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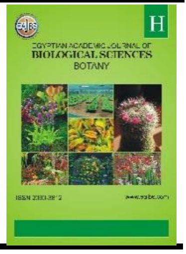

Response of Maize to Organic Fertilization and Some Nano-Micronutrients

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ABSTRACT

To study the response of maize hybrids to organic manure and micronutrients NPs application. In this regard, two field experiments were conducted at the Experimental Farm, Faculty of Agriculture (Saba Basha), Alexandria University during 2018 and 2019 seasons at factorial experiments (two factors) in a split-plot system in three replicates. Where, the main plots allocated by farmyard manure rates (0, 10, 20 m^3), while, the sub-main plots assigned with nano- practices of micronutrients (NPs) (spray water (control), nano- Fe, nano-Zn, nano- Mn, nano- Fe + Mn, nano-Fe + Zn and Fe + Zn + Mn) in both seasons. The results revealed that ear length (cm), number of rows/ear, number of grains/row, number of grains/ear, 100-grains weight (g), grain yield (t/fed), straw yield, biological yield (t/fed), harvest index (%) and grain protein content (%) of maize hybrid were, significantly, affected by organic manure and micronutrients NPs application, where soil application of sheep manure at the rate of 20 m^3/fed with foliar application of combination between nano- Fe + nano- Zn + nano- Mn increased yield and its components of maize hybrid 'TWC1100' under the conditions of Alexandria, Egypt.

INTRODUCTION

Maize is the third most important staple food crop in terms of area and production after wheat and rice in Egypt. Also, in the world, it is one of the important cereal crops in the world after wheat and rice (Gerpacio and Pingali, 2007). Maize is one of the most vital cereal crops in Egypt. The grain of maize is used for human food, animal and poultry feeding, and industrial purposes. The harvested area in Egypt was about 1.58 million fadan (one fadan=4200 m^2) producing up to 5.85 million tons of grains with an average yield of 24.02 ardab/fadan (ardab = 140 kg grains) according to FAO (2018).

Among agronomical practices, the advantages of the utilization of plant residues or farmyard manure (FYM) for improving the physicochemical properties of soil have been partially documented (Rudrappa *et al.*, 2006).The importance of farmyard manure (FYM) on increasing crop yield. FYM is rich in nutrients and can supply all major macronutrients (N, P, K, Ca, Mg, and S) essential for plant development, as well as micronutrients. A small part of its nitrogen is readily available for plant uptake and a large part is released during and after decomposition (Mwahija, 2015). The application of farmyard manure (FYM) significantly increases the organic matter content in the soil. The organic matter helps as a pool of many nutrients and water in the soil, assists to decrease compaction and surface crusting, and increases water infiltration into the soil (Schmidt *et al*., 2011). Also, FYM can increase the availability of nutrients for plant uptake; it improves soil physical properties such as structure and water holding capacity and creates a suitable environment for the activity of soil microorganisms (Mwahija, 2015). Micronutrient deficiencies such as limited zinc (Zn) availability are one of the main problems limiting agricultural productivity, especially in alkaline calcareous soils. Therefore, Zn is often included in macronutrient fertilizers to improve crop quality and productivity (Khalilv *et al*., 2012). The application of compost significantly enhanced grain yield of maize (Gomaa *et al*., 2015)

