Impact of fertilization on yield in garden beet, cucumbers, celery, radish and spring onion

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Abstract Research carried out on the nitrite and nitrate contents are directly influenced by the level of fertilisation. Applying very high rates of fertilisers on vegetable crops has a negative impact on produce quality, despite the high level of the yield. Analysing yield in the field depending on the level of fertilisation confirms the fact that between the level of fertilisation and the yield there is a positive correlation. In garden beet, yield oscillated between 8,050 kg/ha and 27,325 kg/ha. In cucumbers, absolute yield oscillated between 29,353 kg/ha and 140,260 kg/ha. Celery yield oscillated between 7,840 kg/ha and 25,460 kg/ha. Radish yield had lower values between 4,280 kg/ha and 15,845 kg/ha. Yield in spring onion was lower, i.e. it reached about 16,000 kg/ha in the variant fertilised with $N_{60}P_{45}K_{45}$.

Key words

vegetable crops, mineral fertilisers, level of fertilisation, yield

Vegetables are foods with a special nutritious value due to their permanent source of vitamins, micro-elements and other nutritious substances. The disadvantage is that at a certain point in time there are, in their composition, some compounds toxic for the human body: nitrates and nitrites. These contaminants can be found permanently or temporarily in the plant, with very different levels depending on a series of factors; this is why it is absolutely necessary to know the ways to diminish the level of nitrates and nitrites in the vegetable produce to lower their content at the time of consumption.

Choosing the proper mineral fertilising method should take into account plant needs, i.e. the amount of nitrogen absorbed by the plant under optimal nutrition conditions. The amount absorbed by the plant depends on the value of the yield and it depends on the soil fertiliser supply plus the supplementary amount of fertiliser [1, 2, and 3].

Material and Method

Field trials were set at the Didactic Station in Timişoara and aimed at developing technologies that allow profitable vegetable crops and, most important, vegetables with nitrite, nitrate, and ammonia content below maximum admitted levels. The trials were set on a cambic chernozem with high humus content (3.41%), normal nitrogen supply (0.018%), low mobile phosphorus supply (17.8 ppm), high assailable potassium content (187.6 ppm), and neuter reaction. All these confer the soil good fertility.

The trials were monofactorial and set after the randomised block method; we cultivated five vegetable crops (garden beet, celery, cucumber, radish, and spring onion), in four variants and three replications.

Within the trials, we managed to materialise the following trials:

Garden beet and Celery:
V_1 – $N_0P_0K_0$
V_2 – $N_{60}P_{60}K_{30}$
V_3 – $N_{90}P_{60}K_{30}$
V_4 - $N_{120}P_{60}K_{30}$
Cucumbers:
a_1 - $N_0P_0K_0$
a_2 – $N_{60}P_{45}K_{45}$
a_3 – $N_{90}P_{45}K_{45}$
a_4 - $N_{120}P_{45}K_{45}$
Radish and Spring onion:
a_1 - $N_0P_0K_0$
a_2 – $N_{30}P_{45}K_{45}$
a_3 – $N_{45}P_{45}K_{45}$
a_4 – $N_{60}P_{45}K_{45}$

Absolute yields were related to area unit (hectare) and the results were statistically processed through variance analysis [4, 5].

Results and Discussions

Depending on the level of fertilisation, yield in the vegetable species cultivated in the field had different values. In garden beet, absolute yield oscillated between 9,475 kg/ha ($N_0P_0K_0$) and 27,325 kg/ha ($N_{120}P_{60}K_{30}$), respectively. The increase in yield in the variant fertilised with $N_{120}P_{60}K_{30}$ compared to the average of the field is 7,125 kg/ha, a very significant difference in yield (Table 1).

In cucumbers, relative yield had values between 34.01% ($N_0P_0K_0$) and 139.20% ($N_{120}P_{45}K_{45}$) (Table 2).

In celery, the highest yield was in the variant $N_{120}P_{60}K_{30}$, i.e. 25,460 kg/ha, with an increase in yields of 7,001 kg/ha, i.e. a very significant increase in yield (Table 3).

In radish, yield reached values between 6,237 kg/ha ($N_0P_0K_0$) and 15,845 kg/ha ($N_{60}P_{45}K_{45}$) (Table 4).

In spring onion, yield oscillated between 3,105 kg/ha ($N_0P_0K_0$) and 16,250 kg/ha ($N_{60}P_{45}K_{45}$), respectively (Table 5).

Depending on the level of fertilisation, yield in the different vegetables cultivated in the field oscillated in 2008 as shown below. Thus, in garden beet, yield oscillated between 8,050 kg/ha and 25,460 kg/ha (Table 6), respectively.

