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Effect of foliar spray by different ascorbic acid and zinc concentration on yield and yield components of maize under heat stress

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ABSTRACT

Two field experiments were conducted at the Experimental Farm, Faculty of Agriculture, Fayoum University at "Dar El-Ramad" Fayoum Governorate, Egypt during the summer growing seasons of 2019 and 2020. The main objective of this study was to determine the effect of sowing dates, ascorbic acid (vitamin C), zinc and their interaction on growth and yield of maize (*Zea mays L.*). The experimental layout was a split- split plot arranged in randomized complete block design with three replications where sowing dates were considered as the main plot, ascorbic acid arranged in the sub plot and the sub-sub plot occupied by zinc foliar application treatments.

Results indicated that sowing dates, ascorbic acid and zinc treatments had a significant impacts on yield and its attributes in the two seasons, except ear number per plant in two seasons and number of grains per row in the second season as well as 100 grain weight in the first season. Foliar spray of ascorbic acid treatments led to significant differences in yield and its attributes i.e. number of ears/plant, ear length, ear dimeter, ear weight, number of row/ear, number of grains/row, ear grain weight, 100-grain weight and grain and biological yield/fed, as well as harvest index. The obtained data reveale also that the effect of zinc treatments on yield and its attributes was significant in the two seasons, except ear number per plant in two seasons and ear length in second season as well as number of grains/row in the first season.

Key Words: Corn, Sowing dates, Vitamin C, Zinc, Growth, Yield.

INTRODUCTION

Maize (*Zea mays* L.) is one of the highest yielding cereal crop in the world, and occupies a key position amongst the most important cereals for human and animal. Moreover, it is one of the most important staple food crops in the most African countries under irrigated conditions of arid and semi - arid regions. Maize grain has high food value and its oil is used for cooking purposes while green fodder is quite rich in protein. As well, it is also called as miracle crop and as queen of cereals. Being a C4 plant, it is very efficient in converting solar energy in to dry matter. Typical kernel composition for the commodity yellow dent corn on a dry matter basis is 71.7% starch, 9.5% protein, 4.3% oil, 1.4% ash, and 2.6% sugar **(Watson, 2003).**

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The cultivated area of maize in world was 193, 733, 586 hect
are with annual production of 1,147,621,938 tones and average productivity equal 5. 92 ton/ha. Total area under cultivation of maize in Egypt reached about 994818 hectare producing 7.45 million ton, thus the average production of maize is 7.489 ton/ hectare **(F A O, 2019).**

Most plants live in environments where they are constantly exposed to one or combinations of various abiotic stresss, such as extreme temperatures, salinity, drought and excessive light, which can severely limit plant growth and development **(Hoque et al., 2016).** Changes in climate particularly temperature have made sowing timing of maize and other summer crops uncertain. Maize is an essential cereal crop which grown in the summer or at late- summer seasons in Egypt **(Hassaan 2018).** High temperature stress may cause severe damage to the proteins, disturb their synthesis, inactivate major enzymes and damage membranes. Ascorbic acid is an organic acid with antioxidant properties. Many oxidants, typically reactive oxygen species such as the hydroxyl radical (formed from hydrogen peroxide), contain an unpaired electron and thus highly reactive and damage plant cells at molecular level. This is due to their interaction with nucleic acid, proteins, and lipids. **(Younis et al. , 2009)**. Ascorbate has been shown to play multiple roles in plant growth, such as in cell division, cell wall expansion, and other developmental processes **(Pignocchi and Foyer, 2003).** Zinc (Zn) application in maize improves photosynthetic rate, chlorophyll synthesis, metabolism of nitrogen and resistance to abiotic and biotic stresses **(Ali et al., 2008; Mousavi, 2011;).** (Zn) is required for plant growth as an activator of several enzymes and is directly involved in the biosynthesis of growth regulators such as auxin, which promotes production of more plant cells and biomass that will be stored in the plant organs especially in seed **(Hussein and Alva 2014)** .

The present study was conducted to evaluate the effects of ascorbic acid (vitamin C), zinc and their interaction on growth and yield of maize hybrid TWC 374 (Agaseed) under heat stress.