Nanomaterial could be used in scheming more soluble and diffusible sources of Zn fertilizer for increased plant productivity. The smaller size, higher specific surface area and reactivity of nanoparticles of Zn may affect Zn solubility, diffusion and hence availability to plants. Gangloff *et al*. (2002) reported that an application of zinc sulphate in maize plants increased dry matter and zinc accumulation in leaf and grain. In the dry and semi-dry areas of Iran, the absorption of micronutrients is low due to a high pH level of the soil. Foliar application of micronutrients or leaf feeding is one of the effective methods in resolve plant's nutrition requirements to micronutrients (Wang *et al*., 2010). Manganese (Mn) is an important nutrient that considered a key role in numerous physiological processes, particularly photosynthesis, lignin synthesis, and stress tolerance (Alloway, 2008). Application of nano-Iron (Fe) had a better effect on the seed yield of faba bean than the other Iron forms. Also, the highest Iron concentration (i.e. 6g/L) had the highest grain yield and grain iron content, whereas the highest (467.7 g/m^2) and lowest (352.7 g/m^2) seed yield of faba bean belonged to Nano-Iron 6 g/L and control, respectively. Increasing Nano-Iron concentration had a positive and significant effect on seed yield, protein percent, and chlorophyll content. Moreover, spraying at the vegetation period had the lowest effect on both seed yield and seed protein percent. In conclusion, the highest seed yield was obtained with spraying Nano-Iron 6 g/L during the flowering period (Nadi *et al*., 2013). Using nano-fertilizers as foliar applications at vegetative, flowering or filling stages increased the yield and yield components (Gomaa *et al*., 2015). A soil application of mineral fertilizer + a foliar application of nano- fertilizer improved maize yield (Gomaa *et al*., 2017). The plant height yield and yield components of the wheat crop increased after the application of nano-fertilizer (Kandil and Marie, 2017). Using NPs nutrients increased the yield and its components of wheat as compared with mineral NPK fertilization (Abdelsalam *et al*., 2019), however, Fouda *et al*. (2020) revealed that using nanomaterials increase growth and yield of onion.

Keeping in view the importance of FYM and nano- micronutrient for the crop, the study was conducted to find out the optimum organic manure and micronutrients NPs rates and their interaction for getting a higher yield of maize.

MATERIALS AND METHODS

The present study was carried out at the Experimental Farm, Faculty of Agriculture (Saba Basha), Alexandria University, Egypt, during the two successive summer seasons of 2018 and 2019, to study the response of maize to farmyard manure rates (sheep manure) and foliar application of nano- micronutrients in a split-plot design in three replicates. Whereas, the main plots allocated by farmyard manure rates (0, 10, 20 m^3), while, the sub-main plots assigned with nano- practices of micronutrients (NPs) (Fe, Zn, Mn, Fe + Zn, Fe + Mn, Zn + Mn and Fe + Zn + Mn) in both seasons.

The preceding crop was Egyptian clover (berseem) in the first and the second seasons. Soil texture was clay loam. A surface sample (0-30 cm) was collected before planting to identify some physical and chemical properties of this soil, as shown in Table (1) according to Chapman and Pratt (1978).

Table 1. Some physical and chemical properties of the experimental soil in 2018 and 2019 seasons.

Soil properties		
A) Mechanical analysis:	Season	
	2018	2019
Clay %	41.00	40.00
Sand %	29.00	28.00
Silt %	30.00	32.00
Soil texture	Clay loam soil	
B) Chemical properties		
pH (1: 1)	8.00	8.01
E.C. (dS/m) (1:2)	2.60	2.50
1) Soluble cations (1:2) (cmol/kg soil)		
K^+	1.52	1.44
Ca^{++}	8.40	9.11
Mg^{++}	12.03	12.20
Na^{++}	11.50	10.50
2) Soluble anions (1 : 2) (cmol/kg soil)		
$CO_3^{--} + HCO_3^-$	1.90	1.80
Cl^-	19.4	18.90
SO_4^{--}	12.00	12.5
Calcium carbonate (%)	6.50	6.00
Total nitrogen %	1.00	0.91
Available phosphate (mg/kg)	3.70	3.55
Organic matter (%)	1.41	1.40

The grains of the three ways cross (TWC) hybrids (1100) were obtained from Maize Research Section Agriculture Research Center, Ministry of Agriculture and Land Reclamation. The grains were sown on May 10^{th} and 8^{th} of 2018 and 2019 seasons, respectively.

Phosphorus fertilizer was added at the rate of 200 kg calcium superphosphate (12.5% P_2O_5) just before sowing with soil perpetration. Also, sheep manure as organic manure applied just before sowing with soil perpetration at the rates of (0, 10 and 20 m^3/fed) and its structure showed in Table (2). Mineral nitrogen fertilizer at the rate of (120 kg N/fed) was given at two equal doses in a form of urea (46% N) after thinning before the first irrigation and before the second irrigation.

