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Response of some maize genotypes traits (Zea mays L.) to Nano NPK fertilizer

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Abstract

A factorial experiment was conducted through fall season 2022 in the Bani Magan area belonging to the Directorate of Agriculture of Chamchamal and affiliated to the General Directorate of Agriculture of Sulaymaniyah using randomized complete block design in split plot system with three replication, to know the effect of three concentrations (0, 2, and 4) $g.L^{-1}$ of nano-sama NPK and the response of seven genotypes of maize crop to some growth traits and total yield، and the following results were obtained:

The concentration of 4g L^{-1} NPK nano-compound fertilizer was significantly surpassed for the characteristics of the duration from sowing up to 50% of male flowering, plant height, ear height, and total grain yield. The two genotypes (Yugoslavian and DKC6664) were significantly surpassed for period from sowing to 50% male flowering, and the genotype (DKC6664) was significantly surpassed for the period from sowing to 50% female flowering (day).The two genotypes (Babylon and Bahia) were significantly surpassed for plant height, the genotype (Bahia) for ear height, the genotypes (Sangunto, Bahia and Babel) for leaf area, and the two genotypes (DKC6664 and Erbil 215481) for grain yield Total and the effect of combination between, treatment $2g.L^{-1}$. and genotype (Yugoslav) had the least number of days 50% of the female flowering, and the combination between the fertilizer level 2 and 4 $g.L^{-1}$ and genotype (DKC6664) had the least number of days 50% of the female flowering, and the combination between the fertilizer level was 4 g. L^{-1} with genotype (Babylon) significant in plant height and fertilizer level 4g. L^{-1} with genotype (Bahia) in ear height character and control treatment .The level of fertilizer is 2 and 0 $g.l^{-1}$ with genotypes (Bahia) in the characteristic of leaf area, and the level of fertilizer is 4 $g.l^{-1}$ with genotype (Erbil 215481) in total grain yield.

Key words: corn, NPK nan fertilizer, vegetative growth and yield characteristics.
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Introduction

Maize (*Zea mays L.*) is an important crop belonging to the Poaceae family and ranks third in economic importance after wheat and rice due to its diverse uses [1]. It is commonly cultivated as a grain food crop, often mixed with wheat flour to produce bread and pastries. Maize starch is utilized in various confectionery processes, and the kernels contain 4-10% oil, making them a staple in the diets of poultry, cows, and sheep due to their rich protein starch %81, oil %4.6, , and mineral %1.6 content (2). The United States of America leads the world in Maize cultivation, followed by China and Brazil (3). Maize crop is one of the main ancient crops in Iraq; however, its production rate per unit area still remains relatively low. In the year 2021, the total cultivated area of Maize in Iraq was estimated to be 81,476. thousand hectares. Out of this area, the harvested area was approximately 78,041.75 thousand hectare. On the basis of the total cultivated area, the average yield per hectare was estimated to be 4595.2 kg, while on the harvested area, the average yield per hectare was estimated to be 4797.6 kg for the year 2021 [4].

The proper management of nano-fertilizers is regarded as a crucial factor for successful crop cultivation, as it significantly influences growth and yield characteristics. In today's agricultural practices, environmental protection and sustainable agriculture have become top priorities. Excessive use of conventional chemical fertilizers is a leading cause of soil and environmental degradation. As a solution, the concept of utilizing nano-fertilizers has emerged. Nano-fertilizers are considered one of the most advanced and modern fertilizers available, , providing crops with all the essential mineral nutrients they require for proper nourishment and treatment. By adopting nano-fertilizers, farmers aim to address environmental concerns while optimizing crop productivity and health[5].

The study was conducted for the purpose of achieving the following objectives:

1- To determine the response of the genotypes of maize crop to spraying with NPK nanofertilizer.

2- determine the best concentration for foliar application of NPK nano fertilizer and its effect on growth characteristics, the harvest, its components, and the qualitative characteristics of maize crop.

3- investigating the interaction between the genotypes of maize with the levels of NPK nanofertilizer.

Materials and methods

The experiment was conducted in the Bani Magan area belonging to the Chamchamal Directorate of Agriculture and affiliated to the General Directorate of Sulaymaniyah Agriculture, It is located at longitude 44-78□ east and 49-35□ north latitude, in atumn season 2022 using randomized complete block design in split plot system with three replications.

