EFFECT OF WASTE LIME APPLICATION ON YIELD AND PRODUCTION ECONOMY OF SOME ARABLE CROPS

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Summary

Apart from a check variant and standard fertilization, an increased amount of waste lime from 100 to 100.000 kg/ha in wheat, maize and sugar beet has been surveyed in this paper. The yield of all the three crops and sugar beet digestion were increased in the standard ferilization and went up further by each increase in the amount of waste lime. 100.000 kg/ha waste lime increased the yield of maize for 2.219 and 3.514 respectively, the yield of wheat for 856 and 863 respectively, yield of sugar beet for 15.556 and 12.589 kg/ha respectively and sugar beet digestion for 1.07 and 1.16% respectively on the localities in Lukač and Grubišno Polje. An increase in the amount of waste lime had an effect on the increase in pH from 4.63 to 7.64 and from 4.96 to 7.75 in Lukač and Grubišno Polje respectively.

Key words: waste lime, maize, wheat, sugar beet, yield, digestion, pH

Mehtods

Block method in five repetitions. With seventeen variants control without fertilization, standard fertilization (maize N-180, P_2O_5 = 130, K_2O - 150 kg/ha, wheat N - 150, P_2O_5 and K_2O 120 kg/ha, sugar beet N - 180, P_2O_5 - 120, K_2O - 250 kg/ha). The amount of waste lime was 1 to 10 tons per hectar. In variants with waste lime we applied 100 kg/ha of N and 80 kg/ha

of P_2O_5 and K_2O. The investigation was carried out in Lukač and Grubišno Polje in the three year period with the following crop rotation: maize, wheat, sugar beet. Type of soil is pseudogley. Chemical composition of the applied waste lime is : 79% $CaCO_3$, 0.26% N, 0.57% P_2O_5, 0.025% K_2O, pH 8.2 and 39.95% of the available lime.

Introduction

A great number of soils in our republic belong to the pseudogley type which is characterized by a series of unfavourable properties. These soils have unfabourable structure, they are poor in available substances, have shallow active layer and are inclined to too much wetting, then they show a poor microbiological activity, are poor in humus and very often distinctly acid - pH ranges from 4 - 5.5. These soils have an increased percentage of silt so they are inclined to form not only puddled condition but also crust which is 5 cm thick and makes impossible shooting up of seeds and those crops that are characterized by a great penetrating vigour. Consequently, they are soils with bad physical, chemical and biological properties.

These problems can be partly solved by calcification. Calcium has manifold favourable effect in the soil. Calcium changes favourably pH value of soil, increases sorption capability of the soil, increases availability of plant nutrients, increases biological activity of the soil, controls neutralization of toxic sublstances and prevents development of some diseases, and is also an important element for plant nutrition.

Calcium is carried avay from the soil by nature and is lost by leaching, and in this way, the soil is continually made poor in calcium, which requires that the soils poor in calcium are regularly supplied with this element.

In the processing of sugar beet in sugar refineries, what is left over among other by-products, is waste lime. Regarding its chemical composition, it can be used as material for calcification. Its transport costs can be negligible as it can be transported on the way back, after sugar beet is brought in the sugar refinery.

Sedimentary or deposited waste lime can be very well applied by means of manure distributing machinery. In processing about 300.000 tons of sugar beet (capacity of one refinery in its annual processing) 42.000 tons of waste lime is obtained with about 50% of dry matter. Regarding its composition waste lime can be used as fertilizer and in this way it can increase the yield, cut down costs for artificial fertilizers, and also decrease pollution of the environment and keep and enlarge soil fertility.

Dry matter from waste lime contains mainly $CaCO_3$ which is formed by combinating CO_2 and CaO.
Chemical composition of waste lime varied depending on the amount of lime (most often about 3% on beet for sap cleaning) which is added for cleaning extraction sap, and also on sap composition.

Faculty of Technology in Novi Sad (1986) quotes the basic composition of waste lime in the refineries in Hungary. According to the quoted data on the average, waste lime contains 44.90% of water, 9.36% of organic matter, 71.17% of $CaCO_3$ on dry matter, 0.47% of P_2O_5, 0.2% of K_2O and 0.29% of N.

The samo source qoutes also average chemical composition of waste lime for twelve German refineries, everything in dry matter. Sand 1.56% Mg^{++} 3.27% Ca^{++} 31.21% SO_4^{--} 1.57% PO_4^{---} 1.36%, oxalate 0.29%, citrate 2.54%, protein 2.81%, pectin 0.79%, arobane 1.53%, galactane 1.68% and other organic substances 11.88%.