Each plot size was 12.60 m^2 included 6 ridges each 3 m in length and 0.70 m in width with the distance between hills (25 cm).

Table 2. Composition of sheep manure as farmyard manure (FYM).

Properties	FYM
Moisture (%)	20.00
Organic matter (%)	33.30
Total N (%)	1.90
Total P (%)	1.01
Total K (%)	1.99
p^H	6.70
EC	1.40
Fe (ppm)	17.90
Zn (ppm)	19.00
Mn (ppm)	19.00
Cu (ppm)	12.50

Foliar application of nano Zinc (Zn NPs): was sprayed at the rate of 2 g/L, nano Iron (Fe NPs): was added at the rate of 2 g/L and a mixture of Fe NPs and Zn NPS were added at the rate of (2 g /element/L). All fertilization of nano- micronutrients were added in two times (30 and 45 days after sowing) on maize plants. The structure of nano- fertilizer is shown in Table (3).

Table (3). Structure of nano- Zn and Fe fertilizer as foliar application

Element	Name of compound		
	Super nano- Iron (%)	Super nano- Zn (%)	Super nano- Mn (%)
Iron (nano form)	6 %	-	-
Zinc (nano form)	-	10	-
Mn (nano form)	-	-	10
Amino acids	5 %	5 %	5 %
Organic acids and Cydroforce	25 %	25 %	20

Plant height (cm), grain yield and yield components as ear weight (g), number of grains/row, number of grains/ear,100- grain weight (g), straw yield (t/fed), grain yield (t/fed), biological yield (t/fed), and harvest index (H.I.%) were measured as an average of the 2 middle ridges from mid of each subplot.

Data obtained was exposed to the proper method of statistical analysis of variance as described by Gomez and Gomez (1984). The treatment means were compared using the least significant differences (L.S.D.) test at 5% level probability by using the split model as obtained by CoStat 6.311 (2005) as a statistical program.

RESULTS AND DISCUSSION

The results obtained in Table (4) showed that plant height, ear weight, number of grains/rows, number of grains/ears, 100-grains weight (g), of maize hybrid were, significantly, affected by sheep manure as organic manure (OM) nano- micronutrients fertilizer (NPs) in 2018 and 2019 seasons.

Table 4. Plant attributes of maize as affected by sheep manure, nano- micronutrients fertilization rates and their interaction in both seasons.