The agricultural operations were carried out on an experimental land of plowing and leveling, and then the land was divided into three replicates. The first factor. Includes three levels of NPK nanofertilizer (0, 2, and 4) $g.L^{-1}$ placed in the main plots, and the second factor includes seven genotypes of maize (Sagunto, Erbil 215481, Jameson, Bahia, Yugoslavian, Babylon and DKC6664) placed in sub plots in each main plot. Data were recorded for traits: duration to 50% of the male flowering (day) (6), Duration to 50% female flowering (day) (6), Plant height (cm) [7], upper ear height (cm) (8), The leaf area of the plant ($cm^2.plant^{-1}$) (9) and Grain yield ($ton.ha^{-1}$) [10].Sowing took place on 4/7/2022 in lines, where the repeater for one included 21 experimental units, and each experimental unit contained 4 lines, the length of the line was 3 m, and the distance between the lines was 0.70 m And between one plant and another 0.20 m. From cultivation and the process of thinning to a single plant in all its aspects،Compound fertilizer was added in the amount of 320 kg. ton^{-1} DAP fertilizer (18% N and 46% P2O5) before the softening process [11], then adding (200) kg ha^{-1} urea (N46%) as a single batch at the branching stage [12], that soil and crop service operations were carried out whenever the need arises and harvesting on 3/12-7 /12/2022. The program

(SAS) [13] was used in conducting the statistical analysis [14] and [15] .

Results and discussion:

1- The period from planting until 50% male flowering (day):

Table (1) demonstrates significant differences among various levels of spraying NPK nano fertilizer for the mentioned traits. Plants treated with 2 and 4 g.L-1 of NPK nano fertilizer reduced the number of days from sowing until 50% male flowering (48.43 and 48.87 days, respectively). In contrast, the control plants experienced a significant delay in reaching 50% male flowering (52.78 days). The early flowering in the treated plants can be attributed to the role played by NPK nano fertilizer at 2 and 4 g.L-1 in reducing stomatal resistance and enhancing stomatal conductivity. This adjustment allowed the plants to have sufficient access to CO2 and water, facilitating the carbon metabolism process and nutrient uptake from the soil. As a result, the vegetative growth significantly increased. The NPK nano fertilizer contains essential major elements that promote a nutritional balance during the early stages of plant growth, leading to improved metabolism and metabolic activity [16] [17]. Consequently, this shortened period influenced the plant's growth traits, development, and transition from vegetative to reproductive growth stages. These findings are consistent with what has been reported by other researchers [2].

It is determined from the table that significant differences exist between the genotypes, as the two genotypes (DKC6664 and Yugoslavian) were significantly earlier in the number of days to reach 50% male flowering (42.04 and 42.52 days), at the same time, while the genotype (Bahia) was significantly late in reaching This stage reached an average of (58.88) days. The cause of the variation in genotypes at the time of male flowering is due to differences in their genetic structure. These results are consistent with what was mentioned in [18], [19], and [20]

Furthermore, the table also reveals a significant interaction between the levels of NPK nano fertilizer and the genotypes. The combination of the treatment with 2g.l^{-1} of NPK nano fertilizer and the Yugoslavian genotype resulted in a significantly early flowering, with plants reaching 50% male flowering in just 35.56 days. On the contrary, the interaction between the no-spray treatment and the Bahia genotype caused a significant delay in reaching this stage, taking 61.00 days. The distinct time needed for male flowering in different cultivars may be attributed to varying heat requirements at different growth stages as a consequence of genetic differences.

Table (1) Effect of spraying with NPK nanofertilizer and genotypes and the interaction between them on the period from planting to 50% of male flowering (day)

Genotypes	NPK nano fertilizer levels (g.L^{-1})			means of Genotypes
	0	2	4	
Sangunto	55.33 bc	57.33 ab	56.66 a-c	56.44 b
Erbil 215481	49.33 d-f	40.67 hi	40.00 e-g	45.33 d
Jameson	48.50 ef	53.00 cd	50.33 de	50.61 c
Bahia	61.00 a	57.66 ab	58.00 ab	58.88 a
Yugoslavian	49.33 d-f	35.56 j	42.66 gh	42.52 e
Babylon	60.33 a	57.66 ab	45.09 fg	54.36 b
DKC6664	45.66 fg	37.140 ij	43.33 gh	42.04 e
NPK nano fertilizer means	52.78 a	48.43 b	48.87 b	

means of genotypes, nano fertilizer levels or their combinations that followed by the same letter indicate not significantly different.

