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Effect of Foliar Application with Growth Promoters and Mixture of Fe, Zn and Mn on Growth and Yield of Corn under Different Nitrogen levels

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ABSTRACT

In the summer of 2020 and 2021, two field experiments were conducted at the Sakha Agricultural Research Station in Kafr el-Sheikh, Egypt. The primary aim of the research was to optimize the growth characteristics and yields of hybrid TWC.360 corn by applying nitrogen fertilizer rates and foliar application. Experiment was conducted in a split-plot design with four replication. The results indicated that in all seasons, grain production, protein percentage, growth parameters, and yield attributes all greatly outperformed other study levels (80 and 100 kg N/fed) when nitrogen fertilizer was administered at a rate of 120 kg N/fed. In corn, foliar application of amino total, melagrow, and combinations (Fe+Zn+Mn) produced the highest values for grain protein percentage and growth parameters in both seasons. However, in both seasons, the maximum values of yield and its constituents were obtained with foliar application of Amino complete. In general, based the results obtained in from study, this resulted in reducing the costs of nitrogen fertilization while obtaining the same yield value / average costs it can be concluded that to maximize the growth and productivity of corn under environmental conditions in the North Delta location of Egypt.

Keywords: Corn, foliar nutrition, growth promoters Nitrogen rates.

INTRODUCTION

Corn (Zea mays L.) is a major cereal and versatile grain crop in the grass family. It is used in industry to make dextrose, corn starch, corn syrup, and corn flakes, as well as for human consumption and animal and poultry feed. (Gulet *et al.* 2021). Additionally, it thrives in a variety of climates and soil types. It can gain more from certain nutrients than other crops such grain legumes and cereals. A variety of uses exist for corn cultivation, such as grain and silage for cattle feed, grain for poultry and swine feed, and grain and sweet corn for human use. After wheat and rice, it is one of the most significant food crops in Egypt in terms of both cultivated area and production. 1.03 million hectares, or roughly 25.2% of Egypt's total cultivated land, are planted with corn, and FAOSTAT (2020) estimates that the crop produces 8.3 tons of grain per hectare. The Egyptian government aims to improve the production of grains per unit area of agricultural land. For maize plants, nitrogen (N) is a crucial nutrient.

It is a crucial component of several metabolic processes that are vital to photosynthetic activity and agricultural output. The availability of nitrogen influences maize grain output and plant growth. An effective of radiation interception, nitrogen partitioning to reproductive organs, and other physiological parameters can be used to quantify the effect of nitrogen availability on maize grain output. (Sandhu *et al.*2021). Effects of nitrogen fertilizer on maize plants, including how it affects the growth, maintenance, and photosynthetic efficiency of leaf area (Shah *et a*l. 2021a), (Habtegebrial *et al*. 2007), and (Kaur *et al*. 2012). High nitrogen application to corn improved plant elongation and yield as well as maximum germination rate (Keskin *et al.*,2005) and (Siddiqui *et al*., 2006). (Ogola *et al*., 2002). stated that higher rates of nitrogen caused higher in dry matter (25–42%) and corn grain output (43-68%). Additionally, nitrogen is necessary for metabolism and physiological processes (Vijayalakshmi *et al.* 2013). Spraying varied amounts of N, P, and K increased the amount of protein in the grain and changed the proportions of different amino acids in the grain protein of corn (Ali *et al*. 2011). (El-Azab 2012) discovered applying Maringa loafer leaf extracts, a natural source of cytokinin, to maize enhanced its leaf area, grass height, and root fresh and dry weight. Additionally, he discovered that using Melagrow topically improved corn's yield and characteristics while producing the highest yields. On the other hand, control (water) showed the lowest values. According to (Kasrai *et al.,* 2012) the number of grains per row, number of rows per ear, weight of 1000 grains, yield of corn grains, and protein content of grains were all impacted by the number of times an amino acid was sprayed. Prior to water deficiency stress, foliar application of amino acids produced maximum number of ears per plant, number of grains per row, number of rows per ear, 1000 grain weight, and number of rows per hectare of grain yield. When safflower plants were treated with Melagrow is an organic growth enhancer, twice, 30 and 70 days after seeding, (Seadh *et al.* 2012) reported the highest grain yield and its characteristics. In contrast, the lowest yield and component levels were seen in the control treatment, which was without any spraying. A variety of amino acids play key roles in the production of hormones like auxin, increase environmental chlorophyll levels, promote photosynthesis, and function as chelating agents to facilitate the uptake and transfer of micronutrients.

Therefore, the purpose of this study was to ascertain the optimal amount of mineral nitrogen fertilizer, foliar

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application of growth promoter and mixture of micronutrients to maximize the productivity of three way cross (TWC 360) under environmental conditions in the Egypt's North Delta region.

