The effect of nano-foliar spraying with G-Power calcium, organic fertilizer, and spraying stages on the growth and yield of maize (*Zea mays L.)*

Haider Ghatar Aswad Al-Kraiti[1*], Zaidoun Saad Chiyad Hadi[2], Nawras Jassim Muhammad[3]

[1] Field Crops Department, College of Agriculture, University of Kerbala, Karbala, Iraq.
[2] Ministry of Agriculture, Agricultural Extension and Training Department, Agricultural Extension and Training Center in Karbala, Iraq
[3] The Ministry of Agriculture, the General Company for Agricultural Supplies, Karbala, Iraq.
***Corresponding author E-mail: haider.khatar@uokerbala.edu.iq**
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Abstract

The experiment took place during the spring season of 2022 AD. The objective of the study was to investigate the impact of various concentrations of G-Power ca and spraying dates on the growth and yield of maize. The experimental design employed was a randomized complete block design (RCBD) arranged in a factorial order with three replications. The first factor examined was the different concentrations of the nano fertilizer G-Power ca, specifically at levels of 0, 2, 4, and 6 ml L-1. The second component encompassed three distinct time points for foliar application: spraying at 20 days post-planting, spraying at 40 days post-planting, and spraying at 60 days post-planting. The findings of the study indicate that the application of nano-foliar spraying of G-Power ca at a concentration of 6 ml L-1, two months after planting, resulted in considerably improved outcomes compared to other treatments. This treatment exhibited the highest average values for the characteristics under investigation. Each of the variables in the study possesses distinct characteristics, including plant height (measured in centimeters), leaf area (measured in square centimeters), average number of leaves per plant (measured as leaf.plant-1), average percentage of chlorophyll in the leaves (measured as spad), and total plant yield (measured in kilograms per hectare, denoted as kg.ha1-). These variables were observed and recorded sequentially, with corresponding values of 183, 4209, 14.50, 44.67, and 8012, respectively. Therefore, it can be inferred that the utilization of nano-fertilizers has a major impact on the vegetative characteristics of Maize, resulting in a notable enhancement of the aforementioned qualities

Keywords: Nano-foliar particles, Calcium, Maize

Introduction

Zea mays L. is one of the most important economic cereal crops at the global level, and it ranks third in terms of the area cultivated globally [1]. That the availability of nutrients for any plant in the quantities needed by the plant is considered a determining factor and necessary to obtain the best yield in quantity and quality, and that the lack of one or more of the major or minor nutrients for a particular crop becomes the determining factor in the nature of growth and productivity of that crop [2]. Therefore, more advanced solutions and means must be taken for the purpose of increasing production per unit area, this can be achieved by using the most advanced and economical means in agriculture, including foliar nutrient, which is meant to add the elements needed by the plant by spraying it on the vegetative part and running it into the leaf, then moving to plant parts quickly ensures that they will be replaced in a short time [3]. The G-power Ca is a type of nano-fertilizer utilized for plant nutrition, which has demonstrated significant efficacy in enhancing crop yield through foliar nutrition, as evidenced by a study conducted by [3]. The application of nano-organic fertilizer resulted in a notable enhancement in the vegetative attributes of Maize plants, including plant height, number of grains per row, weight of 500 grains, and other relevant parameters (Reference 2). Given the significant economic and nutritional value of maize, as well as the recognized importance of fertilization and foliar nutrition using nano-fertilizers, this research endeavor was undertaken with the objective of determining the optimal concentration for applying G-power Ca nano-fertilizer through spraying, as well as identifying the most effective timing for foliar spraying. The ultimate goal was to ascertain the concentration and timing that would yield the maximum impact on the growth and yield of maize. Understanding the impact of the interplay between foliar spraying and spraying dates on the growth and yield of maize is of utmost importance.

