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**MIXED FERTILIZERS INCORPORATED IN ORGANIC POLIMER MATRIX
AND PRESSED IN TABLETS AS MEANS OF ENHANCING THE NUTRIENTS**

PRODUCTIVE USE IN INCREASED CROP YIELDS

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YIELDS

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Summary

MATRIX MATERIALS

In view of increasing productive use of fertilizer nutrients in crops an admixture of brown coal dust containing up to 40 % carbon ammonia lignosulfonate with 50 % lignoles dry matter as binding agent were used to press water soluble fertilizer sources with a total of $N+P_2O_5+K_2O$ content of up to 26 % in tablets. These may be manufactured at different $N:P_2O_5:K_2O$ ratios as for instance 1:1:1; 1:0.75:0.50 etc. Brown coal and coal refuse dust were used as matrix for inclusion while lignosulfonates served for binding the ingredients when pressing them in tablets of 15-20 g dry mass each. These were tested in accurate field experiments to compare the agronomic effectiveness of equal amounts of NPK in tablets with equivalent rates of powdered sources of nutrients in the same chemical forms. NPK pressed in tablets were applied locally along the plant row, while the powdered mixed fertilizer have been thoroughly mixed in the ploughed layer.

Accurate field experiments have pointed out the higher agronomical effectiveness of NPK pressed in tablets as compared to equal ammounts of NPK powdered and thoroughly mixed into the ploughed layer of soil. Indicators were higher yield increases per nutrient unit and higher degrees of apparent productive use of nutrients in crops.

1. Introduction

The productive use of the nutrients in crops may be enhanced also by manufacturing mixed fertilizers containing adequate solid sources of nutrient thoroughly mixed with brown coal dust consolidated with lignosulfonates and pressed in tablets. The soluble nutrients so incorporated into a matrix of coal powder and

lignosulfonates are protected against direct contact with soil colloids having a binding strength for phosphorus and potassium^{1,2}. The organo-mineral matrix of the pellets ensures also a certain degree of protection of soluble nutrients against leaching and subsequent losses. As a result of such effects the productive use of nutrients from fertilizer pressed in tablets significantly increases along with corresponding decrease of environment pollution risk. Formerly Ciocan (1989)³ tested such mixed fertilizers using synthetic polymers as inclusion and consolidating matrices but these proved to be resistant to degradation by the soil microbial population. In 1998, Romanian patent office⁴ has issued a patent nr. 112610 to Borlan et al for mixed fertilizers pressed in tablets using brown coal dust and carbon containing refuse from cleaning coal for coke production, both as matrix of incorporation and lignosulfonate 50 % suspension as matrix of consolidation.

2. Materials and methods

A mixture of coal dust, containing up to 40 % C, and lignosulfonate suspension with 50 % organic dry matter (lignoles) were used to produce fertilizers pressed in tablet with a total N + P₂O₅ + K₂O content of up to 26 %. These tablets were manufactured at 1:1:1 N:P₂O₅:K₂O ratio.

The resulting dry and solid tablets with a dry mass of 15 - 20 g/tablet were tested in exact field experiments (during 1995 - 1998) in different pedo-climatic conditions with the aim to compare the effect of the amounts of nutrients included in tablets with equal powdered nutrient amounts applied mixed into the plough layer, recording the yields of mature plants.

From 140 to 150 kg N + P₂O₅ + K₂O/ha were applied taking into account plant density (one tablet at 5-6 cm under each plant) in case of maizes and 226.8 kg N + P₂O₅ + K₂O/ha for potatoes. The experimental sites the authors of the cited experimental data are mentioned in the table 1, which contains the experimental results.

3. Results and discussions

In order to compute the apparent degree of productive nutrient use (ADPU) from tablet fertilizers (TF) and from powdered nutrient compounds (PF) the following formula was used:

$$\text{ADPU}_{\text{TF or PF}} = \frac{D \times E}{D} \times 100$$

To compute the degree of productive nutrient use from soil ($DPNU_{soil}$) the following formula was used:

$$ADPU_{soil} = \frac{A - B}{C} \times 100$$

In these formulas: A = nutrient in yield with fertilizers; B = nutrient from fertilizers; C = nutrient in yield without fertilizers (control); D = yield increases; E = nutrient uptaken in yield increases.

The obtained results were statistically tested and are significant.

The yield increases of maize for kernels (table 1) are comprehended in a large domain of values in correlation with the climate and soil conditions (temperature, moisture) and also, with the genetic potential of maize hibrids.