MATERIALS AND METHODS

This Investigation was conducted in the Sakha Agricultural Research Station, Egypt during the two summer seasons of - 2020 and 2021. The experimental site is located at 31.07 North Latitude, 30.05 East Longitude with an elevation of about 6 meters above sea level. The study was to maximize productivity of corn triple (TWC.360) through determination of optimal nitrogen fertilizer levels and foliar application of growth promoter and mixture of Fe+Zn+Mn treatments. Experiment was conducted in a split- plot design in four replication. For the main - plots, three different nitrogen fertilizer amounts were applied: N1–80 kg N/fed, N2–100 kg N/fed, and N3–120 kg N/fed. Applying urea (46.5% N) as the mineral nitrogen fertilizer to the soil in two equal portions before the first irrigation and the second irrigation was the first step in the process. Sub plots received foliar sprays of the following 7 growth promoters: - F_1- spraying with water (control); F_2- spraying leaves with Mixture of (Fe+Zn+Mn); F_3- spraying leaves with Amino total; F_4- spraying leaves with Melagrow; F_5- spraying leaves with Mixture of (Fe+Zn+Mn) and Amino total sprayed leaves with (Fe+Zn+Mn) F_6- spraying leaves with mixture (Fe+Zn+Mn) and Melagrow; F_7- Spraying leaves with mixture (Fe+Zn+Mn), Amino total and Melagrow. The foliar spraying 25 and 35 days after sowing, the addition of zinc sulfate (Zn So_4.), (Fe So_4 $7H_2o$) and (Mn So_4 $7H_2o$), at rates 2g/liter water, Amino total and Melagrow at 200g/200L water /fed. Respectively. These are the said nutrients used in the test site. A naturally occurring growth promoter called melagrow is taken from cabbage pollen. It has an excellent effect on many field crops. Melaglow has a combined action of cytokinene, gibberellin, ethylene, and hydrogen cyanamide. Melagron has a chemical composition of 20% phosphorus, 10% potassium, and 3% boron. Brassinolide Natural 0.2% is a naturally occurring plant growth stimulant that enhances the growth, yield, and quality of all crops. As seen in Table 1, 17 free amino acids in the form of L-amino acids make up aminototal.

Table 1. Chemical composition to Aminototal as foliar growth promoter.

Aminototal Content	Concentrate (%)	Aminototal content	Concentrate (%)
Aspartic	3.20-3.45	Leucine	0.23-0.31
Threonine	3.05-3.56	Valine	2.80 - 3.10
Glutamic	7.24-9.12	Phenylalamine	1.26-1.70
Serein	3.76-4.49	IsoLeucine	1.98 - 2.80
Glysine	1.87-2.43	Arginine	0.42- 0.90
Proline	2.23-3.50	Histidine	1.03 - 1.78
Cystine	1.87-2.45	Methionene	0.48- 1.02
Alanine	2.16-2.20	Tyrosine	5.20 - 6.30
Lysine	1.39-2.30		

Each plot was 14.7 m^2 , 7 rows, 3.0 m long and 0.7 m wide. The experimental sites were preceded by wheat in the both seasons. Corn grown was sown on May 19th and 15th in 2020 and 2021 seasons, respectively, at 25 cm spacing. Six irrigations were performed on the plots; the first irrigation took place 21 days after seeding, and the others happened every 14 days. The experimental plots were plowed, leveled, compacted, and ridged twice and divided into experimental units (14.7 m^2). Hills were spaced 25cm, at a rate of 15kg grains /fed.in the both seasons 150 kg of calcium superphosphate (15.5% P2O5) was added to the soil throughout the amendment process. Harvesting took place on September 8th and 6th in 2020 and 2021 seasons, respectively. The physical and chemical properties of the experimental soils are shown in Table 2. Except for the factors under study, other farming practices were applied is recommended Table 1 according to the method described by Klute, (1986).

Table 2. Soil analysis at the experimental sites during the two growing seasons of 2020 and 2021.

Soil analysis	2020 season	2021 season
A- Physical properties		
Silt %	24.35	25.76
Clay %	47.04	47.40
Texture	Clayey	Clayey
B- Chemical properties		
Organic matter %	1.94	1.87
Available N (ppm)	29.6	31.04
Available P (ppm)	11.5	12.84
Exchangeable K (ppm)	291.3	314.5
pH	7.85	7.94
EC m. mohs/cm	0.59	0.62

Studied Characters:

A- **Physiological parameters:**

Characters related to crop growth rate and net assimilation rate were estimated for the 45–60 and 60–75 days after sowing (DAS) growth phases.

1-**crop growth rate (CGR)**

$$W_2\text{-}W_1/\ T_2\text{-}T_1 = (g/m^2/week).$$

2-Net assimilation rate (NAR)

$$(W_2\text{-}W_1)\ (\log_e A_2\text{-}\log_e A_1)/\ (T_2\text{-}T_1)\ (A_2\text{-}A_1) = (g/m^2/week)$$

Where: $W_1$and W_2=difference on dry matter accumulated between the successive simples, respectively.

A_1 and A_2 = difference on leaf area /plant "cm^2" between the successive simples, respectively.

Loge = logarithm to the base "e" where is the base of natural logarithm (2.71828). (t_2-t_1) member of weeks esteems two successive samples. The basic formula of physiological attributes studied was used according to Radford (1967).

Photosynthetic pigments contents of leaves:-

One hundred days after planting, ten guarded plants were selected at random from each plot to determine the following growth traits. Chlorophyll a, chlorophyll b, and carotenoids were determined from five disks collected from corn harvests. Disks were extracted by pounding in 85% aqueous acetone (20 ml), and sometime after pounding, the $CaCO_3$ squeeze was included in acetone. After filtration, the volume of acetone was reduced to 20 ml. The overall chlorophyll color was determined by measuring the wavelengths at 662 nm and 644 nm, while 470 nm for carotenoids in a spectrophotometer and computed the photosynthetic pigment concentration based on the parameters of Lichtenthaler and Buschmann (2001).

Chl.a =11.24 (0.D) 662-2.04 (0.D)644= (mg/dm F.W)

Chl. b =20.13 (0.D) 644-4.19 (0.D)662=(mg/dm F.W)Car. =1000 (0.D) 470- 1.90 chl.a -63.14 chl b)/214= (mg/dm F.W)

B- Yield and its components:

During harvest (120 days after planting), ten guarded plants and ears were randomly picked from each plot, and the following yields and their constituent parts were measured.

1-Plant height (cm). 2- Length of ear (cm). 3- Ear diameter of the ear (cm).4- Weight of ears (g). 5- weight of ear grain (g). 6- Shelling (%). 7- 100-grain weight (g). 8- Grain yield (tons/fed) 9-stover yield (tons /fed.): calculated by converting the weight of grain per kilogram to tons per feddan, adjusted to 15.5% moisture content in each plot.