MATERIALS AND METHODS

Experimental site and plant materials:

Two field experiments were conducted at Experimental Station Farm, Faculty of Agriculture, Fayoum University, Fayoum Governorate Egypt, during the two summer seasons of 2019 (SI) and 2020 (SII). The representative soil samples (0-30 cm depth) were taken before adding fertilizers and during soil preparation for assessing physical and chemical properties of the experimental soil in (table 1).

Table 1. The Mechanical and chemical analysis of the experimental soil in both growing seasons of 2019 and 2020.

2019				2020			
Mechanical analysis							
Sand, %	**Silt,** %	**Clay,** %	**Texture Class**	**Sand,** %	**Silt,** %	**Clay,** %	**Texture Class**
21.83	35.50	42.67	Clay loam	21.63	35.21	43.16	Clay loam
Chemical analysis							
Organic M %	**CaCo3 %**	**PH**	**EC(ds/m)**	**Organic M %**	**CaCo3 %**	**PH**	**EC(ds/m)**
2.07	7.10	7.26	1.86	1.99	6.97	7.48	1.98

Layout and experimental design:

Cultural practices:

The preceding winter crop was wheat (*Triticum aestivum L.*)in both seasons. N fertilizer was added on the form of ammonium nitrate (33.5% N) at rate of 120 kg N/fed., splitted into two equal doses, one half after thinning (before 1st irrigation, and the other half(before 2nd irrigation), 200 kg calcium super-phosphate; (15.5% P_2O_5) was added during the soil preparation. Potassium fertilizer was applied before sowing (during seedbed preparation) at rate of 50 kg/fed., in the form of potassium sulphate (48% K_2O). The first irrigation was applied at 21 days after sowing then plants were irrigated every 15 days till the dough stage. All other agricultural treatments for maize production were carried out as recommended by the Ministry of Agriculture.

The experiments were laid-out in a split – split plot design, having three replications, the treatments of the experimental factors were allocated as follows: three sowing dates i.e. 1st May, 1st June and 1st July in the main plots, while three foliar spraying with ascorbic acid concentrations i.e. tap water, 150mg/L^{-1} and 300 mg/L^{-1} in the sub – plots, and three zinc treatments i.e. tap water, full dose 1 spray with 400g of ZnSo4.7H2O and 400g of ZnSo4.7H2O divided into 2 sprays in the sub-sub-plots. The net size of plot unit was 3×3.5 m, resulted an area of 10.5 m^2 (1/400 fed). Maize grains (hybrid TWC374) were obtained from Egyptian Agricultural Company for Seed Production Agaseed. Maize hybrid seeds (12kg/fed.) were hand planted into rows 70 cm apart into digs spaced 25 cm. apart, at the rate of 2 grains/dig using dry methods (Afeer) on one side of the ridge.

Data recorded:

Yield and yield component:

At harvest time (after 120 days from planting), samples of five plants were taken at random from each sub–sub plot, the middle two rows from each sub plot were harvested to determine the following characters:

1- Plant height (cm)
2- Ear height (cm)
3- Ear length (cm)
4- Ear diameter (cm)
5- Ear weight (g)
6- No. of row/ear
7- No. grains/row
8- Ear grain weight(g)
9- 100-grain weight
10- Biological yield (ton/fed)
11- Grain yield(ton/fed): it was determined by the weight of grains per kilograms adjusted 15.5 % moisture content of each plot.

All data obtained in both seasons were subjected to analysis using of variance (ANOVA) by GenStat Statistical computer software (edition12). Treatment means were compared using the least significant difference (LSD) test according to (Gomez and Gomez, 1984) at the 5% level of significance.