By application of tablet fertilizers in comparison with powdered nutrient compounds fertilization the average values of the yield increases were between 12.6 kg grain/ha (respectively 0.2 %) at Sînanđrei - Timis experimental station, where droughty climate prevailed during experimentation, and 1325.0 kg grain/ha (respectively 26.0 %) at Dăbuleni - Dolj experimental station under irrigation conditions.

The yield increases of potatoes were between 3630.0 kg/ha (respectively 11.1 %) and 3860.0 kg/ha (respectively 11.2 %) at ICPCB Braşov experimental station.

There are no significant differences of yield increases between tablets with carbon containing refuse from cleaning coal for cooke production (TF_S) and tablet with brown coal dust (TF_L).

The table 1 shows also that the specific yield increases (kg main product/kg N + P_2O_5 + K_2O) in maize for kernels are 0.1 up to 12.7% higher than for the powdered nutrient compounds.

The specific increase of yields for potatoes are between 36.8 and 48.0 kg/kg N + P_2O_5 + K_2O (with 16.0 to up 17.0 kg more than powdered nutrient compounds fertilization).

The results showed a significant increase of productive nutrient use from soil and from applied fertilizers in experimental data obtained during 3 and 4 years with tablets fertilizers.

This is reflected by the large apparent degrees of productive use of nutrients from tablet fertilizers, ADPU (table 2), and from soil (table 3).

Table 1

The effect of mixed NPK fertilizers in tablets on maize for kernels and on potatoes as compared with powdered fertilizers of the same chemical forms (average experimental data for 3-4 years, 1995 - 1998)

Fertilization	Yields	Yield increases				Specific yield increase	
		Comparative with check		Comparative with equiv. NPK powdered		*)	**)
	kg/ha	kg/ha	%	kg/ha	%		
Maize (Turda-260). SCPP Caransebeș - Caraș Severin, alluvial mollic litic soil, Bandu G. (1995 - 1998)							
Control	6600	-	-	-	-	-	-
TF _§ ^{***)}	7839.7	1239.7	18.8	544.2	7.5	8.6	3.8
Equiv.NPK _§	7295.5	695.5	10.5	-	-	4.8	-
TF _L ^{****)}	7714.7	1114.7	16.9	505.2	7.0	7.7	3.5
Equiv.NPK _L	7209.5	609.5	9.2	-	-	4.2	-
Potatoes (Sânté). ICPCC Brașov, chernozem soil, Ianoși Maria (1996 - 1998)							
Control	27550	-	-	-	-	-	-
TF _§ ^{***)}	38430	10880	39.5	3860	11.2	48.0	17.0
Equiv.NPK _§	34570	7020	25.5	-	-	31.0	-
TF _L ^{****)}	35890	8340	13.0	3630	11.3	36.8	16.0
Equiv.NPK _L	32260	4710	17.1	-	-	20.8	-
Maize (HT - SV 108). SCA Suceava, chernozem like soil, Bandu G. (1995 - 1997)							
Control	5165.3	-	-	-	-	-	-
TF _§ ^{***)}	6147.7	982.4	19.0	153.7	2.6	6.8	1.0
Equiv.NPK _§	5994.0	828.7	16.0	-	-	5.8	-
TF _L ^{****)}	6251.0	1085.7	21.0	148.3	2.4	7.5	1.0
Equiv.NPK _L	6102.7	937.4	18.1	-	-	6.5	-
Maize (PI-110). SCA Podul Iloaie-Iași, cambic chernozem, Rusu C. and Istrati Elena (1995-1998)							
Control	7390.0	-	-	-	-	-	-
TF _§ ^{***)}	8895.0	1505.0	20.4	322.5	3.8	10.5	2.3
Equiv.NPK _§	8572.5	1182.5	16.0	-	-	8.2	-
TF _L ^{****)}	8995.0	1605.0	21.7	595.0	7.1	11.1	4.1
Equiv.NPK _L	8400.0	1010.0	13.7	-	-	7.0	-
Maize (NSSK - 420) Sîndreii. OSPA Timis, brown argillic mollic soil, Țîmbota L. (1996 - 1998)							
Control	4296.0	-	-	-	-	-	-
TF _§ ^{***)}	6253.6	1957.6	45.6	12.6	0.2	13.6	0.1
Equiv.NPK _§	6241.0	1945.0	45.3	-	-	13.5	-
TF _L ^{****)}	6158.3	1862.3	43.3	25.3	0.4	12.9	0.1
Equiv.NPK _L	6133.0	1837.0	42.7	-	-	12.8	-
Maize (PI - 110). USAMV Iași, cambic chernozem, Bireescu L. (1995 - 1998)							
Control	5326.3	-	-	-	-	-	-
TF _§ ^{***)}	7069.3	1743.0	32.7	774.0	12.3	12.1	5.4
Equiv.NPK _§	6295.3	969.0	18.2	-	-	6.7	-
TF _L ^{****)}	7137.0	1810.7	34.0	872.4	13.9	12.6	6.1
Equiv.NPK _L	6264.6	938.3	17.6	-	-	6.5	-
Maize (HD - 420). SCCPN Dăbuleni - Dolj, sandy soil, Prodan (1995 - 1997)							
Control	2832.6	-	-	-	-	-	-
TF _§ ^{***)}	6425.0	3592.4	126.8	1325.0	26.0	24.9	5.2
Equiv.NPK _§	5100.0	2832.6	80.0	-	-	19.7	-
TF _L ^{****)}	6115.0	3847.6	115.9	1270.0	26.2	26.7	12.7
Equiv.NPK _L	4845.0	2012.4	71.0	-	-	14.0	-

