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EFFECT OF NEW $CaCO_3$ FORMULATION ON CORN COBS

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Abstract
Providing nutrition is a key factor in plant growth and development. Among the basic nutrients is calcium, in the form of ions (Ca^{2+}). In the present research, it was observed how the new formulations of this macroelement demonstrate the achievement of positive effects. From the conducted research it emerged that the production of cobs increased between 12 and 33% and the grain yield remained constant. Against the background of calcium fertilization, the cobs showed insignificant lengths between 19 and 22 cm. At the same time, an increase in grain production was found between 10-30% and the absolute grain weight (MTG) was generally higher than that of the control. Crude protein (PB%) in grains was between 9-12% with slight increases. The other quality elements showed slight decreases in the case of starch content, while the oil fell within insignificant parameters. Among the correlations obtained between the studied characters, negative values were noted between cob production and grain yield (r = -0.58), between grain yield and crude protein (PB%) (r = -0.810) and between the production of grain and oil content (r = -0.026). Positive correlations were obtained between cob production and mass of one thousand grains (MTG) (r = 0.882), between grain production and mass of one thousand grains (r = 0.828) and between grain production and grain moisture (r = 0.329). As a result of the research carried out, it was found that positive effects were obtained through liming the corn crop, which recommends the use of new formulations in production conditions.

Keywords: acid soil, $CaCO_3$ quality, cobs, grains.

1. INTRODUCTION

Among the biochemical activities of calcium (Ca^{+2}), (Dayaod et al, 2010; Franceschi & Nakata, 2005) the most important refer to the growth and development of cobs. At the same time this chemical element plays an important role in biochemical functions through metabolic action (Karley et al, 2009; Withe, P.J. & Broadley, 2003). They activate a series of enzyme systems with a role in the normal development of plants and in the role of stability of cell membranes and their integrity. In the absence of calcium, there is a slower development of roots and tissues and cell division is inhibited. In terms of how calcium moves within the plant, research has also shown uptake into the plant, usually associated with the presence of nitrogen. After entering the plants, calcium circulates between organs through xylem and phloem (Hepler, P.K., Winship, L.J et al 2010) Calcium also has a positive effect on soil properties, thus: it improves the structure and increases the penetration of water into the lower layers. Due to this, the agricultural environment becomes more active in the absence of food. At the same time, an activity of microorganisms with a positive role in soil biology was also found. From the research carried out, the beneficial action of

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some positive ions from plant food was also found: Mg, K, Na, Cl. Together with all of them, the formation and activation of enzymes takes place. Among other advantages of the presence of calcium in plants, we mention the synthesis of organic compounds such as chlorophyll, carbohydrates, proteins. In the present work, the action of some new formulations on obtaining corn production is presented.

2. MATERIALS AND METHODS

The research was carried out under the conditions of the Albota Station on an illuvial clay type soil, whose chemical characteristics require the use of $CaCO_3$ amendments. For example, these soils have the following characteristics: pH 5.12 (very acid), humus content below 2%, nitrogen content (0.125 ppm) and other macroelements in insufficient quantities. In these conditions, fertilization is necessary to supplement the food and reduce its acidity. Among the positive effects regarding the characteristics of the soil, it follows that this macroelement blocks exchangeable mobile aluminum ions (Al^{+3}), an effect by which they are blocked, and the plants develop normally both their roots and the rest of the plant.

In the present experience, the following treatments were used:

- Non-calcified witness;
- Agrocalcium granules 93% $CaCO_3$ 1.0 t/ha;
- Agrocalcium granules 93% $CaCO_3$ 0.7 t/ha;
- Agrocalcium granules 88% $CaCO_3$ + 5% N 1.0 t/ha;
- Agrocalcium granules 88% $CaCO_3$ + 5% N 0.7%;
- Doloflor granules 58% $CaCO_3$ + 38% MgO 1.0 t/ha;
- Doloflor granules 58% $CaCO_3$+38% MgO 0.7t/ha;
- Doloflor granules 55% $CaCO_3$ + 36% MgO +5% N 1.0 t/ha;
- Doloflor granules 55% $CaCO_3$ +36% MgO +5% N 0.7 t/ha.

