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INFLUENCE OF DOLOMITE AND NP DOSAGE ON SOME MORPHOLOGICAL CHARACTERISTICS OF WHEAT

Nicolaie Ionescu [1,*], Oana Badea [1], Diana Popescu [1], Mariana Nicolae [1]

[1]Agricultural Research and Development Station Piteşti,
Piteşti-Slatina road km. 5, 117030, Piteşti, România

Abstract
Being necessary both for a normal plant physiology and for the improvement of acid soil properties, calcium (Ca^{2+}) applied alone and together with magnesium (Mg^{2+}) is permanently required in agricultural crops. Recent research has shown some positive effects of the two chemical elements in the case of the winter wheat crop. Thus, as an effect of dolomite, the height of the plants increased by 6-7 cm, and the straw thickened by 0.3 mm. The spike was 0.5 cm longer, formed 0.7 extra spikelets and was 0.1 g heavier. The spikelet membranes (glume, palea) fluctuated less in length, and the awns elongated slightly. In one spike, 0.3 extra grains were formed and weighed approx. 0.1 g. TGW experienced modest reductions against the backdrop of chemical fertilizers. The most favorable correlations were obtained between the morphological characters of the Ursita variety fertilized only with dolomite. The obtained results recommend the application of the amendment to the white clay soil existing in the South and to the winter wheat crop.

Keywords: dolomite, ears, grains, wheat, Ursita variety

1. INTRODUCTION
Recently, there has been a growing demand for the widest possible use of amendments to correct the acidic reaction of soils (Cramer et al., 2009; Karley & White, 2009; El Habbasha & Faten, 2015). The aim is to improve both soil properties and plant nutrition (White & Broadley, 2003). In natural conditions, the whitish clay soil from the resort, due to the extremely small amounts of calcium, cannot maintain the normal saturation of soil colloids with bases. That is why the exchangeable Al^{3+} ions dominate the exchange sites of the clay, contributing to the excessive acidification of the soil through the presence of soluble Al^{3+}. The soluble form of $Al^{3+}$is highly toxic to most plants (Milivojevic & Stojanovic, 2003). The appropriate way to correct Ca deficiency is the application of dolomite amendments (Dayod et al., 2010). Calcification thus contributes to reducing the activity/solubility of aluminum-Al and manganese-Mn, these being removed from the soil solution (SSoil). If the Ca activity in SSoil decreases due to washing or absorption, it tends to be displaced from the adsorption phase. If Ca in SSoil is suddenly increased by calcification, it tends to follow the adsorption pathway. The qualities of calcium in the soil are materialized by the fact that it is a macro-nutrient necessary for plant food (Gilliham et al., 2011), it improves the structure of the soil - increasing the permeability of air and water, and the culture environment becomes more favorable for the growth of plant roots and microorganisms.

*Corresponding author, E-mail address: nicolaeionescu50@gmail.com

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In plants there is an association between: Ca, n.10^{-1}, in the form of Ca^{2+}, Mg, n.10^{-2}, as Mg^{2+} and $MgATP^{2-}$, K, 1.6, in the form of K^+, Na, n.10^{-2}, as Na^+, Cl, n.10^{-2}, like Cl^-.
Together, they all participate in specific reactions related to the formation of enzymes as well as their activation (Karley et al., 2009). At the same time, there is a regulation of the osmotic pressure of the cell, favoring transpiration, as well as the circulation of carbohydrates and translocation (Karley et al., 2000b; Helpler & Winship, 2010). Also, this group of elements takes part in the synthesis of organic compounds such as chlorophyll, carbohydrates and proteins (White, 1998). Calcium is also an element considered unique, due to its fundamental physiological roles in the plant structure (Rahman & Punja, 2007; Villegas-Torres et al., 2007) and plant physiology (White, 2001; De Boer & Volkov, 2003; Han et al., 2003). Ca^{2+} acts as:
- an osmotic product through vacuoles,
- a stabilizing element of the cell membrane,
- a powerful agent in the cell wall,
- a second messenger for a multitude of physiological signals.

