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MICROGRANULAR STARTER FERTILIZER EFFECTS ON GROWTH AND PRODUCTIVITY OF A HIGH-YIELD MAIZE HYBRID CULTIVATED UNDER CLIMATIC CONDITIONS OF ILFOV COUNTY

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Abstract

The researches presented in this paper were carried out during agricultural year 2019 in Grădiștea, Ilfov County and the main objective was investigation of the variability of yield for maize hybrid P0268 under application of a starter microgranular fertilizer with a 25 kg·ha^{-1} dose. The chosen hybrid is characterized by high yield, resistance to drought and high temperatures, being suitable for all types of soils, including those with low level of organic matter. The selected microgranular fertilizer for experiment ensures fast start of crops, accelerating the germination and influence positively the development of root system. The efficiency of microgranular fertilizer was evidenced at all maize vegetation stages and consisted in more vigorous and intense green colored plants, well developed radicular system and stems in comparison with unfertilized control variant. At harvest time, the grain yield in the case of fertilized variant was with 229 kg·ha^{-1}, higher in comparison with control. This experiment reveals the efficacy of microgranular fertilizer application on maize yield, but under climatic conditions of the agricultural year 2019, economic efficiency was low.

***Key words**: maize, microgranular fertilizer, yield.*

INTRODUCTION

To accomplish obtaining yields high enough to provide food for growing world population is essential to use inputs: mineral and organic fertilizers, different commercial formulations of fertilizers, phytosanitary products etc.

In the literature, there are many researches that emphasize the effects of fertilization on yield and quality parameters of yield for various crops.

Considering maize, it is known that high yields can be achieved by adequate supply and balance of essential nutritive elements and a limitative factor is water deficiency during any growth stage (Fageria & Baligar, 2011).

For instance, in the case of maize, the importance of fertilization is valued by many authors (Crista et al., 2014 (a, b); Barșon et al., 2021; Luță et al., 2022; Madjar et al., 2022).

Nowadays, beside mineral and organic fertilizers, application of microgranular fertilizers is currently increasing, due to their advantages: nutrients have immediate effects on plants, influence vegetative development leading to taller and more vigorous plants (Crista et al., 2014b), great spreading properties, higher yields (Balawejder et al., 2020), decrease of fertilizations costs (Jankowski et al., 2018) even reduce environmental impact (Thielicke et al., 2022). Furthermore, microgranular fertilizers favour intense roots development, assure a more efficient emergence and a better and homogenous density. In addition, in the case of late autumn or early spring sowing when plants could be affected by extreme climatic conditions, microgranular fertilizers ensure the reduction of negative effects resulted from these situations. Beside these, influence the efficient use of soil water and increase drought resistance. Also, provide resistance to weeds, pathogens and pests (https://agrointel.ro/48168/timac-agro-romania-10-motive-pentru-a-alege-ingrasamintele-microgranulate-pentru-fertilizarea-culturilor-agricole/).

A study (Jankowski et al., 2018) evidenced the efficacy of microgranular fertilizer application on winter oilseed rape: stimulated dry matter accumulation in rosette leaves, increased seeds and straw biomass and minimized the risk of soil salinization.

Application of microgranular fertilizer based on protein and calcined bones on maize crop increased the plant resistance to water stress during growing and consequently led to higher yields in comparison with control (Balawejder et al., 2020).

Other research (Haraga et al., 2022) investigated the effects of microgranular fertilizers over yield components and development of maize plants. The obtained results evidenced that applied fertilizer assured a better emergence of plants in the field combined with better development of root system, even increased seed yield in severe drought conditions.

Considering the importance of fertilization, it was developed an experiment with the purpose to evaluate the variability of yield for maize crop under application of 25 kg·ha^{-1} dose of microgranular starter fertilizer. The experiment site was Grădiştea, Ilfov County during agricultural year 2019.

MATERIALS AND METHODS

Experimental site

Experimental field was located at SC Picmar Prod Com SRL Society which is located in Grădiștea commune, Ilfov County (Figure 1). For researches were chosen two plots, sown with the same maize hybrid, one of them being fertilized with microgranular fertilizer.