2- The period from cultivation until 50% flowering (day):

From table (2), significant differences are observed between the various levels of spraying NPK nano-fertilizer concerning the characteristic of days from sowing until 50% female flowering is reached. Plants treated with 2g.L-1 of NPK nano-fertilizer exhibited a significantly earlier flowering, taking only

55.80 days. In contrast, the plants without any spraying treatment showed a significant delay in reaching 50% female flowering, which took 57.48 days. The reasons for these differences in flowering time may be similar to those mentioned for the variations in days until 50% male flowering, which is likely influenced by the NPK nano-fertilizer treatment. These findings are consistent with previous studies [2], supporting the notion that NPK nano-fertilizers play a role in influencing flowering time.

Furthermore, significant differences were observed among the genotypes regarding the number of days until 50% female flowering is reached. Genotype DKC6664 demonstrated significantly earlier flowering at a rate of 46.91 days. On the other hand, genotypes Bahia and Babel significantly lagged behind all other genotypes, taking 62.44 and 62.22 days, respectively, to reach 50% female flowering. These differences can be attributed to the genetic structure of the genotypes, aligning with previous research findings [20], [21] and [22].

The table also indicates a significant interaction between the levels of NPK nano-fertilizer spraying and the genotypes. The combination between no spraying treatment and genotype Bahia resulted in a significant delay in reaching 50% female flowering (66.33 days). Additionally, the combination between comparison coefficient (possibly referring to a specific concentration of NPK nano-fertilizer) and genotype Bahia showed a significant delay in reaching this stage, which took 66.33 days. The effect of nitrogen in the NPK nanocomposite may be responsible for increasing cell size and division speed, leading to enhanced growth and vegetative activity, likely affecting the flowering time (66.33) days, which supports the tendency of the plant to focus on vegetative growth.

Table (2) Effect of spraying with NPK nanofertilizer and genotypes and the interaction between them on the period from planting to 50% female flowering (day)

Genotypes	NPK nano fertilizer levels ($g.L^{-1}$)			means of Genotypes
	0	2	4	
Sangunto	49.76 g	54.55 f	61.66 c	55.32 d
Erbil 215481	58.00 d	58.33 d	53.61 f	56.64 c
Jameson	58.00 d	58.33 d	58.00 d	58.11 b
Bahia	66.33 a	55.33 ef	65.66 a	62.44 a
Yugoslavian	58.00 d	57.33 de	46.94 h	54.09 e
Babylon	57.00 de	63.66 b	66.00 a	62.22 a
DKC6664	55.33 ef	43.09 i	42.30 i	46.91 f
NPK nano fertilizer average	57.48 a	55.80 b	56.31 ab	

means of genotypes, nano fertilizer levels or their combinations that followed by the same letter indicate not significantly different.

3-Plant height (cm):

From the data presented in Table (3), it is evident that the levels of spraying with NPK nano-fertilizer have a significant effect on the plant height characteristic. The treatment with spraying $4g.L^{-1}$ of NPK nano-fertilizer resulted in a significantly taller height, reaching the highest average of 187.19 cm, whereas the control treatment showed the lowest average of 175.04 cm. The superiority of the $4g.L^{-1}$ spray treatment can be attributed to the addition of NPK nano-fertilizer, which contributes to providing essential nutrients in sufficient quantities through its absorption by the stomata, translocation through cell membranes, and rapid metabolism. This, in turn, promotes cell formation and division, influences plant growth and development, and regulates the action of plant hormones such as auxins and cytokinins, leading to elongation of internodes and increased plant height [23]. These results align with previous research findings [24].

Furthermore, the table indicates significant differences between the genotypes concerning plant height. The genotype Babylon demonstrated the highest average height of 204.66 cm, which did not significantly differ from genotype Bahia. On the other hand, genotypes DKC6664, Jameson, and Yugoslavian had the lowest average height, measuring 165.66, 165.00, and 164.44 cm, respectively. The variations in height among the yellow maize genotypes can be attributed to different genetic factors and the interaction between environmental factors and the length of the vegetative growth period for specific genotypes, or the period from planting to maturity. These factors allow cells to divide and elongate, thereby influencing plant height. These findings are consistent with previous research conducted by (13), (25), and (26).