Calcium enters the plant predominantly passively with the flow of water, through the un-suberized apical zones of the roots (White, 2001). Circulation takes place through woody vessels-xylem, together with evapotranspiration-ET flows and root pressure. The roles also refer to Ca action (White & Broadley, 2003) by:
- the important role for plant growth and development,
- resistance to diseases through the protection of the cell wall,
- biochemical functions and metabolic processes,
- the action of some enzyme systems,
- role in membrane stability and
- cell integrity.

Being a critical part of the cell wall (Han et al., 2003), Ca induces strong structural rigidity by forming cross-links with the pectin-polysaccharide matrix. Thus, in wheat, as in other *Poaceae* family, in the primary cell wall, cellulose microfibrils are linked together by glycan-type bonds, usually xyloglucan (xG) polymers, as well as gluco-arabin-oxylases (Dayod et al., 2010).

2. MATERIALS AND METHODS

In the last year, three variants were experimented to express the effect of the amendment on the variability of morphological characters in a recently approved variety of winter wheat, Ursita: V_1-doloflor/granulated dolomite 2.5 t/ha, V_2-dolomite 2.5 t/ha + N_{40} P_{40} and V_3-dolomite 2.5 t/ha + N_{80} P_{80}. The dolomite had a content of 59% $CaCO_3$ and 38% $MgCO_3$. The experience was established according to the block method, with variants of 25 m^2 each in 4 repetitions. The technology used was the one recommended by the resort. At full maturity, 25 plants/stems were randomly chosen from each repetition (100 in total), cut and brought to the laboratory. The 100 stems were measured and determined: the total length of the straw, the thickness of the basal internode, the length and weight of the ear, the number of spikelets in the ear, the lengths of the glume, the palea and the awn, the number of grains in an ear and their weight, mass of one thousand grains (MTG, or thousand grains weight- TGW), as well as grain dimensions: length and thickness (figure 1 and figure 2).
The obtained morphological characters were analyzed by the method of histograms (or frequency polygons, FP%). In expressing them, the class intervals established according to the specific string of values obtained were used. The conducted study highlighted several aspects, namely: the mode values (with the highest frequencies), the limits of the variability intervals of the studied characters

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and the specificity of each character of the cultivated wheat variety. Correlations were established between the analyzed characters, with the help of which their trends could be observed within this ecotype. The Excel program was used to express the values. The significance of the correlation coefficients was obtained by comparison with the rmax values (Erna Weber, 1961) for the 5%, 1% and 0.1% levels of transgression probabilities. In the statistical calculation of all the values obtained, the analysis of variance (the anova test) was used, namely on the variation strings. Statistical parameters were calculated using the formulas: $\bar{a} = \Sigma x/n$, where $\bar{a}$ = the average of the determinations, and x = the determined values, S^2 (variance) $=1/(n-1)\ [\Sigma x^2 - (\Sigma x)^2/n]$, S (standard error) = $\sqrt{(S^2)}$, S % (coefficient of variation) = $S/\bar{a}.100$.

Figure 1. Ursita variety after flowering

Figure 2. Grains and ear of Ursita variety

3. RESULTS AND DISCUSSIONS

Variability of wheat straw dimensions. The stem or straw of wheat generally consists of several internodes (5-7) with increasing lengths towards the ear. Straw length ranges from 50 cm to 150 cm, with smaller values in new creations obtained for intensification conditions (new trends). This is also the case with the recently approved Ursita variety. The measurements showed that the straw of this new variety of winter wheat was between 50 and 80 cm. The 65-70 cm straws had the dominant frequencies. On the N_{80} P_{80} doses the formed straws were somewhat longer (figure 3). The diameter of the basal internode was located in the three treatments at the modal value of 3.5 mm, with a tendency to decrease on the case of exclusively with dolomite, average on the average dose of NP and relatively thicker on the higher dose of NP (figure 4).