The experimental variants were favored according to the method of blocks in 3 repetitions. They had an area of 50 m^2 (5 x 10 m). Maize was used in the culture according to the technology specific to the station, with Fundulea 376 (F.376) hybrid as its representative. At harvest, the following determinations were made regarding: the weight of the cobs, the length of the cobs, the grain yield of the cobs, the production of grains and the mass of one thousand grains. At the same time, determinations were also made regarding the quality of the grains on the content in: crude protein (PB%), starch, oil and water. Analysis of variance was used in the statistical calculation. Quality indices were obtained using the Infragmatic 9500 Plus device. Correlations were established between the studied characters and respectively with their help the trends that were due to fertilization with $CaCO_3$ were observed.

3. RESULTS AND DISCUSSIONS

In the agricultural year 2023, the experiment with $CaCO_3$ in corn, although it generally had a climatic background with many periods of drought, benefited from an important reserve of water accumulated during the cold period (110 mm in January). The influence of climatic factors on maize plants. Regarding the temperature of this agricultural year, corn benefited from a cooler period at sowing and starting from sunrise to maturity, all months had temperatures above the area average. (Table 1).

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Table 1. Evolution of climatic factors in corn vegetation in 2023

Month	Temperature, tn^0C				Precipitation, mm		
	N*	2023	±	Σtn^0 $>10^0C$	N	2023	±
My	16.3	15.6	-0.7	1749.7	79.5	53.9	-25.6
Jun.	19.4	20.0	0.6		91.0	69.6	-21.4
July.	21.7	24.3	2.6		83.1	36.6	-46.5
Aug.	21.3	24.2	2.9		61.2	16.4	- 44.8
Sept.	16.9	20.6	3.7		48.3	72.6	24.3
Oct.	11.1	15.2	4.1		45.3	6.8	-38.5
Nov.	5.5	7.3	1.8		50.9	66.5	15.6
±	16.0	18.1	2.1	170 days	459.3	322.4	-136.9

N-normal values

If the normal values showed an average during the corn vegetation period of 16°C, in the crop year there was an increase of 2.1°C. Among the 6 months, the most severe drought was recorded in the period: July, August, September, with temperatures between 2 and 4°C. It can be concluded that from the point of view of the heat that the corn benefited from, the limits were very high in this period. And yet, on this thermal background, the corn plants grew in relatively normal conditions. The vegetation period of the plants was 170 days, and the sum of the temperature degrees (∑tn0> 10°C) was 1750°C. From this point of view, the thermal regime characterized a semi-late ripening hybrid. Regarding the precipitation regime, it is found that the normal of the area is 459 mm in the corn vegetation. Compared to this, a deficit of 137 mm was observed. From the analyzed values, it was found that in 5 months the deficit was substantial and only in 2 months was the multi-year level exceeded. From the point of view of September's favorability, although temperatures were recorded 3.7°C higher, the rainfall regime brought an extra 24 mm. This aspect contributed to a prolonged ripening, the vegetation period and the deposition of nutrients in the grains.
Favorable aspects of the growth and development of maize plants are shown in Figures 1 and 2.

Figure 1. Maize fertilized with agrocalcium granules+N

Figure 2. Maize fertilized with doloflor granules+N

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Influence of new $CaCO_3$ formulations on maize production

Regarding cob production, a significant differentiation was found (Cosmin, M Căbulea et al, 2004; Ștefan, I et al, 1990) between the control used without calcium treatment and the other variants (Table 2).

Table 2. Influence of $CaCO_3$ formulations on corn production

Nr.	Treatments	Cob prod. t/ha	Cob length, cm	Yield %	Grain production, t/ha	MTG, g
1	Check	9.5	19.0	82.7	7.9	313.7
2	A-Ca 1.0 t/ha	**11.3**	20.2	80.7	9.7	304.3
3	A-Ca 0.7 t/ha	11.7	21.0	81.1	9.5	362.7
4	A-Ca/N5% 1.0 t/ha	12.5	22.0	82.0	10.3	**405.3**
5	A-Ca/N5% 0.7%	12.1	21.0	82.1	9.9	349.3
6	D-Ca 1.0 t/ha	10.7	20.1	81.6	8.7	326.0
7	D-Ca 0.7 t/ha	11.1	21.0	82.3	9.1	350.7
8	D-Ca/N5% 1.0 t/ha	10.5	19.4	82.5	8.7	325.3
9	D-Ca/N5% 0.7 t/ha	12.6	21.0	79.9	10.0	406.0
LSD 5%		*1.7*	*3.5*	*1.453*	*1.4*	*65.606*
LSD 1%		*2.4*	*4.8*	*2.002*	*1.9*	*90.395*
LSD 0,1 %		*3.3*	*6.6*	*2.752*	*2.6*	*124.250*