Treatment		**Plant height (cm)**		**Ear weight (g)**		**No. of grains/row**		**No. of grains/ear**		**100- grain weight**	
		Seasons									
		2018	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
A) Sheep manure (OM= m^3/fed):											
0		174.33	176.50	103.22	99.79	30.48	29.76	365.71	357.14	35.17	34.84
10 m^3		204.62	208.03	146.26	144.93	38.33	37.57	460.00	450.86	44.30	43.26
20 m^3		224.02	227.91	191.98	189.35	44.05	43.19	528.57	518.29	47.72	46.85
$LSD_{0.05\ (A)}$		4.81	5.46	7.92	6.80	1.78	1.61	21.40	19.28	1.34	1.46
B) Nano- micronutrients fertilization											
Spray water		189.78	194.18	121.28	117.14	32.11	31.11	385.33	373.33	38.58	37.86
Nano- Fe		190.06	193.32	129.21	126.26	36.56	35.44	438.67	425.33	40.82	40.10
Nano- Zn		195.89	198.61	136.02	132.42	39.33	38.56	472.00	426.67	42.18	40.92
Nano- Mn		200.94	204.37	146.38	142.78	34.11	33.22	409.33	398.67	39.92	40.65
Nano- Fe + MN		204.89	206.53	156.86	155.12	38.33	37.22	460.00	446.67	44.66	43.63
Nano- Fe + Zn		206.61	210.47	159.20	158.40	41.78	41.00	501.33	492.00	42.56	41.37
Nano- Fe + Zn + Mn		218.78	221.58	181.11	180.69	41.11	41.33	493.33	496.00	48.08	46.99
$LSD_{0.05\ (B)}$		10.50	9.88	5.92	6.81	3.52	3.57	42.22	42.87	3.61	3.53
Interaction											
A x B		*	*	*	*	*	*	*	*	*	*
Sheep manure	Nano- micronutrients fertilization										
0	Spray water	165.67	169.07	72.10	67.33	24.33	23.33	292.00	280.00	30.33	30.67
	Nano- Fe	162.00	165.60	88.27	86.07	27.33	26.33	328.00	316.00	33.97	33.24
	Nano- Zn	170.83	172.03	85.68	82.08	32.00	31.00	384.00	372.00	34.57	33.48
	Nano- Mn	174.50	178.10	111.32	107.72	26.33	25.33	316.00	304.00	32.17	34.84
	Nano- Fe + MN	180.17	177.90	109.19	106.12	29.33	28.33	352.00	340.00	38.47	37.38
	Nano- Fe + Zn	178.67	182.27	118.66	115.06	36.00	35.67	432.00	428.00	33.03	31.94
	Nano-Fe + Zn + Mn	188.50	190.57	137.33	134.13	38.00	38.33	456.00	460.00	43.67	42.30
10	Spray water	194.83	198.23	126.85	122.79	31.33	31.00	376.00	372.00	39.03	37.94
	Nano- Fe	197.83	200.43	122.85	119.81	37.33	36.33	448.00	436.00	43.27	42.21
	Nano- Zn	196.00	200.23	143.90	140.30	41.67	40.67	500.00	488.00	44.37	43.04
	Nano- Mn	203.67	207.27	137.73	134.13	33.33	32.33	400.00	388.00	42.77	43.14
	Nano- Fe + MN	209.17	212.77	161.53	157.93	39.33	38.33	472.00	460.00	46.43	45.34
	Nano- Fe + Zn	214.33	218.07	155.26	160.06	43.00	42.00	516.00	504.00	45.03	42.97
	Nano-Fe + Zn + Mn	216.50	219.23	175.67	179.47	42.33	42.33	508.00	508.00	49.23	48.14
20	Spray water	208.83	215.23	164.89	161.29	40.67	39.00	488.00	468.00	46.37	44.97
	Nano- Fe	210.33	213.93	176.51	172.91	45.00	43.67	540.00	524.00	45.23	44.84
	Nano- Zn	220.83	223.57	178.47	174.87	44.33	44.00	532.00	528.00	47.60	46.24
	Nano- Mn	224.67	227.73	190.09	186.49	42.66	42.00	512.00	504.00	44.83	43.97
	Nano- Fe + MN	225.33	228.93	199.88	201.31	46.34	45.00	556.00	540.00	49.07	48.17
	Nano- Fe + Zn	226.83	231.07	203.67	200.07	46.33	45.33	556.0	544.00	49.60	49.17
	Nano-Fe + Zn + Mn	251.33	254.93	230.33	228.47	43.00	43.33	516.00	520.00	51.33	50.54
$LSD_{0.05\ (A\ x\ B)}$		18.19	17.12	10.25	11.80	6.09	6.18	73.12	74.25	6.25	6.12

*: significant difference at 0.05 % level of probability.

Table (4) revealed that increasing organic manure (sheep manure) from 0 up to 20 m^3 caused a significant increase of plant attributes of maize such as plant height (cm), ear weight (g), number of grains/row, number of grains/ear, 100-grains weight (g), meanwhile control (0 OM) gave the lowest values of these traits in the first and second seasons. The increase of these traits may be attributed to OM which plays an important role in the maize hybrids and soil properties. These findings are in the same line with those obtained by Rudrappa *et al.* (2006), Schmidt *et al*. (2011); Gomaa *et al*. (2015) they showed that organic manure had a vital role for improving soil properties, increasing essential macronutrients, increasing micronutrients availability, and increasing crop yield.