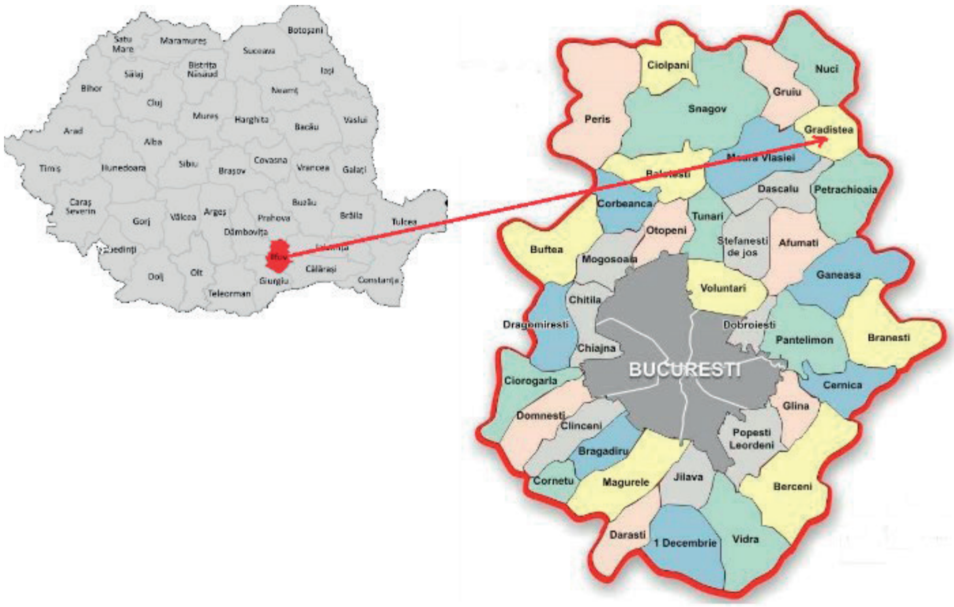

Figure 1. Position of Grădiștea commune on geographical map

Maize hybrid

For experiment was used P0268 a semi-late maize hybrid which is characterized by high yield, suitable for different types of soil, including those with low level of organic matter. Also, it is resistant to drought and high temperatures. Recommended densities are between 65000-70000 plants/ha for unirrigated plots and between 75000-84000 plants/ha for irrigated plots. In our experiment, P0268 maize hybrid was sown (April, Ist decade) with density of 70000 seeds/ha. Preceding crop was wheat.

Fertilization scheme

During experiment were applied several fertilizers: triple superphosphate (**TSP**), complex fertilizer NP 20:20 + 7SO_3 + Zn (**CF**), microgranular fertilizer (**MF**) and ammonium nitrate (33.5% N) (**AN**) as it is presented in fertilization scheme (Table 1).

Table 1. Fertilization scheme

Moment	Fertilizer	Dose ($kg \cdot ha^{-1}$)
October (II[nd] decade)	TSP	150
April (I[st] decade)	CF	250
	MF	25
May (II[nd] decade)	AN	140
June (I[st] decade)	AN	140

Used fertilizers

Characterizations of used fertilizers (**TSP, CF, MF, AN**) are depicted in Tables 2-5.

Table 2. Triple superphosphate (**TSP**) characterization

Characteristics	Details
Granule colour	grey
Granule size	1 to 5 mm (98% min.)
P_2O_5 content, %	46
P_2O_5 (soluble in citrate and water), %	45.5 (max.)
P_2O_5 (soluble in water), %	43 (max.)
Moisture, %	4 (max.)

Table 3. Complex fertilizer NP 20:20 + $7SO_3$ + Zn (**CF**) characterization

Characteristics	Details
Granule colour	dark grey
Granule size	3.3-4.1 mm
$N\text{-}NO_3^-$, %	7.5
$N\text{-}NH_4^+$, %	12.5
P_2O_5 (soluble in neutral ammonium citrate and water), %	20
P_2O_5 (soluble in water), %	16
SO_3 (total), %	7.5
SO_3 (soluble in water), %	6.5
Zn (total), %	0.01