⁾ kg/kg of N + P₂O₅ + K₂O

^{**)} Differences (kg/kg of N + P₂O₅ + K₂O)

^{***)} Tablets with carbon containing refuse resulted from cleaning coal for cooke production.

^{****)} Tablet with brown coal dusty.

Table 2

Effect of mixed fertilizers in tablets on apparent degree of productive use of nutrients (ADPU) on maize for kernels^{*)} as compared with powdered forms (using average experimental data for 3-4 years, 1995-1998)

Fertilization	ADPU _{TF} ^{**}) and ADPU _{PF} ^{***}), (%)			Differences comparative with NPK powdered		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
Maize (Turda - 260). SSCP Caransebeş - Caraş Severin, aluvial mollic litic soil, Bandu G. (1995 - 1998)						
TF _§	71.0	32.3	41.8	31.2	14.2	18.3
Equiv.NPK _§	39.8	18.1	23.5	-	-	-
TF _L	63.8	29.0	37.6	28.9	13.1	17.0
Equiv.NPK _L	34.9	15.9	20.6	-	-	-
Maize (HT - SV 108). SCA Suceava, chernozemlike soil, Bandu G. (1995 - 1997)						
TF _§	56.3	25.6	33.2	8.8	4.0	5.2
Equiv.NPK _§	47.5	21.6	28.0	-	-	-
TF _L	62.2	28.3	36.6	8.5	3.9	5.0
Equiv.NPK _L	53.7	24.4	31.6	-	-	-
Maize (PI -110). SCA Podul Iloaic - Iaşi, cambic chernozen, Rusu C. and Istrati Elena (1995 - 1998)						
TF _§	86.2	39.2	50.8	18.5	8.4	10.9
Equiv.NPK _§	67.7	30.8	39.9	-	-	-
TF _L	91.9	41.8	54.2	34.0	15.5	20.1
Equiv.NPK _L	57.9	26.3	34.1	-	-	-
Maize (NSSK - 420) Sîndrei. OSPA Timis, brown argillic mollic soil, Ţimbota I. (1996 - 1998)						
TF _§	112.1	51.0	66.1	0.7	0.4	0.5
Equiv.NPK _§	111.4	50.6	65.6	-	-	-
TF _L	106.7	48.5	62.8	1.5	0.7	0.8
Equiv. NPK _L	105.2	47.8	62.0	-	-	-
Maize (PI - 110). USAMV Iaşi, cambic chernozem, Bireescu L. (1995 - 1998)						
TF _§	99.8	45.4	58.8	44.3	20.2	26.1
Equiv.NPK _§	55.5	25.2	32.7	-	-	-
TF _L	103.7	47.1	61.1	50.0	22.7	29.4
Equiv. NPK _L	53.7	24.4	31.7	-	-	-
Maize (HD - 420). SCCPN Dăbuleni - Dolj, sandy soil, Prodan I. (1995 - 1997)						
TF _§	205.8	93.5	121.2	43.5	19.8	25.6
Equiv.NPK _§	162.3	73.7	95.6	-	-	-
TF _L	220.4	100.2	129.8	105.1	47.8	61.9
Equiv. NPK _L	115.3	52.4	67.9	-	-	-

*) Specific consumption with 1 tone of main product + 1,6 tone cobs = 27,5 kg of N, 12,5 kg of P₂O₅ and 16,2 kg of K₂O.