In cucumbers, the values oscillated between 29,353 kg/ha and 120,483 kg/ha (Table 7).

In celery, yield values oscillated between 7,840 kg/ha and 23,475 kg/ha (Table 8).

In radish, the values oscillated between 4,280 kg/ha and 12,635 kg/ha (Table 9).

In spring onion, the values oscillated between 4,845 kg/ha and 14,085 kg/ha, respectively (table 10).

Table 1.

Garden beet yield depending on the level of fertilisation (2007)

Variant	Absolute yield (kg/ha)	Relative yield (%)	Yield difference (kg/ha)	Significance of difference
V_4 - $N_{120}P_{60}K_{30}$	27,325	135.27	+7,125	XXX
V_3 - $N_{90}P_{60}K_{30}$	24,237	119.99	+4,037	XX
Average	20,200	100.00	Mt.	-
V_2 - $N_{60}P_{60}K_{30}$	19,764	97.84	-436	-
V_1 - $N_0P_0K_0$	9,475	46.91	-10,725	000

$Dl_{5\%}$ =2,842 kg/ha;
$Dl_{1\%}$ =3,618 kg/ha;
$Dl_{0.1\%}$ =4,246 kg/ha.

Table 2.

Cucumber yield depending on the level of fertilisation (2007)

Variant	Absolute yield (kg/ha)	Relative yield (%)	Yield difference (kg/ha)	Significance of difference
V_4 - $N_{120}P_{45}K_{45}$	140,260	139.20	+39,498	XXX
V_3 - $N_{90}P_{45}K_{45}$	123,054	122.12	+22,292	-
Average -	105,465	104.67	+4,703	-
V_2 - $N_{60}P_{45}K_{45}$	100,762	100.00	Mt.	-
V_1 - $N_0P_0K_0$	34,270	34.01	-66,492	000

$Dl_{5\%}$ =24,402 kg/ha;
$Dl_{1\%}$ =29,341 kg/ha;
$Dl_{0.1\%}$ =35,425 kg/ha.

Table 3.

Celery yield depending on the level of fertilisation (2007)

Variant	Absolute yield (kg/ha)	Relative yield (%)	Yield difference (kg/ha)	Significance of difference
V_4 - $N_{120}P_{60}K_{30}$	25,460	137.93	+7,001	XXX
V_3 - $N_{90}P_{60}K_{30}$	22,780	111.76	+4,321	-
Average -	18,459	100.00	Mt.	-
V_2 - $N_{60}P_{60}K_{30}$	17,365	94.07	-1,094	-
V_1 – $N_0P_0K_0$	8,230	44.59	-10,229	000

$Dl_{5\%}$ =4,917 kg/ha;
$Dl_{1\%}$ =5,714 kg/ha;
$Dl_{0.1\%}$ =6,842 kg/ha.

Table 4.

Radish yield depending on the level of fertilisation (2007)

Variant	Absolute yield (kg/ha)	Relative yield (%)	Yield difference (kg/ha)	Significance of difference
V_4 – $N_{60}P_{45}K_{45}$	15,845	143.59	+4,810	XXX
V_3 – $N_{45}P_{45}K_{45}$	12,348	111.90	+1,313	-
Average -	11,035	100.00	Mt.	-
V_2 – $N_{30}P_{45}K_{45}$	9,710	87.99	-1,325	-
V_1 - $N_0P_0K_0$	6,237	56.52	-4,798	000

$Dl_{5\%}$ =3,127 kg/ha;
$Dl_{1\%}$ =752 kg/ha;
$Dl_{0.1\%}$ =4,340 kg/ha.

Table 5.

Spring onion yield depending on the level of fertilisation (2007)

Variant	Absolute yield (kg/ha)	Relative yield (%)	Yield difference (kg/ha)	Significance of difference
V_4 – $N_{60}P_{45}K_{45}$	16,250	131.43	+3,886	XXX
V_3 – $N_{45}P_{45}K_{45}$	14,748	119.28	+2,384	XX
Average -	12,364	100.00	Mt.	-
V_2 – $N_{30}P_{45}K_{45}$	12,352	99.90	-12	-
V_1 - $N_0P_0K_0$	3,105	49.38	-6,259	000

$Dl_{5\%}$ = 1,828 kg/ha;
$Dl_{1\%}$ = 2,346 kg/ha;
$Dl_{0.1\%}$ = 3,025 kg/ha.

Table 6.