Table 4. Microgranular fertilizer (**MF**) characterization

Characteristics	Details
Granule size	0.5-1.0mm
Formulation	NP 16:40 + 2MgO + $5SO_3$ + 2%Zn
$N\text{-}NH_4^+$, %	16
P_2O_5 (soluble in neutral ammonium citrate and water), %	40
SO_3 (soluble in water), %	5
MgO (total), %	2
Zn (total), %	2

Table 5. Granular ammonium nitrate (**AN**) fertilizer characterization

Characteristics	Details
Granule size	2-5 mm (90% min.) <1 mm (5% max.) <0.5 mm (3% max.)
Appearance	white slightly colored granules
N(total), %	33.5
$N\text{-}NO_3^-$, %	16.75
$N\text{-}NH_4^+$, %	16.75
pH	4.5 (min.)
Moisture, %	0.45 (max.)

Performed agrochemical analyses

Soil samples were collected and subjected to agrochemical analyses (Table 6).

Table 6. Soil agrochemical analyses

Analyses	Method
Moisture	gravimetry
pH_{H2O} (1:2.5)	potentiometry
K_{AL}	flame emission spectrometry
P_{AL}	spectrophotocolorimetry
Humus	Walkley-Black-Gogoașă method
$Zn_{AcNH4\text{-}EDTA}$ *	Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES)
B_{H2O} #	Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES)

P_{AL} = mobile form of phosphorus using ammonium acetate-lactate for extraction; **K_{AL}** = mobile form of potassium using ammonium acetate-lactate for extraction; **$Zn_{AcNH4\text{-}EDTA}$** = mobile form of zinc using ammonium acetate in the presence of EDTA for extraction; **EDTA** = ethylenediaminetetraacetic acid; **B_{H2O}** = soluble form of boron using boiling water for extraction; *NF X 31-120 (2003); #NF X 31-122 (1999).

Climatic conditions

Climatic conditions of year 2019 are presented in Table 7.

Table 7. Climatic conditions of year 2019

Month	Rainfall (mm)	Temperature (°C) (min./max.)
April	66.7	9-26
May	150.3	12-28
June	34.6	24-34
July	91.0	22-36
August	13.0	26-36
September	36.1	18-33

(Source:https://www.accuweather.com/ro/ro/gradistea/279663/september-weather/279663)

RESULTS AND DISCUSSIONS

Soil agrochemical characterization

The experiment was developed on reddish **preluvosol**, *parent material* - clay and loess deposits.

The agrochemical analyses performed for soil samples evidenced slightly acidic reaction, high level of mobile form of potassium (K_{AL}), middle level of humus and very low level of mobile form of phosphorus (P_{AL}) (Table 8).

Table 8. Results of soil agrochemical analyses

Analyses	Determined value	Interpretation
pH_{H2O}	6.35	slightly acidic
K_{AL}, $mg \cdot kg^{-1}$	214	high level
P_{AL}, $mg \cdot kg^{-1}$	6.74	very low level
Humus, %	2.48	middle level
Zn, $mg \cdot kg^{-1}$	4.03	middle level
B, $mg \cdot kg^{-1}$	0.44	middle level

Considering microelements (B, Zn), found concentrations are associated with middle levels.

In addition, solution used for extraction of mobile form of zinc (ammonium acetate in the presence of EDTA) has proven its efficacy and according to different authors (Vasile et al., 2006) offers the best results regarding mobility of metals in soil.

Visual evaluation of microgranular fertilizer application effects on maize plants

The radicular system of maize hybrid P0268 fertilized with MF is well developed, more vigorous, with increased root ramification as compared to control (without MF) (Figures 2 and 3).

According to Olbrycht and co-workers (2020), application of MF obtained from food industry by-products and fortified with proteins (30 $kg \cdot ha^{-1}$ dose) to maize was effective enough to have an impact on the intensive growth and development of the emerging root system.

At 10-12 leaves stage, the beneficial effects of MF application are more evident, since beside better formed radicular system, stem thickness is higher (Figure 3). Therefore, it could be considered that MF assured a better start in vegetation due to supply of direct accessible nutrients for plants.

Figure 2. Differences of radicular system at 4-6 leaves stage (left - without MF; right - with MF) (original images provided by SC Picmar Prod Com SRL)

Figure 3. Plant development at 10-12 leaves stage (left - without MF; right - with MF) (original images provided by SC Picmar Prod Com SRL)

Also, P_2O_5 high content of MF (40%) (Table 4) sustained proper the plants to overcome the pseudo (false) phosphorus deficiency which occurs mainly in cold, wet springs, as it has been spring of year 2019 (Table 7).