2. Ear height (cm):

Sowing dates showed significant differences on ear height in both seasons. Mean values of ear height, indicates that early sowing date D_1 produced significantly the highest ear at (101.8 cm) for the 1st season, while D_2 produced significantly the highest ear at (115.9 cm) for the 2nd season. Similar results were obtained by **Kharazmshahi et al (2015)** and **Liaqat et al (2018).**

Increasing the application level of As from control As_0 to As_2 caused significant increases in ear height by about 12.4 % and 11.3 % in the 1st and 2nd seasons, respectively. This positive effect of ascorbic acids on ear height could be attributed to its role as a cofactor for enzymes involved in photosynthesis, hormone biosynthesis, and the regeneration of antioxidants. Similar results were obtained by **Abo-Marzoka *et al* (2016).**

Ear height of Maize was significant affected by levels of Zinc (Zn) in both seasons. Application of the highest level of Zn (Zn_2) resulted in a significant increase in plant height from 93.1 to 98.1 and from 103.1 to 108.1 with increasing percentage of almost 5.0 % at the 1st and 2nd seasons, respectively. Similar resultswere obtained by **Mehasen and Saeed (2006)** who indicated that ear height wassignificantly affected by zinc application as spray .

3. Ear length (cm):

Sowing dates reveals a significant influence on ear length in both seasons. Mean values of ear length, indicates that early sowing date D_1 produced significantly the longest ears (20.90 and 20.70 cm) for the 1st and 2nd seasons, respectively, compared to (15.80 and 15.16 cm) at the sowing date D_3 at the 1st and 2nd seasons, respectively. These results are in agreement with **Dekhane and Dumbre (2017)** who indicated that delay planting reduces cob length.

Results of the main effects of sowing dates, ascorbic acid (vitamin C), zinc treatment and their interactions (first and second orders) on maize crop will be elicited and discussed under following topics:

3.1. Some characters of maize at harvest.

3.2. Yield of maize at harvest.

1.Plant height (cm):

Sowing dates reveals a significant influence on plant height in both seasons. Mean values of plant height, indicates that early sowing date D_1 (1st May) produced significantly the tallest plants (244.5 and 250.8 cm) for the 1st and 2nd seasons, respectively, compared to (235.9 and 250.2 cm) at the sowing date D_2 (1st June) and (235.9 and 234.3 cm) at the sowing date D_3 (1st July) at the 1st and 2nd seasons, respectively. Similar results were obtained by **Buriro et al (2015)**, **Kharazmshahi et al (2015)** and **Imran et al (2016)** who indicated that sowing maize on 15th June gave higher plant height (232 cm) while delayed sowing on 30th June decreased plant height to (185 cm).

Ascorbic Acid (As) affected the plant height significant in both seasons. Increasing the application level of As from control As_0 to As_2 caused significant increases in plant height from 233.5 to 245.5 with increasing percentage of 4.9% and from 239.6 to 251.1 with increasing percentage of 4.6% at the 1st and 2nd seasons, respectively. Similar findings had already been reported by **Osman et al (2014)** who showed that on sunflower increasing the concentration of ascorbic acid (0.6 g L^{-1}) gave significant increases in value of plant height.

Plant height of maize was considerably affected by levels of Zinc (Zn) in both seasons. Application of the highest level of Zn (Zn_2) resulted in a significant increase in plant height from 236.1 to 240.8 and from 242.4 to 247.4 with increasing percentage of almost 2.0 % at the 1st and 2nd seasons, respectively. These results are generally in concordance with those obtained by **Iqbal et al (2016).**

maize ear diameter with delay in sowing date.

Ascorbic Acid (As) revealed significant affect on the ear diameter in both seasons. Maximum ear diameter (4.41and 4.36 cm) were recorded in case of foliar application the highest level of As2 in both seasons, respectively. However, Minimum ear diameter (4.24 and 3.92 cm) was recorded with the control level at the 1st and 2nd seasons, respectively. These results are in accordance with the finding reported by **Qasim et al (2019).**

Zinc (Zn) levels significant affect the ear diameter of maize in both season. Increasing of application levels of Zn caused increasing of ear diameter from 4.21 to 4.43 cm and from 4.03 to 4.28 cm at the 1st and 2nd seasons, respectively. These results are in agreement with the results of **El-Badawy and Mehasen (2011)** who found that the spraying of zinc sulphate generally led to significant increases in ear diameter of maize.