C- Grain quality:

1- Crude protein of grains (%): A tiny Kjeldahl device was used to digest a known weight of the finely ground seeds (about 0.1g). The total nitrogen was multiplied by 5.85 to determine the crude protein AOAC. (A.O.A.C. 2007).

2- Total carbohydrates of grains (%): Determined by applying the Enthrone technique, as detailed by Sodasivam and Manickam (1996).

3-Oil content of grains (%): According to the procedures of (A.O.A.C 2007), the oil of the seeds was extracted using a Soxhlet's extractor and petroleum ether (60-80°C). The extractions took at least eight hours, with a siphoning rate of 6-7 per hour.

4-Ash (%): To calculate the grain ash content, take 2.0 g of each sample, weigh it in a crucible, and burn it for 8 hours at 600 degrees Celsius in a muffle furnace as described by (A.O.A.C 2007).

5-Crude fiber of grains %: was ascertained using the conventional method outlined in (A.O.A.C 2007).

D-Economic evaluation:

1- Total yield (EGP/fed.):

Total yield was estimated using the following formula with the main product of corn (grain).

Total harvest = grain yield (tons/fed.) x price of 1 ton (9871EGP.)

2-Total cost of production (EGP/fed.): A-Cost of tested mineral fertilizer = rate of urea fertilizer used/fed. x price of 1 kg of urea fertilizer. Here, 1 kg of urea is equivalent to 6.60 EGP.B-Cost of the tested applying foliar spray using a mixture of (Fe, Zn, Mn), Aminototal and Melagrow: calculated on the basis of 400 g of the tested foliar spraying is equivalent to 600 EGP.C-Other costs include land preparation, seed, planting, pest control, other fertilizers, irrigation, weed control, land rent, harvesting, labor wages, machinery, and other expenses.Production costs were calculated from data presented in the preliminary agricultural statistics (October 2021), Ministry of Agriculture and Reclamation, Economic Department, A.R.E.

3-Net return (EGP/fed.) = total return on production/fed.- total cost of production/fed.

4-change in total return (%)= (Total return of treatments – total return of control / Total return of control) x100

5-Benefit/cost ratio (EGP return/EGP cost): It was estimated by the following described by John and Frank (1987).

Benefit/cost ratio = Total return of production/ Total costs of production.

Statistical analysis: Individual analysis of variance (ANOVA) of split plot design, as described by (Gomez and Gomez 1984), was used to the data collected throughout the two seasons. The (Snedecor and Cochran 1982) analysis of variance was used, and treatment means were compared using (LSD) at the probability threshold of 0.05. Using the "MSTAT-C" (1990) computer software package, the analysis of variance technique was used for all statistical studies.

RESULTS AND DISCUSSION

Growth parameters:

The Data in Table (3) indicated the effects of different levels form nitrogen fertilizer and foliar application of physiological growth parameters as well as mixture of (Fe, Zn, Mn). Results showed that nitrogen fertilizer rates and foliar application with growth promoters and microelements mixture significantly affected impacted the net assimilation rate (NAR) and crop growth rate (CGR). Findings indicated that increasing nitrogen application from 80 to 120 kgN/fed. significantly increased CGR and NAR in two growth periods in both seasons. These results are agree with (Rong and Xuefeng 2011), (Asif *et al*., 2013) (Vishuddha. 2015) (Wasaya *et al*., 2017) and (Hu *et al*.,2020) they showed that improvising nitrogen rate increases progressively and positively affected average yield. Furthermore, many researchers have found that increased nitrogen utilization has a positive impact on maize productivity.The foliar application by a mixture of Aminototal, Melagrow, and (Fe, Zn and Mn) was observed at two growth stages in both seasons which Aminototal + Melagrow + mixture of (Fe,Znand Mn) resulted in higher CGR and NAR.as well as foliar application of Aminototal+ (mixture of (Fe, Zn and Mn) was next. On the other hand, the lowest effective was foliar application with water (control). The interaction between nitrogen levels and foliar spray treatments was significant for CGR and NAR at the two periods in both seasons. This result are agree with the results obtained by (Badawi *et al.*, 2012) and (Ibrahim *et al*., 2014) and (Vishuddha 2015).

Table 3. Effect of mineral nitrogen levels and foliar spraying with growth promoters and (Fe,Zn,Mn)on some physiological attributes of maize plant at periods of 45-60 and 60-75 days after sowing in 2020 and 2021 seasons.

Characters / Treatments		Crop growth rate (g/m^2 /week)				Net assimilation rate (g/m^2/week)			
		45-60 (DAS)		60-75 (DAS)		45-60 (DAS)		60-75 (DAS)	
Seasons		**2020**	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**
A-Nitrogen fertilizer levels:									
80 kg N/fed .	N1	6.02	5.94	12.05	12.15	15.57	16.25	21.19	22.54
100 kgN/fed.	N2	6.87	6.97	13.13	13.26	16.29	17.59	23.24	24.06
120 kgN/fed.	N3	7.61	7.87	15.37	15.54	17.66	19.37	27.09	28.94
F-test		**	**	**	**	**	**	**	**
L S D at 0.05		0.49	0.69	0.10	0.11	0.07	0.09	0.18	0.17
B- foliar spraying with growth promoter:									
1- spraying with water (control)		5.23	5.27	11.00	11.08	13.11	13.52	19.47	20.35
2-spraying by mixture (Fe+Zn+Mn)		5.77	5.77	11.73	11.82	13.96	13.84	20.77	21.38
3-spraying by Aminototal		6.24	6.25	12.63	12.88	15.34	15.87	22.35	23.76
4-spraying by melagrow		6.57	6.62	13.33	13.41	16.24	16.52	23.60	24.47
5- spraying by mixture (Fe+Zn+Mn)+ Aminototal		7.45	7.74	14.45	14.52	17.14	17.36	25.52	26.78
6- spraying by mixture (Fe+Zn+Mn)+ melagrow		7.97	8.12	15.24	15.39	19.32	19.63	26.90	27.67
7- spraying by mixture (Fe+Zn+Mn)+ Aminototal+ melagrow		8.60	8.75	16.25	16.45	20.44	20.42	28.30	31.85
F-test		**	**	**	**	**	**	**	**
L S D at 0.05		0.21	0.23	0. 25	0.26	0.43	0.45	0.52	0.50
C-interaction : A*B		**	*	*	**	*	**	*	**

Photosynthetic pigment content in leaves:-.