Materials and Methods

In March 2022 AD, a field experiment was conducted in one of the fields of Ibn Al-Bitar Vocational Preparatory School, situated in the Al-Hussainiya area of the Karbala Governorate. The soil used in the experiment was prepared by the processes of plowing, smoothing, and leveling. Subsequently, the experimental field was separated into distinct sections. The planting was conducted in the first half of March using experimental units with dimensions of 3m x 4m. The experiment consisted of two components. The experiment was conducted using a randomized complete block design (RCBD), with the first consisting of various concentrations of foliar spraying using the organic nano-fertilizer G-power Ca. The factor was prepared in accordance with the specified concentrations of 0, 2, 4, and 6 milliliters per liter (ml L-1). The treatments in this study were represented by various symbols. The first factor involved foliar spraying with different concentrations of G-power Ca, denoted as A1, A2, A3, and A4. A1 represented the control treatment, which involved spraying with distilled water only. A2, A3, and A4 represented spraying with concentrations of 2ml L-1, 4ml L-1, and 6ml L-1, respectively. The second factor included three different dates for foliar spraying, denoted as N1, N2, and N3. N1 represented spraying after 20 days of planting, N2 represented spraying after 40 days of planting, and N3 represented spraying after 60 days of planting.

1- The length. of the main stem was` measured. from the soil surface.` to the top ,of the plant using, a tape measure.
2- Leaf., area (cm^2):
The leaf.,, area was calculated using. the following formula:
Leaf area., cm^2 = leaf length under, the main., ear x maximum., leaf. width x 0.75 [7].
3- Leaves number.,, (lea $plant^{-1}$):
The number of leaves, was counted from the. first leaf near the. surface of the. soil to the last node below. the male inflorescence of five plants, then the average. was extracted. [7].
4- The content of, chlorophyll in leaves (SPAD):
The chlorophyll. content in the leaves was measured. by a chlorophyll-meter.
5- Total grain. yield (ton ha^{-1}):
The yield of one. plant in grams was, calculated using the. sensitive, and then the, total grain. yield in (kg) was calculated, at the standard humidity, of 15.5%, according to the following. equation [7].
total grain. yield (kg ha^{-1}) = Average yield per, plant., x plant density.

Results and Discussion

Plant height (cm)

The findings presented in Table 1 demonstrate notable variations among the treatments. Specifically, treatment A4 yielded the highest mean plant height of 183.67 cm, whilst treatment A1 exhibited the lowest average of 178.33 cm. The increase in plant height can be attributed to the presence of nano fertilizers containing elements such as nitrogen and potassium. These elements have an impact on metabolic processes, resulting in an increase in cell size and division rate. This finding aligns with previous research [8,9, 10, 11). The data shown in the table demonstrates a notable impact of the spraying dates on the plant height characteristic. Specifically, treatment N3 exhibited superior performance by yielding the highest average height of 185.33 cm. Regarding the interaction, there is no substantial impact.

Table (1): Effect of nano-foliar spraying and spraying times on average plant height

Foliar spray	Spray dates			Average foliar spray
	N1	N2	N3	
A1	174.33	178.33	182.33	178.33
A2	175.67	181.00	184.33	180.33
A3	177.33	183.00	186.67	182.33

A4	179.67	183.33	188.00	183.67
Average spray dates	176.75	181.42	185.33	
L.S.D 0.05	Foliar spray	Spray dates	interaction (Spray X dates)	
	2.37	2.91	NS	

Leaf area (cm2)

The results of Table (2) indicate that there are significant differences, as treatment A4 gave the highest average leaf area of 4209 cm^2, while treatment A1 gave the lowest average of the characteristic amounting to 3844 cm^2, The reason for the superiority of the A4 fertilization treatment may be attributed to the fact that the nano foliar spray fertilizer contains calcium, nitrogen, and organic matter that increase plant growth by increasing biosynthesis enzymes, and this has a role in the growth, development, and division of plant cells, this may be due to the importance of nanoparticles because of their distinctive and unique behavior and properties, their small particles and their high surface area, which enables them to increase their absorption rate and increase enzymatic activity and thus increase the speed of biochemical reactions when it is at the nano level [1]. The data presented in the table indicates that the spraying date labeled as N3 had superior performance in terms of leaf area, yielding the highest average measurement of 4135 cm2. Regarding the interaction, it was determined that there was no statistically significant impact.