Garden beet yield depending on the level of fertilisation (2008)

Variant	Absolute yield (kg/ha)	Relative yield (%)	Yield difference (kg/ha)	Significance of difference
V_4 - $N_{120}P_{60}K_{30}$	25,460	136.93	+6,866	XXX
V_3 - $N_{90}P_{60}K_{30}$	22,618	121.64	+4,024	XX
Average -	18,594	100.00	Mt.	-
V_2 - $N_{60}P_{60}K_{30}$	18,247	98.13	-347	-
V_1 – $N_0P_0K_0$	8,050	43.29	-10,544	000

$Dl_{5\%}$ = 2,452 kg/ha;
$Dl_{1\%}$ = 3,247 kg/ha;
$Dl_{0.1\%}$ = 4,053 kg/ha.

Table 7.

Cucumber yield depending on the level of fertilisation (2008)

Variant	Absolute yield (kg/ha)	Relative yield (%)	Yield difference (kg/ha)	Significance of difference
V_4 - $N_{120}P_{45}K_{45}$	120,483	140.66	+34,826	XXX
V_3 - $N_{90}P_{45}K_{45}$	107,325	125.30	+21,668	X
Average -	85,657	100.00	Mt.	-
V_2 - $N_{60}P_{45}K_{45}$	85,470	99.78	-187	-
V_1 - $N_0P_0K_0$	29,353	34.27	-56,304	000

$Dl_{5\%}$ = 20,485 kg/ha;
$Dl_{1\%}$ = 25,362 kg/ha;
$Dl_{0.1\%}$ = 31,470 kg/ha.

Table 8.

Celery yield depending on the level of fertilisation (2008)

Variant	Absolute yield (kg/ha)	Relative yield (%)	Yield difference (kg/ha)	Significance of difference
V_4 - $N_{120}P_{60}K_{30}$	23,475	140.33	+6,746	XXX
V_3 - $N_{90}P_{60}K_{30}$	20,360	121.70	+3,631	-
Average -	16,729	100.00	Mt.	-
V_2 - $N_{60}P_{60}K_{30}$	15,242	91.11	-1,487	-
V_1 - $N_0P_0K_0$	7,840	46.86	-8,889	000

$Dl_{5\%}$ =5,015 kg/ha;
$Dl_{1\%}$ =5,530 kg/ha;
$Dl_{0.1\%}$ =6,304 kg/ha

Table 9.

Radish yield depending on the level of fertilisation (2008)

Variant	Absolute yield (kg/ha)	Relative yield (%)	Yield difference (kg/ha)	Significance of difference
V_4 – $N_{60}P_{45}K_{45}$	12,635	147.74	+4,083	XXX
V_3 – $N_{45}P_{45}K_{45}$	9,802	114.62	+1,250	-
Average -	8,552	100.00	Mt.	-
V_2 – $N_{30}P_{45}K_{45}$	7,491	87.59	-1,061	-
V_1 - $N_0P_0K_0$	4,280	50.05	-4,272	000

$Dl_{5\%}$ =2,478 kg/ha;
$Dl_{1\%}$ =2,924 kg/ha;
$Dl_{0.1\%}$ =3,561 kg/ha.

Table 10.

Spring onion yield depending on the level of fertilisation (2008)

Variant	Absolute yield (kg/ha)	Relative yield (%)	Yield difference (kg/ha)	Significance of difference
V_4 – $N_{60}P_{45}K_{45}$	14,085	139.37	+3,979	XXX
V_3 – $N_{45}P_{45}K_{45}$	12,178	120.50	+2,072	X
Average -	10,106	100.00	Mt.	-
V_2 – $N_{30}P_{45}K_{45}$	9,316	92.18	-790	-
V_1 - $N_0P_0K_0$	4,845	47.94	-5,261	000

$Dl_{5\%}$ = 2,048 kg/ha;
$Dl_{1\%}$ =2,529 kg/ha;
$Dl_{0.1\%}$ =3,235 kg/ha.

Conclusions

1. In the two trial years, yield in the five species of vegetables was in direct correlation with the level of fertilisation. In all vegetable species, absolute yield after maximum level fertiliser application was three times larger than in the control variant.
2. In garden beet, yield oscillated between 8,050 kg/ha and 27,325 kg/ha.
3. In cucumbers, absolute yield was between 29,353 kg/ha and 140,260 kg/ha.
4. Celery yield was between 7,840 kg/ha and 25,460 kg/ha.
5. In radish, yield was lower, i.e. between 4,280 kg/ha and 15,845 kg/ha.
6. In spring onion, yield was even lower, reaching 16,000 kg/ha in the variant fertilised with $N_{60}P_{45}K_{45}$.

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