Table (4) shows the effect of nitrogen fertilizer rates and growth promoters on Photosynthetic pigment of maize leaves. The data reflect that chlorophyll a, b and total chlorophyll concentration increase with increasing nitrogen fertilizer rates. The highest nitrogen fertilizer application (120kgN/fed.) recorded the highest mean pigment values. These results perhaps due to the role of nitrogen in improving and increasing leaf area and photosynthetic pigment content in leaves. As a result, photosynthesis levels increased Hafez *et al*., (2014). In this respect, these results are certain with Hafez and Abdelaal (2015), Woldesenbet and Haileyesus (2016) and Ali and Anjum (2017).

Table 4. Photosynthetic pigments contents of leaves (Chlorophyll a, chlorophyll b and carotenoids) as effected by nitrogen fertilizer levels and foliar spraying with promoters and mixture (Fe,Zn,Mn) as well as their interaction during 2020 and 2021 seasons.

Characters Treatments		Chlorophyll a (mg/dm F.W)		Chlorophyll b (mg/dm F.W)		Carotenoids (mg/dm F.W)		total Photosynthetic pigments contents	
Seasons		**2020**	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**
A-Nitrogen fertilizer levels:									
80 kg N/fed.	N1.	4.739	4.017	2.214	1.975	1.172	1.107	8.125	7.104
100 kgN/fed.	N2.	4.812	4.023	2.624	2.245	1.566	1.440	9.003	7.721
120 kgN/fed .	N3.	5.089	4.260	2.655	2.329	1.591	1.459	9.335	8.029
F-test		**	**	**	**	**	**	**	**
L S D at 0.05		0.024	0.019	0.011	0.016	0.121	0.194	0.416	0.392
B- foliar spraying with growth promoter:									
1- spraying with water (control)		4.497	3.806	2.138	1.874	1.146	1.119	7.781	6.799
2-spraying by mixture (Fe+Zn+Mn)		4.679	3.915	2.273	1.973	1.269	1.226	8.221	7.115
3-spraying by Aminototal		4.760	3.981	2.371	2.068	1.377	1.294	8.508	7.353
4-spraying by melagrow		4.837	4.051	2.496	2.174	1.436	1.304	8.769	7.607
5- spraying by mixture (Fe+Zn+Mn)+ Aminototal		4.929	4.203	2.619	2.270	1.548	1.383	9.096	7.950
6- spraying by mixture (Fe+Zn+Mn)+ melagrow		5.203	4.339	2.723	2.374	1.639	1.477	9.565	8.250
7- spraying by mixture (Fe+Zn+Mn)+ Aminototal+ melagrow		5.257	4.408	2.863	2.548	1.687	1.541	9.807	8.254
F-test		**	**	**	**	**	**	**	**
L S D at 0.05		0.088	0.091	0.135	0.192	0.027	0.029	0.143	0.156
C-interaction : A*B		**	*	*	**	*	**	*	**

Thus, foliar applied growth promoters and mixture (Fe, Zn, Mn) increased the maize plants' ability to photosynthesize. (Al-Shaheen and Soh 2016) (Alam *et al*., 2016) and (Baddour *et al*., 2017). Indicating that metabolic disorders are the main limit vector of photosynthesis, as many reports. The chlorophyll content of maize leaves shown in Table (4) indicated that foliar application of Aminototal+ Melagrow+ mixture of (Zn, Fe and Mn) gave the higher mean values. This could be as a result of broader leaves increasing the amount of chlorophyll in leaves during photosynthesis. Both the wide leaves and high chlorophyll content led to increase photosynthetic processes to dry matter accumulation. This study supports(Shafi *et al*., 2012)and (Lihiang and Lumingkewas 2017).The results showing the interaction of N-fertilizer in the absence and presence of growth promoters on chlorophyll concentration content (a, b and total) revealed that using 120 kg N/fed. and (Fe, Zn and Mn) fertilizer in the presence of foliar application of a mixture of amino total + (Fe, Zn and Mn) found the highest average values of the previous parameters at the highest average values of the previous parameters were found using 120kgN/fed. in the presence of spraying with aminototal+ (Fe, Zn and Mn). On the other hand, the lowest value was recorded by spraying with water (control treatment). This results are consistent with (Abo Elzz and Haffez 2019).

Yield and its components

Table (5) shows the impact of growth promoters and nitrogen levels on yield and its components. It's clearly that increasing nitrogen fertilizer levels caused increased length of ear, ear diameter, and weight of ear. However, the highest values of this parameter were found to be highest at the recommended application of 120 kg N/fed. The increase in ear diameter could be attributed to the supply of sufficient nitrogen. These results may be due to the effect of nitrogen fertilizers on plant vigor and photosynthetic assimilate accumulation, and microelements resulting in higher to length of ear, ear diameter, ear weight increased yield attributes such and grain yield under highly fritters (120kg N/fed.) gave the highest increased automatically with increasing nitrogen levels. The increase in plant height due to high N may have been due to better vegetation development and increased mutual shading and beam extension. The application of high concentrations of N increased cell division, cell elongation, nucleation, leaf green color, and therefore chlorophyll content, increased the rate of photosynthesis, as well as increased stem elongation, resulting in increased plant height. Was fanned by (Hafez and Abdelaal 2015) (Woldesenbet and Haileyesus 2016) and (Ali and Anjum 2017) Feeding maize plants to improve growth traits and nutritional efficiency with the help of foliar spraying. These results are agree with (Alam *et al.* 2016) and (Al-Shaheen and Soh 2016). The highest plant height (cm), ear length (cm), ear diameter (cm), and ear weight (g) were obtained from the aminototal + mixture of zinc, iron, and magnesium. Nevertheless, the water spraying treatment (control treatment) yielded the lowest value.