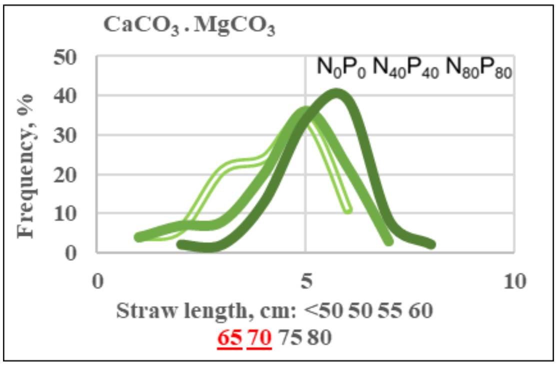

Figure 3. Frequencies of straw length

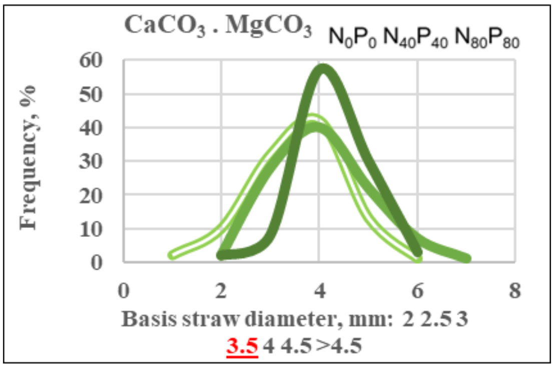

Figure 4. Frequencies of straw width

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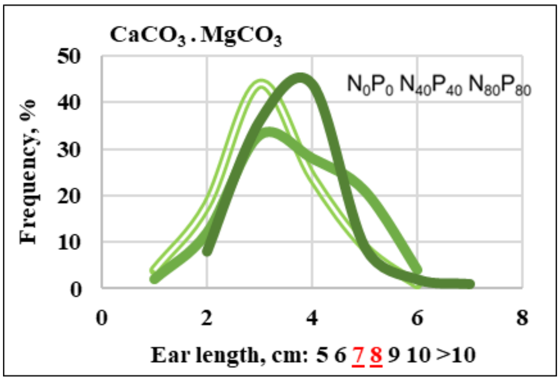

Figure 5. Frequencies of ear length

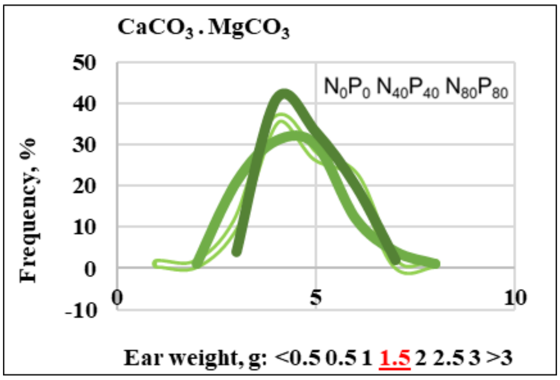

Figure 6. Frequencies of ear weight

The number of spikelets in an ear shows a relatively wide range, namely between 8 and over 18. The higher frequencies were obtained at 14 spikelets/ear in the variant with dolomite and 16 spikelets in the other variants (figure 7). Of the ear pieces the awn generally measured between 6 mm and 9 mm. The sizes between 7.5 mm and 8 mm dominated, with small differences between the variants (figure 8).

Variability of wheat ears. The appearance and dimensions of the ear of this wheat variety were characteristic. Thus, its length had dominant values of 7-8 cm. Treatment only with dolomite had the dominant size at 7 cm, and the variants with NP doses, at 8 cm. In general, its variability was between 5 cm and over 10 cm (figure 5). The biomass of the analyzed ears was generally between 0.5 g and over 3 g (figure 6). Modal values expressed weights of 1.5 g in all three fractions. It is noted that in the variant without NP the wheat reacted just as favorably with the application of dolomite.