The same Table, also demonstrated that using nano- micronutrients, significantly, increased plant height, ear weight, number of grains/row, number of grains/ear, and 100-grains weight (g), where the foliar application of a combination of nano micronutrients (nano- Fe + Zn + Mn) recorded the highest mean values of these traits followed by using a combination between (Nano- Fe + nano- Zn), while the lowest one obtained by control treatment. This increase of yield and its components for maize could be due to the role of foliar application of nano- micronutrients on growth, cell divisions, and finally on dry matter accumulation. These results were in the same trend with those reported by Gangloff *et al.* (2002); Wang *et al.* (2010); Alloway (2008); Nadi *et al.* (2013); Gomaa *et al.* (2016); Gomaa *et al.* (2017); Kandil and Marie (2017) they indicated that by using Nano fertilizer increasing yield and its component for many crops.

The interaction between sheep manure and NPs of Fe, Zn and Mn was significant for all of the plant traits under this study. In this respect, the results in Table (4) reported that the highest mean values of all plant attributes recorded with soil application of sheep manure (OM) at the rate of 20 m^3 with a combination of the tree micronutrients of (nano- Fe + nano- Zn + nano Mn) or combination between (nano- Fe + nano Zn), meanwhile, the lowest one obtained with control treatment in the two seasons (Table 4).

Table (5) revealed that grain yield (t/fed), straw yield, biological yield (t/fed), and harvest index (%) of maize hybrid was, significantly, affected by sheep manure as organic manure (OM) nano- micronutrients fertilizer (NPs) in 2018 and 2019 seasons.

The results in Table (5) showed that increasing organic manure (sheep manure) from 0 up to 20 m^3 caused a significant increase of maize yield and its components such as grain yield (t/fed), straw yield, biological yield (t/fed), and harvest index (%), where application OM at the rate of 20 m^3/fed gave the highest means of these traits, meanwhile control (0 OM) gave the lowest values of these traits in the first and second seasons. The increase of these traits may be attributed to OM which plays an important role in the maize hybrids and soil properties. These findings are in the same line with those obtained by Rudrappa *et al.* (2006), Schmidt *et al.* (2011); Gomaa *et al.* (2015) ;Mwahija (2015) they showed that organic manure had a vital role for improving soil properties, increasing essential macronutrients, increasing micronutrients availability, and increasing crop yield.

The results in the Table (5), also demonstrated that using nano- micronutrients, significantly, increased grain yield (t/fed), straw yield, biological yield (t/fed), and harvest index (%), where the foliar application of a combination of nano micronutrients (nano- Fe + Zn + Mn) recorded the highest mean values of these traits followed by using a combination between (Nano- Fe + nano- Zn), while the lowest ones were given under control treatments. These results confirmed by Gangloff *et al.* (2002); Wang *et al.* (2010); Alloway (2008); Nadi *et al.* (2013); Gomaa *et al.* (2016); Gomaa *et al.* (2017); Kandil and Marie (2017) they indicated that by using Nanofertilizer increasing yield and its component for many crops.

The interaction between sheep manure and NPs of Fe, Zn and Mn were significant of the plant traits under this study. In this respect, the results in Table (5) reported that the highest mean values of grain yield (t/fed), straw yield, biological yield (t/fed), and harvest index (%) recorded with soil application of sheep manure (OM) at the rate of 20 m^3 with a combination of the tree micronutrients of (nano- Fe + nano- Zn + nano Mn) or combination between (nano- Fe + nano Zn), meanwhile the lowest on obtained with control treatments during two cropping seasons (Table 5).

Table 5. Plant attributes of maize as affected by sheep manure and nano- micronutrients fertilization rates and their interaction in both seasons.