This result may be attributed to the fact that as soil moisture decreases, the mobility of nutrients in the soil increases and the rate at which nutrients enter the zone of absorption for roots decreases. Furthermore, calculations of the collected data revealed that the above content values varied significantly within the irrigation treatment. Comparable outcomes were attained by (Alam *et al*., 2016) and (Baddour *et al*, 2017).

Table 5. Plant height, ear length, ear diameter and ear weight as effected by nitrogen fertilizer levels, foliar spraying with growth promoters, mixture of (Zn, Fe and Mn) on 2020 and 2021seasons.

Characters / Treatments	Plant height (cm)		Ear length (cm)		Ear diameter (cm)		Ear weight (g)	
Seasons	2020	2021	2020	2021	2020	2021	2020	2021
A-Nitrogen fertilizer levels:								
80 kg N/fed. N_1.	293.4	304.7	23.5	24.2	6.48	7.31	304.9	310.4
100 kgN/fed. N_2.	315.6	322.3	26.2	27.4	7.4	7.98	327.5	342.6
120 kgN/fed . N_3.	348.5	353.9	28.6	30.6	8.19	8.64	361.6	379.2
F-test	**	**	**	**	**	**	**	**
L S D at 0.05	1.63	1.74	0.50	0.76	0.03	0.05	0.67	0.77
B- foliar spraying with growth promoter:								
1- spraying with water (control)	303.5	277.5	23.5	23.9	5.63	5.84	316.4	321.0
2-spraying by mixture (Fe+Zn+Mn)	307.8	291.8	24.6	25.3	6.22	6.75	320.5	334.1
3-spraying by Aminototal	310.8	302.5	24.9	26.2	6.72	7.73	323.1	336.6
4-spraying by melagrow	313.7	315.9	25.5	27.3	7.07	7.79	325.8	339.4
5- spraying by mixture (Fe+Zn+Mn)+ Aminototal	317.1	324.9	26.5	28.2	8.02	8.77	328.5	340.1
6- spraying by mixture (Fe+Zn+Mn)+ melagrow	321.3	344.6	27.9	29.5	8.58	8.89	332.4	348.2
7- spraying by mixture (Fe+Zn+Mn)+ Aminototal+ melagrow	330.0	355.6	29.8	31.4	9.26	10.08	372.7	389.1
F-test	**	**	**	**	**	**	*	**
L S D at 0.05	2.55	2.70	0.11	0.17	0.12	0.12	1.01	1.16
C-interaction : A*B	**	*	*	**	*	**	*	**

Concerning the effect of nitrogen fertilization levels up to 120kg N/fed. Andfoliar application by growth promoter and mixture of (Fe, Zn and Mn) on yield and its components in Tables (6 and 7). Data clearly show that increased nitrogen fertilization levels increased 100-grain weight, number kernel/ear, ear grains weight, shelling % total grain yield, Stover yield and nitrogen use efficiency in the absence or presence of growth promoter. However, the greatest average values of these characteristics are discovered to be utilized 120 kgN /fed. from the recommended presence of foliar Aminototal, Melagrow, mixture of (Fe, Zn and Mn). In the absence of nitrogen fertilizer, the values of this parameter increased with increasing levels of nitrogen fertilizer on 100-kernel weight, number of kernels, ear-kernel weight, capsular fruit percentage, Stover yield, and nitrogen use efficiency.

Table 6. 100-kernel weight, kernel number /ear, ear grains weight, shelling % as effected by applying nitrogen fertilizer levels and foliar spraying with growth promoters in 2020 and 2021 seasons.

Characters / Treatments	100-kernel weight (g)		Kernel Number /ear		Ear grains weight (g)		Shelling (%)	
Seasons	2020	2021	2020	2021	2020	2021	2020	2021
A-Nitrogen fertilizer levels:								
80 kg N/fed. N_1	29.3	31.2	535.2	545.4	157.4	167.9	55.95	59.34
100 kgN/fed N_2	31.5	33.4	596.0	612.8	190.8	201.5	59.83	62.25
120 kgN/fed N_3	34.0	36.5	657.1	654.5	220.6	236.5	63.38	71.32
F-test	**	**	**	**	**	**	**	**
L S D at 0.05	0.18	0.16	1.98	2.21	7.29	7.12	0.84	0.61
B- foliar spraying with growth promoter:								
1- spraying with water (control)	29.4	30.5	519.8	522.3	156.2	163.4	50.71	52.13
2-spraying by mixture (Fe+Zn+Mn)	29.5	31.6	549.7	554.3	167.7	174.6	53.73	55.41
3-spraying by Aminototal	30.7	32.6	574.6	584.4	182.7	185.6	58.03	62.31
4-spraying by melagrow	31.5	33.6	605.9	612.5	195.1	211.6	61.4	64.32
5- spraying by mixture (Fe+Zn+Mn) + Aminototal	32.4	34.8	622.3	633.3	200.4	218.2	62.53	68.42
6- spraying by mixture (Fe+Zn+Mn) + melagrow	33.6	35.7	642.6	651.6	206.5	223.5	64.29	71.23
7- spraying by mixture (Fe+Zn+Mn) + Aminototal+ melagrow	34.1	37.1	657.8	671.2	218.6	236.9	67.35	76.25
F-test	**	**	**	**	**	**	**	**
L S D at 0.05	0.17	0.13	4.29	4.72	13.28	13.86	8.22	8.38
C-interaction : A*B	**	*	*	**	*	**	*	**

Table 7. Effects of nitrogen fertilizer levels and foliar spraying with a combination of growth promoters (Fe, Zn, and Mn) on grain yield, stockpile yield, and nitrogen. along with how they interacted in the 2020 and 2021 seasons.