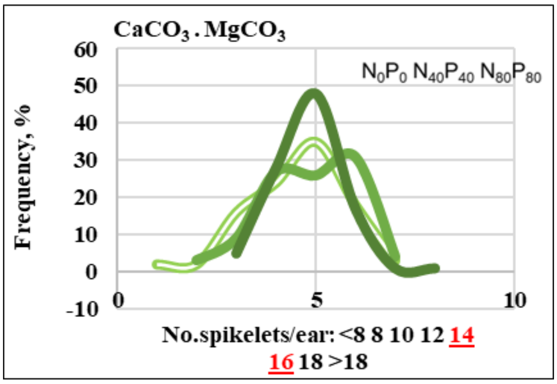

Figure 7. Frequencies of no. spikelets/ear

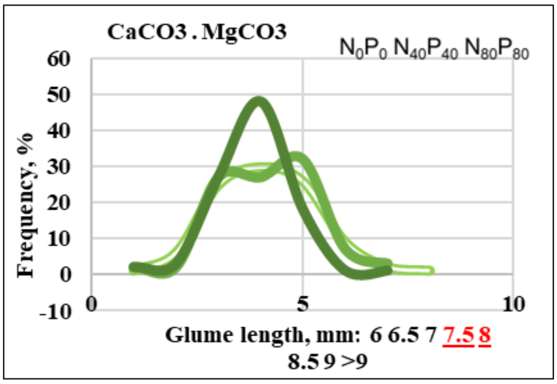

Figure 8. Frequencies of glume length

The dimensions of the ear blades were between 7.5 and 11.5 mm. 9 mm palea dominated in all three cases (figure 9). The limits between which the lengths of the awn were 4 and 7.5 cm (figure 10). Dominant were the lengths of 6 cm in all variants.

Variability of wheat grains. The number of grains in an ear generally were between 10 and 60. Of these, those with 40 grains/ear were dominant, similar with small exceptions, at all three fertilization levels (figure 11). The largest complex: dolomite with N_{80} P_{80} shows a slightly higher frequency, which puts an additional emphasis on this number of grains in an ear.

*Corresponding author, E-mail address: nicolaeionescu50@gmail.com

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The weight of the grains in one ear was between 0.5 and 3 g (figure 12). Dominant were the grains from an ear with a weight of 1.5 g. And in this case, the modal value at the higher fraction of fertilizers stood out as the dominant frequency.

The grain sizes also had some specific characteristics. Thus, the length of the grains was generally between 5 and 7.5 mm. They dominated the grains with lengths of 6-6.5 mm (figure 13). The grain thickness was between the general limits of 2.4 mm and 3.8 mm (figure 14). The modal value for the three fertilizer fractions was 3-3.2 mm grain thickness. Between the two wheat grain sizes, differences due to fertilizers were relatively low.