Table (2): Effect of foliar nano-spraying and spraying dates on the average leaf area of the plant

Foliar spray	Spray dates			Average foliar spray
	N1	N2	N3	
A1	3722	3854	3955	3844
A2	3854	4021	4093	3989
A3	4009	4092	4186	4096
A4	4123	4199	4305	4209
Average spray dates	3927	4042	4135	
L.S.D 0.05	Foliar spray	Spray dates	interaction (Spray X dates)	
	89.6	77.6	NS	

Average leaves number plant(leaf $plant^{-1}$)

The results in Table (3) indicate that there are significant differences, as treatment A4 gave the highest average number of leaves in the plant, amounting to 14.50 leaf $Plant^{-1}$, while treatment A1 gave the lowest average number of leaves in the plant, amounting to 12.67 leaf $Plant^{-1}$. As for the concentrations of nano foliar spray, treatment N3 excelled by giving the highest rate of 14.50 leaf plant-1. This is consistent with the findings of previous studies that the use of organic fertilizer led to a significant increase in the number of leaves per plant because of the compounds it contains that have an effective and effective effect on the yellow Maize plant [2]. As for the interaction, the results indicate that there are no significant differences.

Table (3): Effect of foliar nano spraying and spraying dates on the average number of leaves per plant (leaf plant^{-1})

Foliar spray	Spray dates			Average foliar spray
	N1	N2	N3	
A1	11.67	12.00	14.33	12.67
A2	11.33	13.00	14.00	12.78
A3	13.00	14.00	14.33	13.78
A4	14.33	14.67	15.33	14.50
Average., spray dates	12.58	13.42	14.50	
L.S.D 0.05	Foliar spray	Spray dates		Interaction (Spray X (dates)
	0.83	0.72		NS

The average percentage of chlorophyll in leaves (SPAD)

According to Table (4), there are notable variations seen across the treatments in terms of chlorophyll content in the leaves, as measured by SPAD. Treatment A4 exhibited the greatest average SPAD value of 44.67, whilst treatment A1 had the lowest average SPAD value of 39.78. The superior performance of the leaves can be attributed to the higher concentration of chlorophyll, which is a result of the presence of readily available nutrients. Specifically, the availability of nitrogen plays a crucial role in the formation of the chlorophyll molecule, while calcium activates enzymes and enhances the leaf's magnesium content. This increase in magnesium, in conjunction with nitrogen, contributes to the formation of chlorophyll in the plant (references 6 and 16). The data presented in the table demonstrates a clear relationship between the timing of nano foliar spraying and the chlorophyll content of the leaves. Specifically, treatment N3 exhibited the most favorable outcome, with an average SPAD value of 44.0. Regarding the observed interaction, it is evident from the provided table that there exists a noteworthy impact. Specifically, the interaction between treatment A4 and treatment N3 resulted in the highest recorded chlorophyll rate in the leaves, reaching a value of 49.0 SPAD.

Table (4): Effect of nano foliar spraying and spraying dates on the average of chlorophyll in leaves (SPAD)

Foliar spray	Spray dates			Average foliar spray
	N1	N2	N3	
A1	39.00	41.00	39.33	39.78
A2	40.00	40.67	44.67	41.78
A3	42.00	42.33	43.00	42.44
A4	46.00	39.00	49.00	44.67
Average spray dates	41.75	40.75	44.00	
L.S.D 0.05	Foliar spray	Spray dates	interaction (Spray X dates)	
	2.71	2.35	4.70	

The total yield of the plant (kg ha^{-1})

It is clear from Table (5) that there are significant differences between the treatments, as treatment A4 gave the highest mean for the characteristic of the total yield of the plant amounted to (8012 kg ha^{-1}), while treatment A1 gave the lowest average amounted to 7241 (kg ha^{-1}). It is clear from the same table that the date of foliar spraying significantly affected the total yield of the plant, as treatment N3 excelled in giving the highest mean of 7818 (kg ha^{-1}), This superiority may be due to the fact that the plant has absorbed the maximum possible rate of nutrients, which are the basic components included in the composition of the foliar fertilizer and the addition of fertilizer and nutrients sprayed on the leaves works on the growth of the different parts, which gives a clear increase in the amount of the yield, in order to provide and continuity of the food supply. In addition, the role of nutrients in improving plant growth, which encouraged an increase in total yield and is consistent with what was found [14]and [5].

Table (5): Effect of nano foliar spraying and spraying dates on total plant yield

Foliar spray	Spray dates			Average foliar spray
	N1	N2	N3	
A1	7040	7164	7520	7241
A2	7182	7236	7627	7348
A3	7307	7644	8018	7656
A4	7947	7982	8107	8012
Average spray dates	7369	7507	7818	
L.S.D 0.05	Foliar spray	Spray dates	Interaction (Spray X dates)	
	170	147	N.S	

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