Thus, if in the control version 9.5 t/ha was obtained by applying the respective amendments, values between 11-12.5 t/ha were obtained, the differentiation being significant. The grains were obtained from the harvested cobs and thus their yield was determined. Regardless of the variant, the values were between 80.0% and 82.7%. These data demonstrate that the formed corn cobs were covered with considerably high percentages of kernels. Regarding grain production, it was between the level of 7.9 t/ha in the control variant and 10.3 t/ha in the variant treated with agrocalcium + N 1.0 t/ha. Differences obtained additionally had statistical assurance. Regarding the absolute grain mass, relatively high values were obtained with some differences. Thus, if in the control the grains had a MTG of 314 gr, through both treatments with agrocalcium and doloflor combined with nitrogen, they contributed to increasing this parameter to values of over 400 gr. This determination actually justifies the production level expressed by cobs in this hybrid.

The influence of calcification on the quality of corn grains

From a qualitative point of view, analyzes were made on 3 chemical parameters and one physiological one, namely: the content in crude protein (PB%), in starch, in oil and by the humidity of the grains at harvest. Regarding obtaining the value, this was determined by crude protein (PB%) on average between 9.3 and 12%, both values being above that of the non-calcified control, which had 9.0% crude protein (PB%). The significant difference was the variant doloflor + N 1.0 t/ha with 11.97% crude protein (PB%), (Table 3).

From the point of view of crude protein values (PB%) they were close to the corn average in general with slight excesses. Regarding starch content, the average values were 74.27% and 76.77%. The differences between variants were insignificant. Considering the register of values they describe a starchy corn hybrid. The third parameter analyzed was the oil content of the corn

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germ. The values obtained were between 1.70% and 2.43% and no significant differences were reported between the variants.

Table 3. The influence of $CaCO_3$ formulations on the quality of corn grain

Nr.	Treatments	Crude protein %	Starch %	Oil %	Grain moisture %
1	Check	9.00	75.57	2.43	24.23
2	A-Ca 1.0 t/ha	9.77	75.63	2.50	23.77
3	A-Ca 0.7 t/ha	10.23	76.77	1.70	28.20
4	A-Ca/N5% 1.0 t/ha	9.60	75.63	2.23	25.43
5	A-Ca/N5% 0.7%	10.07	74.70	2.40	23.33
6	D-Ca 1.0 t/ha	9.37	75.17	2.27	23.13
7	D-Ca 0.7 t/ha	9.30	75.90	1.97	24.93
8	D-Ca/N5% 1.0 t/ha	9.57	75.73	2.17	24.30
9	D-Ca/N5% 0.7 t/ha	**11.97**	74.27	2.33	26.63
LSD 5%		*1.6*	*3.4*	*1.1*	*5.0*
LSD1%		*2.2*	*4.7*	*1.5*	*6.9*
LSD 0.1 %		*3.0*	*6.5*	*2.0*	*9.5*

At the same time, compared to some average data obtained in other hybrids, the obtained values were relatively favorably good. The grain moisture physiology at harvest in the Fundulea 376 (F 376) hybrid led to values between 23.1% -26.6%. From these data it can be seen that the corn at harvest showed relatively high levels of water in the grains. The reason lies in the fact that this hybrid required a period of a few more days, this water content in the grains could decrease.

Corn index correlations studied

The links established between all these determinations carried out highlighted both positive and negative situations. Regarding cob production, it had significant positive relationships especially with bean production and crude protein (PB%). The negative relationships of maize production were: grain yield, starch content and oil content (Table 4).