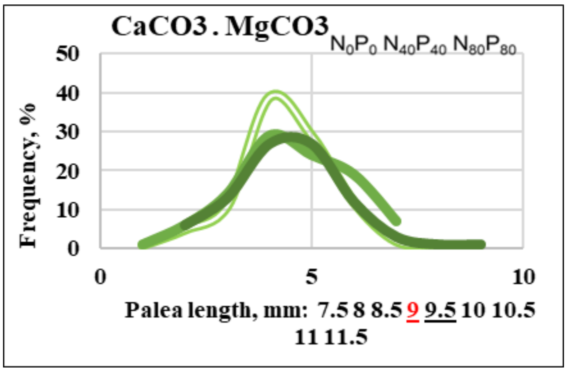

Figure 9. Frequencies of palea length

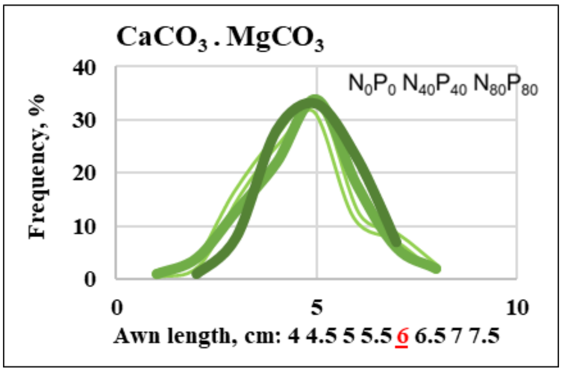

Figure 10. Frequency of awn length

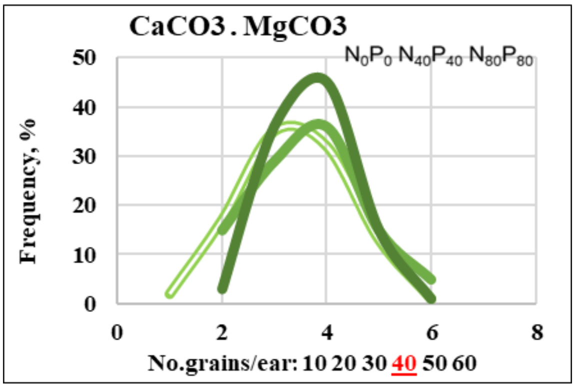

Figure 11. Frequencies of no. grains/ear

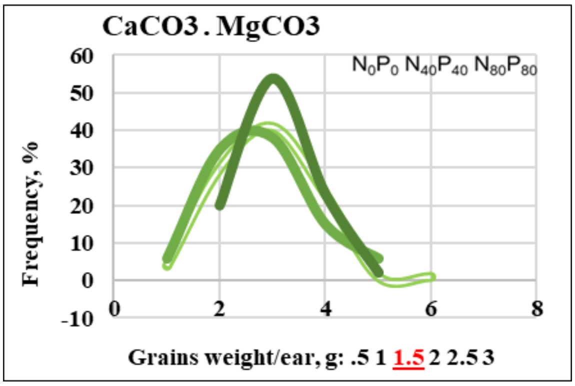

Figure 12. Frequencies of grains weight/ear

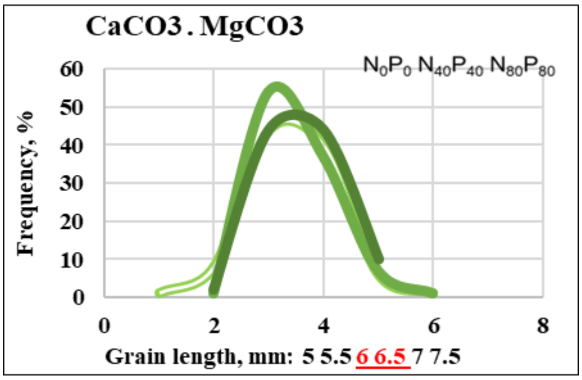

Figure 13. Frequencies of grain length

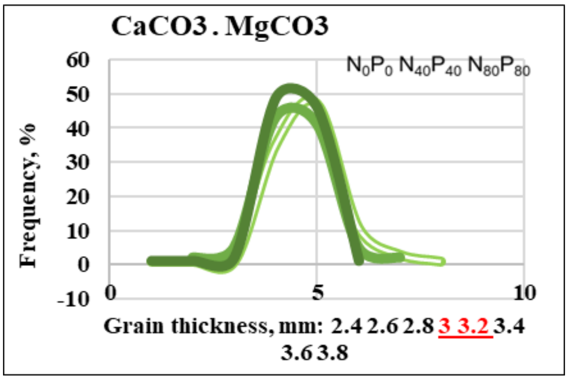

Figure 14. Frequencies of grain thickness

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The mass of one thousand grains (MTG) showed slight differences according to the favorability of the three types of fertilizers. In general, the values were between 20 and over 50 g (figure 15). The dominant values were at 40-45 g. Among the data obtained for the wheat to which only dolomite was applied, the MTG values stood out both in terms of value and frequency, being higher, compared to dolomite together with NP doses. This aspect demonstrates that dolomite applied alone had an effect with a positive premise for productive performance (figure 16).