The table also indicates a significant interaction between the levels of spraying with NPK nano-fertilizer and the genotypes. The combination between the treatment of spraying 4g.L^{-1} and the genotype Babylon resulted in the highest average plant height of 207.00 cm, which did not significantly differ from the interaction between the same spraying level and genotype Bahia (206.66 cm). Conversely, the combination between the no-spray treatment and genotype Jameson showed the lowest average height of 156.33 cm. This observed combination can be attributed to the role of NPK nano-fertilizer and its impact on vital plant processes, being more effective compared to traditional fertilizers due to its high surface area resulting from small particles. The increased surface area facilitates metabolic processes in the plant and enhances photosynthesis, leading to improved growth indicators and plant height. These results align with findings from previous researchers [2]

Table (3) Effect of spraying NPK nanofertilizer, genotypes and the interaction between them on plant height (cm)

Genotypes	NPK nano fertilizer levels (g.L^{-1})			means of Genotypes
	0	2	4	
Sangunto	175.00 fg	176.00 fg	188.66 e	179.88 b
Erbil 215481	164.00 J	169.67 hi	195.66 d	176.44 c
Jameson	156.33 K	161.66 j	177.00 f	165.00 d
Bahia	200.00 c	201.66 bc	206.66 a	202.77 a
Yugoslavian	163.33 J	167.66 I	162.33 j	164.44 d
Babylon	204.33 ab	202.66 bc	207.00 a	204.66 a
DKC6664	162.33 J	161.66 j	173.00 gh	165.66 d
NPK nano fertilizer average	175.04 C	177.28 b	187.19 a	

means of genotypes, nano fertilizer levels or their combinations that followed by the same letter indicate not significantly different.

4-upper ear height (cm):

From the data presented in Table (4), it is evident that the addition of different levels of NPK nano-fertilizer significantly influenced the upper ear height trait. The spraying treatment at 4g.L^{-1} resulted in the upper ear height mean of 83.42 cm, while the no-spray treatment showed the lowest mean of 78.95 cm, which did not significantly differ from the 2g.L^{-1} treatment, with a mean of 79.19 cm. The superiority of the 4g.L^{-1} spray treatment can be attributed to the role played by the nutrients in enhancing plant growth by increasing the process of carbon metabolism and synthesizing nutrients. This, in turn, increases the activity of growth regulators such as auxins and gibberellins, which promote cell enlargement and internode elongation, leading to increased plant height (27). Additionally, the significant increase in plant height observed in Table (3) due to the 4g.L^{-1} spraying treatment likely contributed to the increase in cob height as well. These findings align with previous research (28).

Furthermore, the results in Table (4) indicate significant differences between the genotypes concerning the upper ear height trait. Genotype Bahia demonstrated the highest mean of 103.77 cm, significantly differing from the other genotypes. On the other hand, genotype

Jameson had the lowest mean of 68.55 cm. The superiority of genotype Bahia in plant height (Table 3) and the significant delay in reaching 50% female flowering (Table 2) likely contributed to its superiority in upper ear height as well. These results are consistent with previous research (29), (30), and (31).

The table also shows a significant interaction between the levels of spraying with NPK nano-fertilizer and the genotypes regarding the upper ear height trait. The combination between the treatment of spraying $4g.L^{-1}$ and genotype Bahia resulted in the highest upper ear height mean of 108 cm, while the combination between the no-spray treatment and genotype Jameson led to the lowest mean of 65.33 cm. The significant superiority of the same combination in plant height traits (Table 3) likely contributed to the significant superiority in upper ear height as well, supporting previous research findings (28).

Table (4) Effect of spraying NPK nanofertilizer, genotypes and the interaction between them on cob height (cm)

Genotypes	NPK nano fertilizer levels ($g.L^{-1}$)			means of Genotypes
	0	2	4	
Sangunto	73.66 f-h	71.00 h-j	71.66 g-i	72.11 d
Erbil 215481	74.66 fg	65.66 k	74.66 fg	71.66 d
Jameson	65.33 k	70.33 Ij	70.00 ij	68.55 e
Bahia	100.33 cd	103.00 bc	108.00 a	103.77 a
Yugoslavian	71.00 h-j	71.33 h-j	79.33 e	73.88 c
Babylon	99.33 d	102.00 b-d	104.00 b	101.77 b
DKC6664	68.33 jk	71.00 h-j	76.33 f	71.88 d
NPK nano fertilizer average	78.95 b	79.19 b	83.42 a	

means of genotypes, nano fertilizer levels or their combinations that followed by the same letter indicate not significantly different..