5. Ear weight (g) :

The results showed that sowing dates have a significant effect on ear weight of maize plant in both seasons. Comparison between sowing dates means according to LSD test showed that early sowing date D_1 produced significantly the heaviest ear (310.7 and 154.9 gm) for the 1st and 2nd seasons, respectively. It was clear that the increase in ear weight of maize plant early sowing date may be due to the increases in ear length, ear diameter, No. of kernels/row, No. of kernels/ear , weight of kernels/ear, and 100-grain weight. The results agree with those reported by **Kharazmshahi et al., (2015)** Who indicated that significant difference of sowing date and sweet maize hybrids on cob dry weight.

The ear weight of maize was influenced by Ascorbic Acid (As) application. Results indicated that increasing the application level of As from control As_0 to As_2 caused significant increases in ear weight of maize plant from 225.3 to 324.2 gm and from

Ascorbic Acid (As) affected the ear length significantly in both seasons. Increasing the application level of As from control As_0 to As_2 caused significant increases in ear length from 17.18 to 19.47 cm with increasing percentage of 11.8% and from 16.65 to 20.03 cm with increasing percentage of 16.8 % at the 1st and 2nd seasons, respectively. These results are in agreement with **Dolatabadian et al (2010)** who indicated that maximum length of ear was resulted from foliar application high concentration of ascorbic acid (150 mgl^{-1}).

Ear length of maize was significantly affected by levels of Zinc (Zn) in the 1st season, however, it was non-significant in the 2nd season. Application of the highest level of Zn (Zn_2) resulted in a significant increase in ear length from 17.77 to 18.86 cm and from 18.02 to 18.75 with increasing percentage of almost 5.7 % and 3.4% at the 1st and 2nd seasons, respectively. These results came in the similar point view with those reported by **Xia et al (2019)**.While **Rahouma (2021)** showed that spraying maize plants with zinc concentrations up to 9 ml/ l significantly and gradually increased plant growth, yield and quality, except ear length, where increases did not reach significance level.

4. Ear diameter (cm):

Sowing dates showed significant influence on ear diameter in both seasons. Mean values of ear diameter, indicates that early sowing date D_1 produced significantly the thicker ear diameter than delay sowing date in both seasons. Statistical comparisons among the three investigated sowing dates obviously indicated significant differences in both seasons. The early sowing date gave the biggest ear diameters (4.54 and 4.61 cm) for the 1st and 2nd seasons, respectively, compared to lowest mean values (3.99 and 3.67 cm) at the sowing date D_2 at the 1st and 2nd seasons, respectively. These results are in line with those of **Namakka et al (2008)** who indicated significant increase in and from 119.4 to 133.5 gm at the 1st and 2nd seasons, respectively. Similar results were obtained by **Shahab et al (2016)** who indicated that the application of zinc via soil and foliar i.e. 5.0 and 0.5 kg ha^{-1} respectively significantly increased the maize plant ear weight.

112.3 to 142.8 at the 1st and 2nd seasons, respectively. Similar results were obtained by **Dolatabadian et al (2010)**

The ear weight of Maize was considerably affected by levels of Zinc (Zn) in both seasons. Application of the highest level of Zn (Zn_2) resulted in a significant increase in ear weight per plant from 259.2 to 292.3 gm

Table 2. Effect of sowing dates , ascorbic acid, zinc and their interactions on plant height and some ear characters .