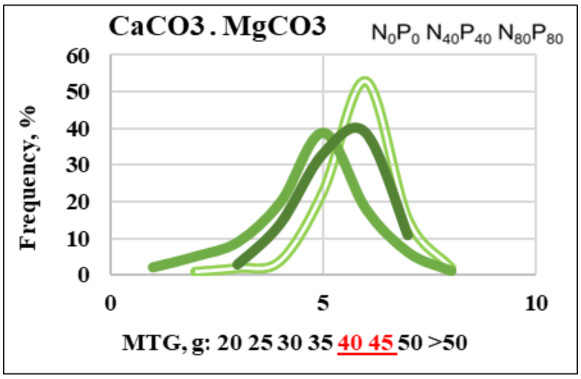

Figure 15. Frequencies of the mass of thousand grains

Figure 16. The grains of Ursita variety

Correlations between the main morphological characters. If the entire set of correlations between all analyzed characters is analyzed, both positive and negative situations are found.
Obvious and very obvious positive correlations were observed between all morphological characteristics of wheat by fertilizing only with dolomite 2.5 t/ha. Very significant positive correlations were also obtained by the two types of fertilization, except for those at the level of wheat grain size and MTG. These correlations were more pronounced at the higher NP dose (table 1).
Statistical analysis of the morphological characters variability in the Ursita wheat variety. The results obtained in the morphological analysis of some characters in winter wheat showed specificity. Thus, the length of the straw measured 58-65 cm. Variability demonstrated small to medium coefficients. The thickness of the internode at the base fell within the range of 3.1-3.4 mm (10-15% variation). The length of the spike was 6.7-7.3 cm, with medium variability. The weight of the spikes was 1.5-1.6 g, but with a medium to high variability. The number of spikelets on spike was 12.6-13.2 (12-18% variability) (table 2).
The length of the awn was 7.3-7.5 mm (under 10% VC), that of the palea 9-9.2 mm with equally low variability, and that of the arista 5.6-5.7 cm (small-medium VC). The number of grains formed in an ear was 30-33 with high variability. The weight of the grains in one ear was 1.16-1.30 g, with great variability. The grains had an average size of 6.1/3.0-3.1 mm. The variability of grain sizes was small (below 10%). The mass of one thousand grains was on average 36-42 g with medium variability (table 2).

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Table 1. Correlations between the main morphological characters of the Ursita wheat variety according to fertilizer status