5-Leaf area ($cm^2.plant^{-1}$):

It is clear from the results in Table [5] that there are no significant differences between the levels of spraying with NPK nanofertilizer for the leaf area trait in the plant, while there were significant differences between the genotypes for this trait, as the genotype (Bahia) excelled in this trait with the highest rate of (6737.9). $cm^2.plant^{-1}$), which did not differ significantly from the two genotypes (Sangunto and Babylon), while the least leaf area for the genotype (Jameson) at a rate of (5063.2 $cm^2.plant^{-1}$), which did not differ significantly from the genotype (DKC6664) that the reason for this variation between the genotypes may be due to the nature of their growth and the genetic differences between them and the variation in the physiological response of these genotypes when treated with nanofertilizer as well as the variation in the number of days needed from cultivation to 50% male flowering (Table 1), within which the available period for the development of leaf area falls, which may It leads to an increase in the number of leaves and thus an increase in the leaf area, and this result was reinforced with [32],and [33] .

It is noted from the same table that there is a significant interaction between the levels of spraying with NPK nanofertilizer and the genotypes of leaf area cm^2, as the combination between the control treatment and the genotype (Bahia) gave the highest mean of the leaf area amounted to (7000.0 $cm^2.plant^{-1}$), while the combination between the control treatment and genotype (Jameson) gave lowest average leaf area of (4840.3 cm 2.plant-1). It is clear from these results that there is positive role of NPK nanofertilizer in increasing the efficiency of the photosynthesis process and regulating the transmission and orientation to areas of need in plants of superior genotype, which exploited its capabilities Genetic and physiological with high efficiency, which led to an increase in leaf area.

Table (5) Effect of spraying with NPK nanofertilizer, genotypes and the interaction between them on the leaf area ($cm^2.plant^{-1}$)

Genotypes	NPK nano fertilizer levels ($g.L^{-1}$)			means of Genotypes
	0	2	4	
Sangunto	66777.5 ab	6597.7 ab	6479.7 ab	6585.0 a
Erbil 215481	5607.5 cd	5577.6 cd	5940.7 bc	5708.6 b
Jameson	4840.3 d	4900.5 d	5448.9 cd	5063.2 c
Bahia	7000.0 a	6836.2 a	6377.5 ab	6737.9 a
Yugoslavian	5147.8 cd	5369.5 cd	5572.2 cd	5363.2 bc
Babylon	6369.0 ab	6457.7 ab	6615.9 ab	6480.9 a
DKC6664	5066.1 d	5055.4 d	5296.7 cd	5139.4 c
NPK nano fertilizer average	5815.45 a	5827.80 a	5961.65 a	

means of genotypes, nano fertilizer levels or their combinations that followed by the same letter indicate not significantly different.

6-Total grain yield ($ton.ha^{-1}$)

The results in Table (6) showed that the effect of spraying at different levels of NPK nanofertilizer was significant in trait of total grain yield, as the treatment of spraying $4g.L^{-1}$ was significantly higher by giving highest rate for this trait, which reached (10.11 $tons.ha^{-1}$), while it gave lowest rate of total grain yield for the no-spray treatment, which reached (7.31 $tons.ha^{-1}$). The reason for the excelled of the $4g.l^{-1}$ spray treatment is due to the role of NPK nanofertilizer directly stimulating cell division and expansion processes, which led to an increase in plant growth rates by increasing the green area of the plant and an increase in its content of chlorophyll and some plant compounds stimulating the processes of cell division and expansion, which led to an increase in plant growth rates, and this led to an increase in the efficiency of the photosynthesis process in the production of dry matter and an increase in the acceleration of its transfer from sources to receptors, which was reflected in an increase in the yield components. This result is in line with the findings of [24].

The results in Table [6]also showed that there are significant differences between the genotypes for the trait of total grain yield, as the genotype (DKC6664) significantly surpassed by highest rate (9.47 $ton.ha^{-1}$) and did not differ significantly from the genotype (Erbil 215481), while the lowest rate recorded by genotype (Jameson) was (7.30 $tons.ha^{-1}$). Generally, genotypes differ among them in grain yield due to the genetic factor and the difference in physiological and environmental performance. This result agrees with [13].

It is noted from the same table that there is a significant interaction between the levels of spraying with NPK nano-fertilizer and the genotypes for total grain yield, $ton.ha^{-1}$, as the combination between the treatment of spraying $4g.l^{-1}$ and the genotype (Erbil 215481) gave the highest average of (11.46 $tons.ha^{-1}$), while the combination between no spraying and genotypes (Babylon) resulted in the lowest average (6.37 $ton.ha^{-1}$), these results agree with [28].