Average resents of four years

Y i e l d kg/ha

Combinations	Maize		Wheat		Sugar beet				pH in n-KCl	
					Moro - OS_2					
	Lukač Bc-488	G.Polje	Lukač Super zlatna	G.Polje	Lukač		G.Polje		Lukač	G.Polje
					Yield	Digesti-on %	Yield	Digesti-on %		
1. Ø without fertilization - Check	5125	564o	2261	2452	21612	13,o3	22o75	13,14	4,5o	4,87
2. Standard technology	8o2o	7237	3524	36o6	337o3	13,53	37577	13,34	4,63	4,96
kg/ha N P_2O_5 K_2O										
Maize 180 130 150										
Wheat 150 120 120										
Sugar beet 180 120 250										
kg/ha waste lime										
3. 1000 100 80 80	8329	8179	3645	3787	36296	13,77	38111	13,65	5,21	5,32
4. 3000 -"- -"- -"-	8332	8258	3856	3928	37o74	13,85	38759	13,7o	5,56	5,59
5. 5000 -"- -"- -"-	856o	8412	3899	3975	39537	13,99	41287	13,9o	5,73	5,91
6. 10ooo -"- -"- -"-	8669	8623	3956	4o13	4o294	14,o1	41924	13,93	6,o8	6,34
7. 15ooo -"- -"- -"-	868o	875o	3988	4o52	4o574	14,14	42194	14,o7	6,42	6,71
8. 20ooo -"- -"- -"-	8896	8911	4o14	4o77	4o91o	14,19	42621	14,1o	6,67	6,95
9. 25ooo -"- -"- -"-	9o58	9247	4o44	4126	41o26	14,2o	42779	14,11	6,87	7,12
10. 3oooo -"- -"- -"-	9152	9371	4o56	4131	41221	14,27	429o7	14,16	7,o3	7,28
11. 4oooo -"- -"- -"-	92o5	95o8	4118	421o	41668	14,32	43389	14,23	7,15	7,3o
12. 5oooo -"- -"- -"-	9314	9592	4132	4295	42543	14,28	44572	14,16	7,26	7,41
13. 6oooo -"- -"- -"-	94oo	9726	425o	4311	43944	14,34	445o5	14,25	7,35	7,5o
14. 7oooo -"- -"- -"-	9454	9955	436o	447o	45759	14,46	46731	14,34	7,44	7,56
15. 8oooo -"- -"- -"-	9517	1o318	44o7	4549	46278	14,54	4712o	14,47	7,48	7,69
16. 9oooo -"- -"- -"-	9736	1o485	4327	44o2	47315	14,59	48417	14,5o	7,59	7,7o
17. 1ooooo -"- -"- -"-	1o239	1o778	438o	4469	49259	14,6o	5o166	14,5o	7,64	7,75
LSD 5%	582	485	-	236	3187	o,74	3414	o,78	-	-
1%	793	643	-	36o	4558	o,91	4743	o,97	-	-

The average composition of waste lime from the reginery in Virovitica which was used in our investigations is the following: CaO 38.5%, $CaCO_3$ 49.56%, sugar 1.55%, MgO 1.68%, K_2O 0.24%, P_2O_5 0.72%, N organic 0.44%, SiO_2 0.35% and water 30%.

A great number of researchers worked on the problem of investigating and applying waste lime, some are quoted here: Andrers, Laszlone (1982), Bajsicy, Horvat, Lugosi (1979), Bugarenko (1983), Curdts (1979), Čiz (1977), Hoffmann-Walbeck (1979), Kubiak (1979), Madsen (1977), Popereka (1987), Vernois (1971, 1976), Gagro (1992).

On both localities the lowest yield of maize was obtained on the check plot without fertilization. By standard fertilization in variant No. 2 we obtained a higher yield for 2.896 in Lukač and for 1.597 kg/ha in Grubišno Polje which is particulatly significant. By applying 1.000 and more kilograms of waste lime per hectar, the yield of maize constantly grew up and it was the highest when we applied the largest amount (100.000 kg/ha) of waste lime in combination No. 17. 1.000 kg/ha of waste lime, in relation to the check with fertilization increased the yield in Lukač for 309 and in Grubišno Polje for 942 kg/ha which is significant. In relation to the variant No. 3 where we applied 1.000 kg/ha of waste lime, a significantly higher yield on the level P=1% was obtained in Lukač with 30.000 (variant No. 10) and in Grubišno Polje with 20.000 kg/ha (variant No. 8).

The difference in the yield between the application of 1.000 and 100.000 kg/ha of waste lime was 1.190 in Lukač and 2.609 kg/ha in Grubišno Polje.

The yield obtained by the largest amount of waste lime (100.000 kg/ha combination No. 17) in Lukač has been significantly higher than the yield in all other combinations, apart from the

one obtained in the combinations No. 14, 15 and 16 in Lukač and 15 and 16 in Grubišno Polje.

Similar results were obtained in the investigations with the wheat. On boot localities, significantly the lowest yield was obtained on the check plot No. 1 without fertilization. By standard fertilization in variant No. 2, the yield was significantly increased for 1263 kg/ha in Lukač and for 1.154 kg/ha in Grubišno Polje in relation to the variant No. 1.

In relation to the variant No. 2, 1.000 kg/ha of waste lime significantly increased the yield of wheat for 121 kg/ha in Lukač and for 181 kg/ha in Grubišno Polje, which is not so significant.

By an increase in the amount of waste lime from 1.000 to 80.000 kg/ha the yield constantly grew up on both localites, when it was the highest, it went down slightly on both localities, at 90.000, and at 100.000 kg/ha it increased insignificantly.