Table 4. Correlations obtained between the morphological characters of corn cobs

	Yield %	Grain production Kg/ha	Cob length, cm	MTG, g	Crude protein (PB%)	Starch %	Oil %	Grain moisture %
Cob production	-0.585	0.992	0.893	0.812	0.705	-0.308	0.118	0.431
Yield %	1	-0.478	-0.330	-0.365	-0.820	0.294	-0.04	-0.441
Grain production kg/ha		1	0.912	0.828	0.637	-0.283	-0.026	0.329
Cob lenght, cm			1	0,806	0,384	-0.045	-0.314	0.426
MTG, g				1	0,629	-0.240	-0.276	0.618
Crude proiein %					1	-0.504	-0.008	0.529
Starch %						1	-0.703	0.384
Oil %							1	-0.700

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Regarding grain yield, it was found that the links with the other characters were negative, which proves that this parameter is influenced more by the crop year and less by the other parameters. Grain production correlated very well with: MTG, crude protein (PB%) and less so with starch and oil. MTG correlated highly significantly with crude protein (PB%) and negatively with starch content and oil content. Crude protein (PB%) again correlated negatively with starch content and oil content. Between starch and oil the correlation was very close but negative.
Next, the main correlations between the production indices of the Fundulea 376 hybrid are presented.

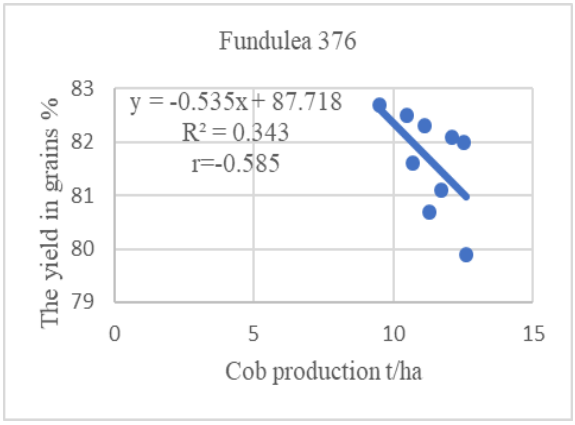

Figure 3. Correlation between grain yield and cob production

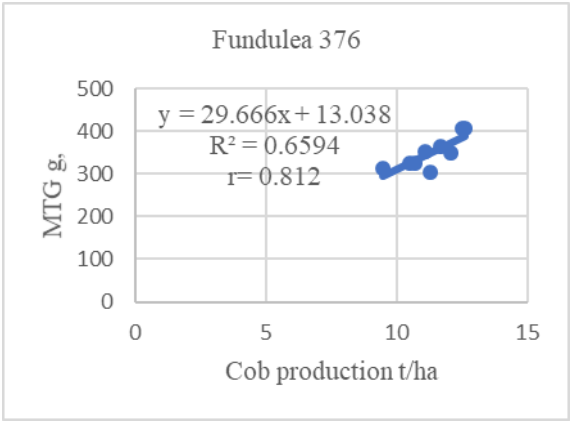

Figure 4. Correlation between MTG and cob

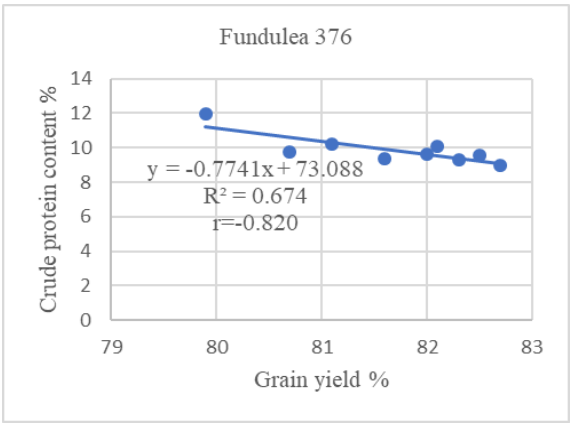

Figure 5. Correlation between protein content and grain yield

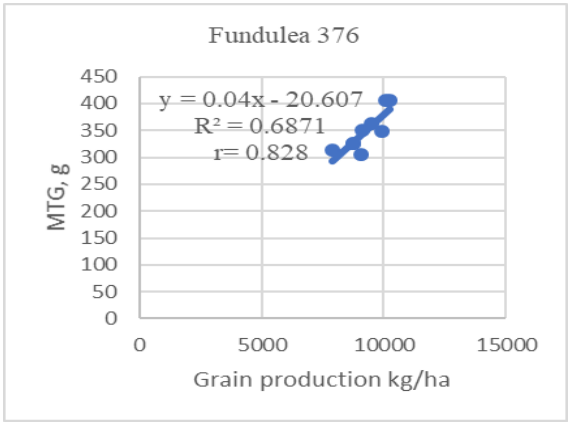

Figure 6. Correlation between mass of one thousand grains and grain yield

Thus, between cob production and their grain yield, the correlation was very significantly negative. This means that grain yield is more genetically controlled (fig.3). The correlation between cob production and MTG showed close, tight and highly significant values. This proves that by obtaining heavier grains, the production obtained becomes much higher (Fig.4). The correlation between the grain yield of cobs and crude protein (PB%) proved negative and with statistical assurance. It is possible that cobs more covered with grains do not influence obtaining a higher crude protein (PB%) (Fig.5). A statistical relationship similar to that of cob production was obtained