Characters / Treatments	Grain yield (t/fed)		Stover (t/fed)		Nitrogen used	
Seasons	2020	2021	2020	2021	2020	2021
A-Nitrogen fertilizer levels:						
80 kg N/fed N_1.	2.053	2.143	4.328	4.458	25.66	26.79
100 kgN/fed N_2.	2.538	2.625	5.061	5.252	25.38	26.25
120 kgN/fed N_3.	2.681	2.709	5.383	6.928	22.34	22.58
F-test	**	**	**	**	**	**
L S D at 0.05	0.176	0.189	0.113	0.140	0.155	0.197
B- foliar spraying with growth promoter:						
1- spraying with water (control)	2.050	2.163	4.76	4.892	20.17	20.30
2-spraying by mixture (Fe+Zn+Mn)	2.232	2.341	4.824	5.041	22.09	22.14
3-spraying by Aminototal	2.346	2.377	4.867	5.291	23.44	23.30
4-spraying by melagrow	2.430	2.447	4.907	5.371	24.90	26.21
5- spraying by mixture (Fe+Zn+Mn)+ Aminototal	2.561	2.474	4.953	5.687	25.42	27.31
6- spraying by mixture (Fe+Zn+Mn)+ melagrow	2.642	2.789	5.069	6.045	27.11	28.11
7- spraying by mixture (Fe+Zn+Mn)+ Aminototal+ melagrow	2.707	2.851	5.085	6.492	28.10	29.04
F-test	**	**	**	**	**	**
L S D at 0.05	0.204	0.264	0.189	0.193	0.193	0.204
C-interaction : A*B	**	*	*	**	*	**

These results may be due to attributed to the effect of nitrogen on vigor Plant growth and photosynthetic assimilate accumulation produce higher grain number/row and grain/ear and maize plant meristematic activity and increase yield attributes as final grain yield. These results are consistent with both Hafez and Abdelaal (2015), Woldesenbet and Haileyesus (2016) and Ali and Anjum (2017). With a little assistance from Aminototal applied topically, Melagrow and (Zn, Fe and Mn) mixture was applied at 120 kg N/fed. These outcomes resemble the conclusions of Mahdi and Ismail (2015). Our results are similar to those of Shresthaet al., (2018), who also reported that as nitrogen dosage increased grain yield of corn. This increase in corn grain yield at higher nitrogen levels may be attributed give to less competition for nutrients, more plant canopy, higher photosynthetic activity, and accumulation of more biomass in the thicker grain. High concentrations of significant interactions between N-fertilizers in the absence of growth promoters as affected by concentration at which the highest average yield attributes of corn plants were realized.

Nitrogen rates 120Nkg/fed with the foliar application with growth promoters, mixture of (Fe,Zn and Mn)camped nitrogen 80kg N/fed. The maize crop is of interest to farmers because it is the backbone of life for feeding livestock resulting from chopping corn stalks and using them as silage to feed livestock on it in Table (8)..

Table 8. The interaction between nitrogen fertilizer levels and foliar spraying with growth promoters, mixture of (Fe,Zn and Mn) on grain yield ,Stover during 2020 and 2021 seasons

Nitrogen rates	Treatments	Grain yield (t/fed)		Stover (t/fed)	
		2021	2020	2021	2020
80kg N/ fed.	1- spraying with water (control)	1.757	1.986	4.071	4.171
	2-spraying by mixture (Fe+Zn+Mn)	1.857	2.051	4.161	4.291
	3-spraying by Aminototal	1.960	2.104	4.229	4.377
	4-spraying by melagrow	2.030	2.182	4.309	4.406
	5- spraying by mixture (Fe+Zn+Mn)+ Aminototal	2.183	2.201	4.458	4.531
	6- spraying by mixture (Fe+Zn+Mn)+ melagrow	2.251	2.200	4.509	4.607
	7- spraying by mixture (Fe+Zn+Mn)+ Aminototal+ melagrow	2.333	2.270	4.559	4.823
100kg N/ fed.	1- spraying with water (control)	2.060	2.201	4.751	4.651
	2-spraying by mixture (Fe+Zn+Mn)	2.363	2.359	4.891	4.969
	3-spraying by Aminototal	2.487	2.466	4.731	5.031
	4-spraying by melagrow	2.552	2.569	5.062	5.304
	5- spraying by mixture (Fe+Zn+Mn)+ Aminototal	2.688	2.707	5.144	5.444
	6- spraying by mixture (Fe+Zn+Mn)+ melagrow	2.771	2.878	5.381	5.524
	7- spraying by mixture (Fe+Zn+Mn)+ Aminototal+ melagrow	2.845	3.195	5.467	5.841
120kg N/ fed.	1- spraying with water (control)	2.333	2.302	5.464	5.851
	2-spraying by mixture (Fe+Zn+Mn)	2.479	2.518	5.423	5.875
	3-spraying by Aminototal	2.595	2.534	5.641	6.468
	4-spraying by melagrow	2.706	2.59	5.350	6.403
	5- spraying by mixture (Fe+Zn+Mn)+ Aminototal	2.810	2.745	5.257	7.086
	6- spraying by mixture (Fe+Zn+Mn)+ melagrow	2.906	3.077	5.317	8.004
	7- spraying by mixture (Fe+Zn+Mn)+ Aminototal+ melagrow	2.938	3.281	5.229	8.809
L S D at 0.05		1.52	1.09	1.43	1.28

Grain quality

The data in Table (9) indicate that the effect of different nitrogen fertilizer levels with growth promoters on grain quality of the maize. Increasing nitrogen fertilizer from 80 KgN/fed. to 120 KgN/fed. increased both of crude protein, ash% and crude fiber as both total carbohydrate and oil decreased in the both seasons. The improvement in corn grain quality could be explained by the rise in nutrients that are now available. Nitrogen is important in the production of proteins and is present in the root zone, which enhances the plant's supply of nitrogen when fertilizer levels are high. These results are agreement with those obtained by (Hafez and Abdelaal 2015) (Woldesenbet and Haileyesus 2016) and (Ali and Anjum 2017).