Characters	Straw thick, mm	Spike, ear Length, cm	Weight, g	No. spikelets	Spikelet pieces Glume length. mm	Palea length mm	Awn length, cm	Grains Number /ear	Weight, g	Length, mm	Thick, mm	MTG g
	$CaMg(CO_3)_2$ 2.5 t.ha^{-1}, N_0 P_0											
Straw length	**.336**	**.414**	**.478**	**.463**	**.316**	**.244**	**.295**	**.444**	**.477**	**.268**	**.202**	**.310**
Straw thick	**1**	**.561**	**.574**	**.589**	**.330**	.157	**.233**	**.574**	**.567**	**.236**	**.259**	**.219**
Ear length		1	**.903**	**.950**	**.493**	**.322**	**.466**	**.932**	**.889**	**.314**	.091	.120
Ear weight			1	**.903**	**.451**	**.355**	**.540**	**.955**	**.998**	**.294**	**.190**	**.366**
No. spikelets				1	**.426**	**.276**	**.446**	**.932**	**.894**	**.288**	.092	.111
Glume					1	**.579**	**.360**	**.501**	**.436**	**.288**	.135	.022
Palea						1	**.211**	**.341**	**.353**	.180	**.206**	.149
Awn							1	**.548**	**.539**	**.302**	.181	.143
No. grains								1	**.949**	**.244**	.097	.109
Grain weigh.									1	**.290**	**.683**	**.389**
Grain length										1	**.331**	**.288**
Grain thick											1	**.483**
	$CaMg(CO_3)_2$ 2.5 t.ha^{-1}, N_{40} P_{40}											
Straw length	**.452**	**.279**	**.624**	**.400**	**.279**	**.216**	**.249**	**.545**	**.611**	.017	**.308**	**.422**
Straw thick	**1**	**.641**	**.674**	**.630**	**.507**	**.311**	**.373**	**.681**	**.634**	.087	-.005	.126
Ear length		1	**.749**	**.915**	**.575**	**.370**	**.338**	**.814**	**.699**	**.253**	-.071	.050
Ear weight			1	**.804**	**.542**	**.342**	**.473**	**.907**	**.977**	**.278**	**.313**	**.481**
No. spikelets				1	**.575**	**.350**	**.401**	**.871**	**.749**	**.192**	-.064	.054
Glume					1	**.618**	**.301**	**.554**	**.503**	.172	-.008	.113
Palea						1	**.267**	**.422**	**.341**	.022	-.035	.042
Awn							1	**.469**	**.443**	.131	.032	.114
No. grains								1	**.906**	.144	.120	.151
Grain weigh.									1	**.289**	**.370**	**.531**
Grain length										1	.155	**.397**
Grain thick											1	**.648**
	$CaMg(CO_3)_2$ 2.5 t.ha^{-1}, N_{80} P_{80}											
Straw length	.081	.144	**.362**	.182	.097	.059	.024	**.205**	**.378**	.058	**.312**	**.460**
Straw thick	**1**	**.357**	**.394**	**.419**	**.268**	.173	**.242**	**.422**	**.379**	.022	.036	.046
Ear length		1	**.776**	**.852**	**.337**	**.319**	**.455**	**.809**	**.744**	.094	.052	.073
Ear weight			1	**.789**	**.339**	**.262**	**.381**	**.916**	**.994**	.082	**.251**	**.443**
No. spikelets				1	**.310**	**.300**	**.447**	**.856**	**.756**	.039	-.022	.010
Glume					1	**.514**	**.317**	**.382**	**.313**	**.639**	-.079	-.024
Palea						1	**.272**	**..291**	**.242**	.188	-.088	-.042
Awn							1	**.408**	**.340**	.092	-.103	-.017
No. grains								1	**.902**	-.008	-.022	.065
Grain weigh.									1	.072	**.302**	**.481**
Grain length										1	.161	.169
Grain thick											1	**.682**

LSD 5 %, .190 LSD 1 %, .250 LSD 0.1 %, .320

Table 2. Statistical indices of morphological characters of wheat plants fertilized with granulated dolomite, with and without chemical fertilizers