**) Apparent productive use of nutrients from tablets fertilizers.

***) Apparent productive use of nutrients from powdered fertilizers.

Table 3

Effect of mixed fertilizers in tablets on apparent degree of productive use (ADPU) of soil nutrients in field experiments on maize for kernels (using average experimental data for 3-4 years, 1995 - 1998)

Fertilization	ADPU _{Soil} (%)			Differences comparative with NPK powdered
	N	P ₂ O ₅	K ₂ O	
Maize (Turda-260). SCPP Caransebeș - Caraș Severin, aluvial mollic litic soil, Bandu G. (1995 - 1998)				
TF _§	92.4	60.6	73.9	8.3
Equiv.NPK _§	84.1	52.3	65.6	-
TF _L	80.5	58.7	72.0	7.6
Equiv. NPK _L	82.8	51.0	64.3	-
Maize (HT - SV 108). SCA Suceava, chernozemlike soil, Bandu G. (1995 - 1997)				
TF _§	85.2	44.6	61.6	2.9
Equiv.NPK _§	82.3	41.7	58.7	-
TF _L	87.2	46.6	63.6	2.8
Equiv. NPK _L	84.4	43.8	60.8	-
Maize (PI -110). SCA Podul Iloaie - Iași, cambic chernozem, Rusu C. and Istrati Elena (1995 - 1998)				
TF _§	96.8	68.4	80.3	4.3
Equiv.NPK _§	92.4	64.0	75.9	-
TF _L	98.1	69.7	81.6	8.0
Equiv. NPK _L	90.1	61.7	73.6	-
Maize (NSSK - 420) Sinandrei. OSPA Timiș, brown argillic mollic, Țimbota L. (1996 - 1998)				
TF _§	104.9	56.2	76.6	0.3
Equiv.NPK _§	104.6	55.9	76.3	-
TF _L	102.7	54.0	74.4	0.6
Equiv. NPK _L	102.1	53.4	73.8	-
Maize (PI - 110). USAMV Iași, cambic chernozem, Bireescu L. (1995 - 1998)				
TF _§	99.9	60.6	77.0	14.5
Equiv.NPK _§	85.4	46.1	62.5	-
TF _L	101.2	61.9	78.4	16.4
Equiv. NPK _L	84.8	45.5	62.0	-
Maize (HD - 420). SCCPN Dăbuleni - Dolj, sandy soil (1995 - 1997)				
TF _§	165.2	91.3	122.2	46.8
Equiv.NPK _§	118.4	44.5	75.4	-
TF _L	154.2	80.3	111.2	44.8
Equiv. NPK _L	108.4	35.5	66.4	-

A higher productive use of the nutrients from soil and from fertilizers applied into soil-plant system in crops is diminishing the risk of the release of nutrients into the environment and the degradation of the soil by chemical pollution (especially with nitrates).

In conclusion, it can be said that in comparison with powdered nutrient compounds fertilization the application of nutrients included in tablets fertilizers determined during 3 and 4 years of field experiments significantly increased yield in correlation with the climate (temperature, moisture) and the soil conditions.

This method of fertilization resulted in a higher productive nutrient use by crops from applied fertilizers and from soil and in a diminishing of the disipation risk of the nutrients into the environment.

The application of these fertilization methods seems to assure an ecological protection of the environment.

4. References

1. Borlan Z., Hera Cr., Bunescu Ov., *Agrochimia fosforului*. Ed.Ceres, București, 1990.
2. Borlan Z., Hera Cr., Dornescu D., Kurtinecz P., Rusu M., Buzdugan I., Tănase Gh., *Fertilitatea și fertilizarea solurilor* (Compendiu de agrochimie). Ed. Ceres, București, 1994.
3. Borlan Z., Dorneanu A., Dorneanu Emilia, Nebunelea Dobrița, Dumitru Georgeta - *Rom. Pat. nr. 112610/06.01.1998*.
4. Ciocan N., *Eficiența fizică a îngrășămintelor complexe pastilate (Fertifag) aplicate la diferite specii de plante testate în experiențe executate în perioada 1987 - 1989*. Referat științific. Arhiva ICPA, București, 1989.