry matter are in the plants grown after treated with manure (Table 5), and for the other variants the differences in dry matter values are insignificant. In the Peev research, 1985, it proves that the sugar content correlates well with that of the dry matter. In this experiment, there is a similar positive relationship between the cited indicators. The foliar fresh weight of plants grown after fertilization with manure has the highest content not only of dry matter, but also of total sugars - 9.3%.

Table 5. *Quality parameters of spinach production.*

Variants	Absolute dry matter (%)	Total sugars (%)	Nitrate (mg.кg^{-1})
1.control	11.40	5.8	76.23
2.100% manure	12.15	9.3	95.68
3.100% mineral fertilizer	11.95	7.4	176.49
4.50%manure+50%mineral fertilizer	11.85	5.2	79.21
F-Ratio	*0,95*	*149,74*	*92,38*
P- Value-	*0,450*	*0,000*	*0,000*
(P≥95%)	*1,060*	*0,489*	*16,006*
(P≥99%)	*1,543*	*0,712*	*23,289*

The accumulation of nitrates in the production of foliar vegetable crops is genetically predetermined (Genkova, 2009, Stoyanov, 1997, Afaf Ghaleb Hafiz Abu-Dayeh, 2006, Mitova and Stancheva, 2003, Rankov et al., 1994). The control of maximum permissible quantities of contaminants in the food is implemented by Ordinance of MAF-31 of 29.07.2004. For

spinach, the limit value for nitrate in production harvested in the autumn-winter period is 3000 mg / kg. Experimental nitrate content ranges between 76.2 and 176.5 mg / kg of fresh weight, the highest concentration of nitrates being regitrated after mineral fertilization.The agrochemical analysis of soil samples from the variants (Table 6) with spinach after harvesting the experience show a significant depletion of nutrients mainly of mineral nitrogen. In accordance with the low yields in the non-preferred embodiment, the residual ammonium and nitrate nitrogen contents are larger than in the other variants. The content of P_2O_5 and K_2O (Table 5) in the soil after the application of manure is still high and at the end of the study

Table 6. *Agro chemical soil analyses 0- 30 cmat end of the experiment with spinach.*

Treatments	pH_{KCl}	NH_4-N	NO_3-N	P_2O_5	K_2O
(T1)without nutrition	6.7	7.42	5.13	14.07	20.66
(T2)100% manure	7.1	6.74	2.00	64.92	34.13
(T3)100% mineral fertilizer	6.8	4.67	4.33	12.28	29.58
(T4)with mixed 50% manure-50% mineral fertilization	6.9	2.56	0.84	27.45	26.50

CONCLUSION

Cultivating spinach in autumn as a sub crop has important economic and agro-ecological significance both through the yields achieved and by the more sufficient and rational utilization of the residual nutrients in the soil after harvesting the main crop.

- The highest yield of spinach is obtained in the variant with the effect of the mineral fertilization.
- Plants grown after mineral fertilization have higher nitrogen, chlorophyll and nitrate content.
- The dry matter content and total sugars are highest in the production of spinach after a previous crop fertilized with manure.

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