Indices	Straw Length cm	thick mm	Ear Length cm	Weight g	No. spikelets	Spikelet pieces Glume mm	Paleea mm	Awn cm	Grains No./ ear	Weight g	Length mm	Thick mm	MTG g
	$CaMg(CO_3)_2$ 2.5 t.ha^{-1}, N_0 P_0												
Mean	**58.1**	**3.11**	**6.73**	**1.56**	**12.56**	**7.41**	**9.02**	**5.59**	**29.61**	**1.23**	**6.05**	**3.10**	**41.47**
s²	65.73	0.21	0.91	0.27	5.24	0.40	0.61	0,45	94,04	0.19	0.13	0.04	17.60
s	8.11	0.46	0.96	0.52	2.29	0.63	0.78	0.67	9.70	0.43	0.36	0.19	4.19
VC %	**14.0**	**14.8**	**41.1**	**33.2**	**18.2**	**8.6**	**8.6**	**12.0**	**32.8**	**35.0**	**6.0**	**6.1**	**10.1**
	$CaMg(CO_3)_2$ 2.5 t.ha^{-1}, N_{40} P_{40}												
Mean	**60.7**	**3.34**	**7.25**	**1.48**	**13.19**	**7.45**	**9.12**	**5.65**	**31.85**	**1.16**	**6.09**	**3.02**	**36.09**
s²	59.26	0.11	1.21	0.30	4.14	0.34	0.52	0.44	106.7	0.21	0.07	0.05	40.3
s	7.70	0.34	1.10	0.55	2.03	0.58	0.72	0.66	10.3	0.46	0.26	0.23	6.35
VC %	**12.7**	**10.1**	**15.16**	**37.2**	**15.4**	**7.8**	**7.9**	**11.7**	**32.4**	**39.5**	**4.2**	**7.5**	**17.6**
	$CaMg(CO_3)_2$ 2.5 t.ha^{-1}, N_{80} P_{80}												
Mean	**64.8**	**3.41**	**7.25**	**1.62**	**13.24**	**7.25**	**9.15**	**5.74**	**32.89**	**1.30**	**6.12**	**3.03**	**39.26**
s²	29.60	0.18	0.65	0.18	2.69	0.22	0.37	0.27	58.18	0.13	0.09	0.02	16.03
s	5.44	0.43	0.81	0.42	1.64	0.47	0.61	0.52	7.63	0.36	0.29	0.15	4.00
VC %	**8.4**	**12.6**	**11.1**	**25.8**	**12.4**	**6.5**	**6.6**	**9.1**	**23.2**	**27.4**	**4.8**	**5.1**	**10.2**

S^2 variance, S standard error, VC variation coefficient

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4. CONCLUSIONS

The morphological characters expressed were specific. Thus, the stem/straw had lengths of 58-65 cm, which shows a variety with a relatively small waist. Basal internode thickness was 3.1-3.4 mm with a good resistance within the wheat field. Part of this resistance is due to the effectiveness of dolomite in the growth and development of wheat plants. The favorable effect was due, on the one hand, to calcium, but also to its interaction with NP doses, on the other hand.

The spike of length 6.7-7.3 cm had a weight of 1.5-1.6 g and is thus characterized as medium to long, with medium weight. The number of spikelets was 12.6-13.2. The parts of the spikelet: glume of 7.3-7.5 mm, palea 9.0-9.2 mm and awn of 5.6-5.7 cm describe specific characters of the newly studied variants.

The number of grains in one spike was 29.6-32.9, with a weight of 1.2-1.3 g. The weight of one thousand grains was 36-42 g and is considered medium to large. The grains measuring 6.05-6.12 mm in length and 3.02-3.10 mm in thickness demonstrate relatively low dimensions in length and somewhat larger in thickness.

Simple correlations were established between all the characters studied, with some differences. Between ear characters the correlations were positive and highly significant. This aspect demonstrates the high productive possibilities that this variety has when fertilized with dolomite, with and without NP doses. It is noted that among all the studied characters of the Ursita variety fertilized exclusively with dolomite, the correlations were entirely positive. They thus highlight degrees of improvement of both soil and wheat plants, both through Ca and through Mg.

The statistical indicators studied demonstrated wheat plants with medium to long ears, sufficiently compact, with many grains and with their absolute mass between 46-42 g.

The obtained results demonstrate the ever-increasing importance in correcting the acid reaction of white clay soil and in wheat culture. In current technology, dolomite with Ca^{2+} and Mg^{2+} contents of over 90% can be applied, namely in annual doses considered small, of 2.0-2.5 t/ha.

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*Corresponding author, E-mail address: nicolaeionescu50@gmail.com

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*Corresponding author, E-mail address: nicolaeionescu50@gmail.com