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between grain production and MTG, so that the higher level of grain production was obtained by increasing absolute weight (MTG) (Fig.6). The relationship between grain yield and grain oil content is slightly negative. This shows that by obtaining higher grain yields, their oil content will decrease (Fig 7). Grain moisture was positively correlated with grain yield, meaning that at higher yields, grains lose water more severely (Fig 8).

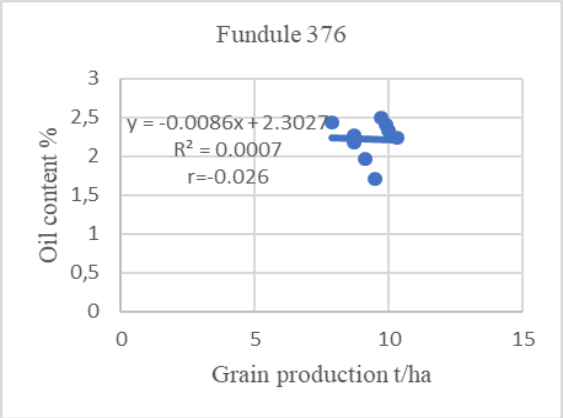

Figure 7. Correlation between oil content and grain yield

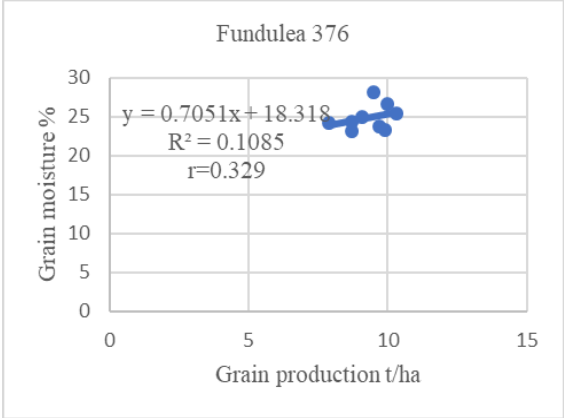

Figure 8. Correlation between grain moisture and grain yield

4. CONCLUSIONS

1. In order to promote the new formulations of $CaCO_3$ amendments, an experiment was set up to observe the formation of corn production. From the specialized literature, a relative improvement in plant physiology has been suggested, which could lead to increases in production.
2. During the agricultural year, the corn benefited from a climatic background with strong accents of drought that could have prevented the morphological expression of the plants. However, against the background of high temperatures recorded at the beginning of the year and with monthly precipitation of more than 10 mm, they ensured the water requirement for a long time. Thus the plants grew and developed approximately normally.
3. Both cob production of those in grain, grain yield, and cob length showed slight increases due to provision of the 2 types of calcium amendments. Thus, the cob production of 11-12 t/ha significantly differed from the control. In a similar way, the formation of grain production was also observed, of 9-10 t/ha. The length of the cobs was relatively large at 19-20 cm and the MTG was below 400 gr. (only 2 values exceeded 400 gr).
4. Considering the morphological parameters obtained, obvious and important increases were observed. Through calcification, the quality of the grains basically followed the same course: crude protein (PB %) compared to an average from the literature, namely around 10%, in variants values of 9-12% were obtained. This aspect again highlights a relatively good increase in crude protein (PB%) in the maize grain. The starch compared to a general average is 63%, the hybrid used had the content around 75%, insignificant. Oil in corn kernels normally oscillated between 1.8-2.7%. In the experimental versions, this content fell within the mentioned limits, without significant differences. From the point of view of grain water content at harvest, the data show the relatively high level and demonstrate the inclusion of the hybrid Fundulea 376 (F 376) in the late vegetation period.

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5. Following the parameters analyzed, both positive and negative links were found. Their highlighting took into account both calcification, the potential of the hybrid and especially the good favorability of plant growth and development.

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