Table 9. Total Carbohydrates %, Crude protein%, oil%, ash% and crude fiber%, as effected by nitrogen fertilizer levels and foliar spraying with growth promoters, (Fe,Zn ,Mn) as well as their interaction during 2020 and 2021 seasons.

Characters Treatments	Total carbohydrates %		Crude protein %		Oil %		Ash %		Crude fiber %	
Seasons	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
A-Nitrogen fertilizer levels:										
80 kg N/fed. N1	83.01	82.04	7.94	8.43	5.75	6.22	1.51	1.50	1.81	1.80
100 kgN/fed . N2	82.13	81.09	8.90	9.52	5.52	5.92	1.56	1.57	1.89	1.90
120 kgN/fed. N3	81.65	80.31	9.22	9.85	5.11	5.64	1.78	1.89	2.19	2.33
F-test	**	**	**	**	**	**	**	**	**	**
L S D at 0.05	0.20	0.18	0.80	0.98	0.07	0.06	0.22	0.31	0.03	0.02
B- foliar spraying with growth promoter:										
1- spraying with water (control)	84.65	82.06	7.49	8.45	6.92	7.63	1.24	1.52	1.29	1.73
2-spraying by mixture (Fe+Zn+Mn)	83.18	81.52	7.73	8.72	6.73	7.39	1.30	1.59	1.42	1.92
3-spraying by Aminototal	82.77	81.04	7.97	8.99	6.60	7.22	1.31	1.61	1.51	2.04
4-spraying by melagrow	82.63	80.87	8.39	9.46	6.42	7.00	1.37	1.68	1.68	2.26
5- spraying by mixture (Fe+Zn+Mn)+ Aminototal	82.09	80.24	8.57	9.87	6.24	6.76	1.47	1.81	1.77	2.38
6- spraying by mixture (Fe+Zn+Mn)+ melagrow	81.79	79.89	8.75	9.67	6.02	6.48	1.54	1.89	1.96	2.64
7- spraying by mixture (Fe+Zn+Mn)+ Aminototal+ melagrow	80.72	78.66	8.99	10.14	5.68	6.04	1.64	2.01	2.05	2.76
F-test	**	**	**	**	**	**	**	**	**	**
L S D at 0.05	0.39	0.45	0.18	0.19	0.17	0.17	0.06	0.06	0.11	0.16
C-interaction : A*B	*	*	*	*	*	*	*	*	**	*

Spraying by mixture (Fe + Zn + Mn) + Aminototal- Melagrow gave the highest crude protein, ash% and fiber% in both seasons. These results are consistent with Al-(Shaheen and Soh 2016) (Baddour *et al*., 2017) and (Gheith *et al*. 2022).

The results aligned with the findings of (Al-Shaheen and Soh2016) (Baddour et al. 2017), and (Gheith et al. 2022) regarding the impact of growth promoters.

Economic evaluation

Table 10 shows the economic evaluation values (gross revenue and production cost/feed, net revenue/feed, gross revenue change, and profit/cost ratio) of corn as affected by foliar application of nitrogen fertilizer levels and growth promoter inoculation for the 2020 and 2021 seasons.From an economic point of view, corn with 120 kg nitrogen and foliar application of a mixture of Aminototal, Melagrow, (Zn, Fe, and Mn) was optimized to 15438 and 17580 EGP/fed in the first and second seasons, respectively (not considering Stover yield prices) The price of Stover yield was Compared to other foliar spray treatments, mixing alone or with another compound was affected by different nitrogen fertilizer rates in the study. Corn plant treatments with water and foliar spray as control treatments (control) for other spray treatment inoculations present, compared to 11636 and 10883 EGP/fed. In both seasons The results showed that in the both seasons, the total return and benefit/cost ratios were 26.18% and 42.53% and 3.004 and 3.132 (EGP revenue/EGP cost) higher than to the control treatment, respectively. However, as averages for both seasons, foliar applications of 100 kg N and mixtures of aminototal, melagrow, and (Zn, Fe, Mn) took first and second place. The foliar application mixture was in second place after the addition of a high amount of nitrogen fertilizer. While it can be said that corn plants respond to high levels of nitrogen fertilizer, nitrogen fertilizer rates ranged from 80, 100, and 120 N of nitrogen with amino total, melagrow, and a mixture of (Zn, Fe, Mn) compounds. This means that the above two treatments produced revenue effects (benefit/cost ratio) of approximately the same value. From these results, we can recomended that foliar application of the mixture of Aminototal, melagrow, and (Zn, Fe, Mn) can reduce the recommended rate of nitrogen levels by 80 kg N. Environmental pollution in this concern ,many investigators previously reported that grain inoculation with growth promoter (Aminototal, Melagrow, mixture of (Zn, Fe and Mn) caused an increase in productivity and/or reduced nitrogen fertilizer and production costs of maize as reported by(Morris *et.al*., 2018) and(Yesuf *et al*., 2022) reported.

Table 10 .Economic evaluation of maize as affected by nitrogen levels and growth promoter 2020and 2021 seasons.