Treatment		**Grain yield (t/fed)**		**Straw yield (t/fed)**		**Biological yield (t/fed)**		**Harvest index (%)**	
		Seasons							
		2018	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
C) Sheep manure (OM= m^3/fed):									
Control		2.06	1.99	3.25	4.29	5.31	6.28	38.79	31.69
10 m^3		2.93	2.98	4.75	5.98	7.68	8.96	38.15	33.26
20 m^3		3.84	3.79	5.84	7.30	9.68	11.09	39.67	34.17
$LSD_{0.05\ (A)}$		0.16	0.10	0.13	0.22	0.24	0.27	1.27	1.22
A) Nano- micronutrients fertilization									
Spray water		2.43	2.50	3.98	4.85	6.41	7.35	37.91	34.01
Nano- Fe		2.58	2.53	4.07	5.27	6.65	7.8	38.80	32.44
Nano- Zn		2.72	2.65	4.19	5.51	6.91	8.16	39.36	32.48
Nano- Mn		2.93	2.88	4.91	6.16	7.84	9.04	37.37	31.86
Nano- Fe + MN		3.14	3.10	4.70	6.33	7.84	9.43	40.05	32.87
Nano- Fe + Zn		3.18	3.11	5.00	6.38	8.18	9.49	38.88	32.77
Nano- Fe + Zn + Mn		3.62	3.64	5.43	6.51	9.05	10.15	40.00	35.86
$LSD_{0.05\ (B)}$		0.12	0.25	0.39	0.48	0.48	0.63	1.63	1.60
Interaction									
A x B		*	*	*	*	*	*	*	*
Sheep manure	Nano- micronutrients fertilization								
0	Spray water	1.44	1.35	2.16	2.90	3.60	4.25	40.00	31.76
	Nano- Fe	1.77	2.96	2.76	3.73	4.53	6.69	39.07	44.25
	Nano- Zn	1.71	3.19	2.63	3.71	4.34	6.90	39.40	46.23
	Nano- Mn	2.23	1.72	3.70	4.99	5.93	6.71	37.61	25.63
	Nano- Fe + MN	2.18	2.57	3.39	4.51	5.57	7.08	39.14	36.30
	Nano- Fe + Zn	2.37	3.31	3.81	4.69	6.18	8.00	38.35	41.38
	Nano-Fe + Zn + Mn	2.74	1.64	4.29	5.52	7.03	7.16	38.98	22.91
10	Spray water	2.55	2.81	4.80	5.33	7.35	8.14	34.69	34.52
	Nano- Fe	2.46	3.50	4.11	5.34	6.57	8.84	37.44	39.59
	Nano- Zn	2.88	2.15	4.49	5.84	7.37	7.99	39.08	26.91
	Nano- Mn	2.75	2.75	4.40	5.72	7.15	8.47	38.46	32.47
	Nano- Fe + MN	3.23	3.73	5.00	6.50	8.23	10.23	39.25	36.46
	Nano- Fe + Zn	3.11	2.12	4.93	6.41	8.04	8.53	38.68	24.85
	Nano-Fe + Zn + Mn	3.51	3.13	5.52	6.75	9.03	9.88	38.87	31.68
20	Spray water	3.3	4.10	4.99	6.32	8.29	10.42	39.81	39.35
	Nano- Fe	3.53	2.30	5.36	6.75	8.89	9.05	39.71	25.41
	Nano- Zn	3.57	3.08	5.45	6.99	9.02	10.07	39.58	30.59
	Nano- Mn	3.80	4.00	5.98	7.78	9.78	11.78	38.85	33.96
	Nano- Fe + MN	4.00	2.68	6.35	7.98	10.35	10.66	38.65	25.14
	Nano- Fe + Zn	4.07	3.53	6.27	8.03	10.34	11.56	39.36	30.54
	Nano-Fe + Zn + Mn	4.61	4.70	6.47	7.27	11.08	11.97	41.61	39.26
$LSD_{0.05\ (A\ x\ B)}$		0.21	0.44	0.68	0.84	0.83	1.09	2.82	2.58

*: significant difference at 0.05 % level of probability.

Conclusions:

Regarding the observed results, it can be concluded that soil application of sheep manure at the rate of 20 m^3/fed with foliar application of combination between nano- Fe + nano- Zn + nano- Mn increased yield and its components of maize hybrid ‘TWC 1100’ under the conditions of Alexandria, Egypt.