The efficiency of microgranular fertilizers with high content of P_2O_5 on maize crop is also sustained by researches reported by Haraga et al. (2022).

Visual comparative analysis of maize field evidenced the positive effects of MF application: dark green leaves, more vigorous stems, higher leaves surface (Figure 4).

Figure 4. Differences of maize field at 10-12 leaves stage (*left - without MF; right - with MF*) (original images provided by SC Picmar Prod Com SRL)

Results regarding maize yield

The analysis of the yield values evidenced the efficiency of MF application, more specific an increase for fertilized variant (V_2) with 229 kg·ha^{-1}, meaning 2.26% higher than control variant (V_1). Variance analysis indicates distinct significant differences for V_2 (Table 9). Some authors (Balawejder et al., 2020) reported an increase of maize yield by 6.6% in comparison with control after MF application of 30 kg·ha^{-1}.

Table 9. Variability of yield under influence of microgranular fertilizer (MF) application

Variants	Yield		Differences		
	kg·ha^{-1}	%	kg·ha^{-1}	%	sign
Control (**V$_1$**)	10125	100	Control	-	-
MF application (**V$_2$**)	10354	102.26	229	2.26	**
DL 5%=72 kg/ha; DL 1%=166 kg/ha; DL 0.1%= 529 kg/ha					

Beside proven beneficial effects on maize plants and yield, application of MF influenced also the moisture of seeds. Hence, in the case of V_2 the standard grain moisture of 14% has been achieved easily than in the case of V_1.

Variance analysis for crop yield at a standardized moisture content of 14% indicates distinct significant differences in the case of V_2 variant, the yield being with 257 kg·ha^{-1} higher, representing an increase of 2.50% over control (V_1) (Table 10).

Table 10. Variability of yield at standard moisture content of 14% under influence of microgranular fertilizer (MF) application

Variants	Yield		Differences		
	kg·ha^{-1}	%	kg·ha^{-1}	%	sign
Control (**V$_1$**)	10242	100	Control	-	-
MF application (**V$_2$**)	10499	102.50	257	2.50	**
DL 5%=79 kg/ha; DL 1%=183 kg/ha; DL 0.1%= 584 kg/ha					

Having in view the obtained results it could be concluded that application of MF (dose of 25 kg·ha^{-1}) has generated a yield higher with 229 kg·ha^{-1} (2.26% increase) in the case of fertilized variant (V_2).

Other perspectives

As gaining profit on the basis of obtained yield is an objective for each agronomist, in the context of our research was evaluated economic efficiency of MF application on maize crop.

Considering the costs with MF acquisition, applied doses, maize yield market value, it has been found that economic efficiency is very low corroborated with extreme climate events of year 2019 (low temperatures, intervals with high temperatures, heavy downpours, water shortage etc).

For example, for maize crop optimal rainfall levels are from 60-80 mm in May, 100-120 mm in June, 100-120 mm in July and 60-80 mm in August (Roman et al., 2011), conditions which for year 2019 were not fulfilled (Table 7). In addition, some authors (Butts-Wilmsmeyer et al., 2019) stated that both grain yield and compositional quality are related with water availability during flowering and grain fill. Moreover, good performances of yield components for maize crop under irrigation conditions were reported by Madjar et al. (2017).

However, the experiment has proven clearly the importance of choosing the proper maize hybrid suitable for agricultural area where it is cultivated, combined with proper fertilization system, including use of microgranular fertilizer. Still, despite all agronomic precautions, determinant factor it seems to be climatic conditions.

CONCLUSIONS

Influence of microgranular fertilizer on maize crop has evidenced positive effects on root development, plants were more vigorous and the grain yield in the case of fertilized variant was with 229 kg·ha^{-1}, higher in comparison with control.

Economic efficiency of microgranular fertilizer application it has been insignificant in the climatic conditions of year 2019. Therefore, it may be concluded that the influence of climatic conditions was higher than the influence of fertilizer application but the researches on this subject will be extended in the future.

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