In relation to the variant No. 2, a significantly higher yield was obtained on both localities by the application of 5.000 kg/ha of waste lime.

When we applied 80.000 kg/ha of waste lime we obtained the highest yield on both localities (variant No. 15). In relation to the check variant No. 2, the yield from the variant No. 15 was higher for 883 in Lukač and for 943 kg/ha in Grubišno Polje.

The yield from the variant No. 15 was significantly higher than the yield from all other variants, apart from the variants 9-17 in Lukač and 11-17 in Grubišno Polje.

Sugar beet gave also significantly lowest yield on check plot No. 1 on both localities without fertilization. In relation to the variant No. 1, by standard fertilization (variant No. 2) we obtained a higher yield for 12.091 in Lukač and for 15.502 kg/ha in Grubišno Polje.

By an increase in the amount of waste lime from 1.000 to 100.000 kg/ha the yield of sugar beet constantly grew up on both localities and it was the highest in variant No. 17 (100.000 kg/ha). A difference in the yield between variant No. 17 and variant No. 2 (standard fertilization) was 15.556 in Lukač and 12.589 kg/ha in Grubišno Polje.

In relation to check variant No. 2 (standard fertilization) a significantly higher yield was obained in Lukač with 5.000 and in Grubišno Polje with at least 20.000 kg/ha of waste lime. The highest yield which was obtained by the application of 100.000 kg/ha of waste lime is significantly higher than the yield from all variants, apart from the yield of variants 14 and 17 on both localities.

The lowest digestion on both localities was obtained in variant No. 1 (wihtout fertilization). By standard fertilization (variant No. 3) digestion in Lukač was increased for 0.50 and in Grubišno Polje for 0.20% which is not significant. 100.000 kg/ha of waste lime, in relation to variant No. 2, slightly increased the digestion in Lukač for 0.24% and in Grubišno POlje for 0.31%. By an increase in the amount of waste lime on both localities, digestion constantly grew up (except in variant No. 12 where we had a slight drop of digestion). So, the highest digestion was obtained in variant No. 17 (100.000 kg/ha) and the same percentage of sugar in variants No. 16 and 17 in Grubišno Polje. Digestion of variant No. 17 is significantly higher in both localities than variants No. 1 and 2.

In relation to variant No. 1 (without fertilization) a significant increase in digestion was obtained by application of 5.000 kg/ha of waste lime in Lukač and 30.000 kg/ha in Grubišno Polje. In relation to variant No. 2 (standard fertilization) only when we applied at least 70.000 kg/ha of waste lime digestion was significantly increased on both localities.

Conclusion

Apart from the variant without fertilization and the variant with standard fertilization, we investigated effect of the increased amounts of waste lime from 1.000 to 100.000 kg/ha in maize, wheat and sugar beet on two localities. All the three crops on both localities gave the lowest yield, including digestion for sugar beet on check variant without fertilization.

By standard fertilization in Lukač the yield of maize was increased for 2.896, yield of wheat for 1.263, yield of sugar beet for 12.091 kg/ha and digestion for 0.50%. In Grubišno Polje the yield of maize was increased for 1.597, yield of wheat for 1.154, yield of sugar beet for 15.502 kg/ha and digestion for 0.20%.

By application of waste lime in larger amounts, as a rule, the yield of all surveyed crops went constantly up, including digestion of sugar beet. Thus, the largest amount of waste lime (100.000 kg/ha) obtained the highest yield and digestion of sugar beet. In this way 100.000 kg/ha of waste lime in relation to standard fertilization increased the yield of maize for 2.219 in Lukač and for 3.541 kg/ha in Grubišno Polje, yield of wheat for 856 in Lukač and for 863 kg/ha in Grubišno Polje, yield of sugar beet for 15.556 in Lukač and for 12.589 kg/ha in Grubišno Polje and digestion for 1.07 in Lukač and for 1.16% in Grubišno Polje.

In relation to 1.000 kg/ha of waste lime, on the level of P=1% the yield of maize is significantly increased with 20.000 in Grubišno Polje and with 30.000 kg/ha in Lukač, yield of wheat with 25.000 in Lukač and with 40.000 kg/ha in Grubišno Polje, yield of sugar beet with 20.000 in Lukač and 30.000 kg/ha in Grubišno Polje, while there was not a significant

difference in digestion between the applied variants of waste lime.

By application of waste lime pH is increased from 4.63 to 7.64 in Lukač, from 4.96 to 7.75 in Grubišno Polje. Neutral reaction is obtained with 25.000 kg/ha of waste lime. In variants with waste lime, we applied decreased amounts of N from 50-100 kg/ha, P_2O_5 from 40-50 kg/ha and K_2O from 40 to 170 kg/ha depending on different crops in relation to the variant with standard fertilization.

The application of waste lime increased significantly the yields in comparison to standard fertilization, which means that, apart from other useful effects, production costs can be significantly decreased, as well as pollution of the environment Waste lime can be easily applied by machinery for spreading manure.

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