Ttable (6) Effect of spraying NPK nano fertilizer and genotypes and the interaction between them on total grain yield (ton.ha-1)

Genotypes	NPK nano fertilizer levels (g.L^{-1})			means of Genotypes
	0	2	4	
Sangunto	7.71 f-h	8.79 de	10.45 b	8.98 b
Erbil 215481	7.95 fg	8.69 de	11.46 a	9.37 a
Jameson	6.54 i	6.50 i	8.87 c-e	7.30 d
Bahia	7.23 h	7.70 f-h	8.91 c-e	7.95 c
Yugoslavian	7.36 gh	8.58 e	10.83 b	8.92 b
Babylon	6.37 i	8.60 e	9.24 cd	8.07 c
DKC6664	8.02 f	9.41 c	10.99 ab	9.47 a
NPK nano fertilizer average	7.31 c	8.33 b	10.11 a	

means of genotypes, nano fertilizer levels or their combinations that followed by the same letter indicate not significantly different.

Conclusion

The level of NPK nanofertilizer 4g.l^{-1} gave the highest grain yield, and this is due to the role of NPK nanofertilizer directly on the processe **s**s of division and cell expansion, which led to an increase in plant growth rates by increasing the green area of the plant and increasing its content of chlorophyll and some plant compounds activating the processes division and expansion of cells, which led to an increase in plant growth rates and led to an increase in the efficiency of the photosynthesis process in the production of dry matter and an increase in the acceleration of its transfer from sources to receptors, which was reflected in an increase in the components of the yield, where it led to an increase in the grain yield of the plant. On all genotypes in the grain yield, where the role of the difference in the genotype appeared in the performance of traits of the yield, and grain, as it is reflected in the physiological performance of the plant.

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مجلة جامعة كركوك للعلوم الزراعية

إستجابة صفات بعض أصناف الذرة الصفراء (*Zea mays L.*) لتسميد NPK النانوي

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المستخلص

أجريت تجربة عاملية في الموسم الخريفي 2022 في منطقة باني مقان العائدة المديرية الزراعة جمجمال وتابعة للمديرية العامة لزراعة السليمانية لمعرفة تأثير ثلاثة تراكيز (0 و2 و4)غم.لتر−1 من السما NPK النانوي واستجابة سبعة تراكيب وراثية من المحصول الذرة الصفراء لبعض الصفات النمو والحاصل الكلي، طبقت تجربة عاملية بتصميم القطاعات العشوائية الكاملة (R.C.B.D) وفق نظام القطع المنشقة، وتم التوصل الى النتائج التالية:

تفوق التركيز4غم لتر−1 من السماد المركب NPK النانوي معنوياً في صفات المدة من الزراعة حتى 50% تزهير الذكري وارتفاع النبات وارتفاع العرنوص وحاصل الحبوب الكلي، وتفوقت التركيبين الوراثيين(يوغسلافي وDKC6664) في تبكيره معنوياً في المدة من الزراعة حتى 50% تزهيرالذكري وتفوق التركيب الوراثي(DKC6664) في تبكيره معنوياً في المدة من الزراعة حتى 50% تزهيروالانثوي وتفوق التركيبين الوراثيين (بابل وBahia) معنوياً في ارتفاع النبات و والتركيب الوراثي (Bahia) في ارتفاع العرنوص والتراكيب الوراثي (Sangunto وBahia و بابل) في مساحة الورقي والتركيبين الوراثيين(DKC6664 واربيل 215481) في حاصل الحبوب الكلي. واثارالتداخل بين، معاملة 2غم.لتر−1 والتركيب الوراثي (يوغسلافي) اقل عدد الايام 50% التزهيرالذكري، وتداخل تفوقت معنوياً بين مستوى السماد 2 و4غم.لتر−1 والتركيب الوراثي (DKC6664) اقل عدد الايام 50%التزهير الأنثوي، وتفوقت التداخل بين مستوى السماد 4غم.لتر−1 مع التركيب الوراثي (بابل) معنوياً في ارتفاع النبات ومستوى السماد 4غم.لتر−1 مع التركيب الوراثي (Bahia) في صفة ارتفاع العرنوص ومعاملة المقارنة ومستوى السماد2 و0 غم.لتر−1 مع التراكيب الوراثي (Bahia) في صفة مساحة الورقية ، ومستوى السماد 4غم.لتر−1 مع التركيب الوراثي (اربيل 215481) في صفة حاصل الحبوب الكلي.

الكلمات المفتاحية: الذرة الصفراء، السماد NPKالنانوي، صفات النمو الخضري والحاصل.