Treatments		Grain yield (ton/fed)		Total return of yield(EGP/fed)		Totalcosts ofproduction (EGP/fed)		Net return (EGP/fed)		Changein totalreturn %		Benefitcost ratio (EGP) return/EGP) cost	
seasons		2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
80kg N/fed	T1	1.757	1.986	17343	19604	6135	6535	11208	13069	-	-	2.83	3.00
	T2	1.857	2.051	18330	20245	6735	7135	11595	13110	3.45	3.14	2.72	2.84
	T3	1.960	2.104	19347	20769	6735	7135	12612	13634	12.53	4.32	2.87	2.91
	T4	2.030	2.182	20038	21539	6735	7446	13303	14093	18.69	7.84	2.98	2.89
	T5	2.183	2.201	21548	21726	7335	7546	14213	14180	26.81	8.50	2.94	2.88
	T6	2.250	2.21	22210	21815	7335	7546	14875	14269	32.71	9.18	3.03	2.89
	T7	2.333	2.27	23029	22407	7935	7975	15094	14432	34.67	10.43	2.90	2.81
Mean		2.053	2.143	20265	21154	6992	7288	7288	13866	21.48	7.24	2.31	2.90
100kg N/fed	T1	2.060	2.201	20334	21726	6419	6981	13915	14745	-	-	3.17	3.11
	T2	2.363	2.359	23325	23286	7019	7365	16306	15921	17.18	7.98	3.32	3.16
	T3	2.487	2.466	24549	24342	7019	7365	17530	16977	25.98	15.14	3.50	3.31
	T4	2.552	2.569	25191	25359	7019	7365	18172	17994	30.59	22.03	3.59	3.44
	T5	2.688	2.707	26533	26721	7219	7658	19314	19063	38.80	29.28	3.68	3.49
	T6	2.771	2.879	27353	28419	7219	7658	20134	20761	44.69	40.60	3.79	3.71
	T7	2.846	3.197	28093	31558	7619	8127	20474	23431	47.14	58.91	3.69	3.88
Mean		2.538	2.625	25053	25911	6703	7503	7503	18408	34.1	29.0	2.82	3.74
120kg N/fed	T1	2.333	2.302	23029	22723	6703	7236	16326	15487	-	-	3.44	3.14
	T2	2.479	2.518	24470	24855	7303	7564	17167	17291	5.15	11.65	3.35	3.29
	T3	2.595	2.534	25615	25013	7303	7564	18312	17449	12.16	12.67	3.51	3.31
	T4	2.706	2.59	26711	25566	7303	7564	19408	18002	18.88	16.24	3.66	3.38
	T5	2.810	2.745	27738	27096	7503	7934	20235	19162	23.94	23.73	3.70	3.42
	T6	2.906	3.078	28685	30383	7503	7934	21182	22449	29.74	44.95	3.82	3.83
	T7	2.940	3.281	29021	32387	7703	8245	21318	24142	30.58	55.89	3.77	3.93
Mean		2.681	2.721	26464	26859	7332	7720	7720	19139	20.08	27.52	2.88	2.83

T_1without(control),T_2spraying by mixture (Fe+Zn+Mn),T_3 spraying by Aminototal,T_4 spraying by melagrow,T_5 spraying by mixture (Fe+Zn+Mn)+ Aminototal,T_6spraying by mixture (Fe+Zn+Mn)+ melagrow,T_7 spraying by mixture (Fe+Zn+Mn)+ Aminototal+ melagrow.

CONCLUSION

In based on the study's conclusions, it can be said that high grain productivity and good quality can be achieved by using foliar spraying of a mixture of Amino Total, Melagro, (Fe, Zn, and Mn) to increase nitrogen concentrations is effective in maintaining and improving green and dry matter forage corn yields. Therefore, it is advised that the adding of 120 kg N/fed. or foliar application of Aminototal, Melagrow and mixture of (Fe, Zn and Mn) is the most economical strategy to obtain the highest quality grain corn yield.

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أثير الرش الورقي بمنشطات النمو ومخلوط (الحديد والزنك والمنجنيز)على نمو ومحصول الذرة الشامية تحت معدلات مختلفة من السماد النيتروجيني

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الملخص

تم إجراء تجربه حقلية في محطة البحوث الزراعية في سخا ، كفر الشيخ ، مصر خلال موسمين 2020 و 2021. الهدف الرئيسي من هذه الدراسة هو الوصول الى اعلى انتاجية من هجين الذرة الثلاثي ((360. TWC من خلال اضافة معدلات مختلفة من السماد النيتروجيني والرش الورقي لمعاملات منشطات النمو ومخلوط من(الحديد والزنك والمنجنيز). تم استخدام تصميم قطع منشقة مرة واحدة بأربعة مكررات. يمكن تلخيص اهم النتائج كالاتي: نباتات الذرة الشامية التي اضيف اليها 120كجم نيتروجين /فدان اعطت اعلى القيم لصفات النمو والمحصول ، المحصول او مكوناته، ونسبة البروتين في الحبوب في كلا الموسمين مقارنة بالنباتات التي سمدت بمعدلي (80 و 100 كجم نيتروجين / فدان) بينما النباتات التي رشت بمخاليط منAminototal و Melagrow و Fe + Zn + Mn ادت الى تحسين صفات النمو والمحصول ومكوناته ونسبة البروتين في الحبوب في كلا الموسمين. سجلت النباتات التي رشت بـAminototalأعلى قيم للمحصول و مكوناته في كلا الموسمين. من هذه النتائج يمكن تقليل كمية السماد المعدني الموصي به (120كجم نيتروجين /فدان) الي 83%من هذ الكمية وذلك من خلال اتباع عملية الرش بمخلوط من melagrowوAminototalمع مخلوط (Fe + Zn + Mn) مما ادى الي تقليل تكاليف التسميد النيتروجيني مع الحصول على نفس قيمة العائد /معدل التكاليف المتحصل علية تقريبا عند اضافة كمية السماد النيتروجيني الموصي لتحقيق أقصى قدر من نمو وإنتاجية الذرة تحت الظروف البيئية في منطقة شمال الدلتا مصر.