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ARABIC SUMMARY

إستجابة الذرة الشامية للتسميد العضوي وبعض المغذيات الصغرى النانوية

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أجريت تجربتان حقليتان بالمزرعة البحثية بكلية الزارعة سابا باشا بمنطقة أبيس جامعة الإسكندرية خلال الموسمين ٢٠١٨ و٢٠١٩، وذلك لدراسة تأثير معدلات التسميد العضوي والعناصر الصغرى المصنعه بتكنولوجيا النانو على محصول هجين الذرة الشامية (ثلاثي ١١٠٠).

اقامة التجارب حقلية على موسـمين في تمصـميم القطع المنشـقة مرة واحدة في ثلاثة مكررات حيث وزعت المعاملات كما يلي:

أ- القطع الرئيسية: معدلات السماد العضوي (بدون إضافة -١٠ – ٢٠ متر مكعب)

ب- القطع الشـــقية: المغذيات الصـــغرى النانوية: [كنترول ، (نانو حديد) ، (نانو زنك) ، (نانو منجنيز) ، (نانو حديد + نانو زنك) ، (نانو حديد + نانو منجنيز) ، (نانو حديد + نانو زنك + نانو منجنيز] .

على أن يتم الرش الورقي مرتين بعد ٣٠ ، ٤٥ يوم من الزراعة بمعدل ٢ جم من كل عنصر لكل لتر).

ولخصت أهم النتائج فيما يلي:

- أثرت معدلات التسميد العضوي تأثير معنوي على محصول ومكونات الذرة الشامية حيث أن زيادة معدل سماد الغنم العضوي من ٠ الى ٢٠ م^{٣}/فدان حققت زيادة معنوية في متوسطات القيم للصفات التالية: ارتفاع النبات (سم) و وزن الكوز (جم) وعدد الحبوب/صف و عدد الحبوب بالكوز ووزن ١٠٠ حبة (جم) ومحصول الحبوب والقش والمحصول البيولوجي ودليل الحصاد حيث أن المعدل الأعلى من سماد الغنم حقق أعلى محصول ومكوناته لهجين الذرة الشامية، بينما أقل القيم سجلت مع معاملة الكنترول (بدون إضافة سماد عضوي) خلال موسمي الزراعة.
- كما أثر الرش الورقي للعناصر الصغري (منتهية الصغر) المصنع بتكنولوجيا النانو معنوياً على جميع الصفات المذكورة حيث أن التوليفة بين الثلاث عناصر (نانو حديد + نانو زنك + نانو منجنيز) سجلت أعلى متوسطات قيم من صفات المحصول ومكوناته للذرة الشامية متبوعاً بتوليفة (نانو حديد + نانو زنك) في حين أن أقل القيم سجلت بواسطة المعاملة الكنترول (الرش بالماء) خلال موسمى الدراسة.
- كما أن التداخل بين عاملي الدراسة معنوياً في جميع الصفات المدروسة حيث وجد أن المعدل العالي من سماد الغنم ٢٠ م^{٣} مع الرش الورقي بتوليفة الثلاث عناصر (نانو حديد + نانو زنك + نانو منجنير) أو (نانو حديد + نانو زنك) سجل أعلى متوسطات قيم لصفات المحصول ومكوناته في حين أن معاملات الكنترول من عاملى الدراسة سجل أقل قيم لصفات المحصول خلال موسمي الدراسة.

التوصية:

تحت ظروف الدراسة بالأسكندرية في جمهورية مصر العربية ومن النتائج المتحصل عليها اتضح دور السماد العضوي (سماد الغنم) والعناصر الصغري المصنعة بتكنولوجيا النانو (منتهية الصغر) في زيادة المحصول ومكوناته لهجين الذرة الشامية الثلاثي ١١٠٠ خاصة تحت ظروف التربة المتأثرة بالملوحة حيث أن المعدل العالي من سماد الغنم ٢٠ م٣ + الرش الورقي لتوليفة (نانو حديد ونانو زنك ونانو منجنيز بمعدل ٢ جم/لتر) حققت أعلى محصول حبوب للذرة الشامية تحت هذه الظروف والظروف المماثلة.