Trait	Plant height (cm)		Ear height (cm)		Ear length (cm)		Ear diameter (cm)		Ear weight (g)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
A- Sowing dates										
D_1	244.5	250.8	101.8	112.8	20.9	20.7	4.5	4.6	310.7	154.9
D_2	235.9	250.2	95.8	115.9	18.3	19.1	4.3	4.2	279.6	136.9
D_3	235.9	234.3	89.2	88.1	15.8	15.2	3.9	3.7	231.1	87.6
B- Ascorbic acid										
As_0	233.5	239.7	89.9	99.3	17.8	17.1	4.3	3.9	225.3	112.3
As_1	237.4	244.6	94.2	105.7	18.4	18.5	4.2	3.9	272.1	124.3
As_2	245.5	251.1	102.7	111.9	18.7	19.4	4.4	3.9	324.2	142.8
C- Zinc (Zn)										
Zn_0	236.1	242.4	93.1	103.1	17.8	18	4.2	4	259.2	119.4
Zn_1	239.5	245.5	95.6	105.7	18.3	18.2	4.4	4.2	270	126.6
Zn_2	240.8	247.4	98.1	108.1	18.9	18.8	4.2	4.3	292.3	133.5
L.S.D at 5%										
A	5.96	3.13	0.91	3.17	2.21	3.17	0.24	0.19	2.60	6.84
B	3.74	1.99	2.18	1.96	Ns	0.96	0.12	0.07	1.59	4.84
C	2.26	1.58	2.08	1.44	0.81	ns	0.13	0.11	1.68	4.56
A×B	Ns	3.46	2.02	3.39	Ns	ns	0.21	0.12	2.75	ns
A×C	3.92	Ns	Ns	Ns	Ns	ns	ns	ns	2.90	ns
B×C	Ns	2.74	Ns	Ns	Ns	ns	ns	ns	2.90	ns
A×B×C	Ns	4.74	Ns	Ns	Ns	ns	ns	ns	5.03	ns

6. Number of rows ear^{-1} :

Ascorbic Acid (As) affected the no. of rows per ear significantly in both seasons. Increasing the application level of As from control As_0 to As_2 caused significant increases in number of ear rows from (14.8 to 15.6 rows) and from (14.3 to 15.4 rows) at the 1st and 2nd seasons, respectively. Similar results were obtained by **Adeem and Ahmed (2017)** showed that spraying ascorbic acid at the concentration of 200 ppm produced maximum average of row number per ear.

Sowing dates resulted in a significant influence on number of rows per ear in both seasons. Mean values of number of rows per ear, indicates that early sowing date (D_1) produced significantly the highest no. of rows per ear (15.6 and 15.8 rows) for the 1st and 2nd seasons, respectively, compared to (15.2 and 14.9 rows) at the sowing date D_3 at the 1st and 2nd seasons, respectively. These results are generally in accordance with those obtained by **Ashik et al (2018)** who observed significant effect of sowing dates on number of rows/ ear.

and 14.7 rows) were stated at the lowest level of Zn0. **Arab et al (2018)** who found the maximum value of number of rows (14.33) with 25 kg fed^{-1} while control which recorded the minimum value, (12.66) with Zinc-sulphate as soil application.

7. Number of grains/row:

obtained by **Adeem and Ahmed (2017)** who noticed that spraying high concentration of ascorbic acid (200 ppm) gave the highest values of No. grains per ear. Zinc (Zn) levels significant affect the number of grains/row of maize in the 2nd season. Increasing of application levels of Zn caused increasing of number of grains per row from 27.5 to 29.7 grains in the 2nd season. However, it showed a non-significant effect at the 1st season. These results were confirmed, by **Potarzycki and Grzebisz (2009)** showed that in comparison to the NPK control treatment, plants fertilized only with 1.0 kg Zn/ha significantly increased the number of kernels per row.

8. Grains weight per ear (gm):

with the results of **Abo-Marzoka et al (2016)** who found foliar application of ascorbic acid with 200 ppm caused significant increases in grains weight per ear**.** Grains weight per ear of Maize was considerably affected by levels of Zinc (Zn) in both seasons. Application of the highest level of Zn (Zn_2) resulted in a significant increase in grains weight per ear from 92.7 to 112.9gm and from 74.2 to 83.2gm at the 1st and 2nd seasons, respectively. These results are in agreement with the results of **Khalid et al (2013)** who reported that grains weight per ear is highly significant when zinc was applied with highest levels of Zn (180 g Zn ha^{-1}).

9. Weight of 100-grains (gm):

the heaviest grains at (26.3gm) for the 2nd season, while D_2 gave the heaviest grains at (31.0gm) for the1st season. Early sown crop had produced bold and plump grains, it may

Maize Ear rows no. were significant affected by levels of Zinc (Zn) in both season. the highest no. of rows/ear (15.3 and 15.2 rows) were noticed at the highest level of Zn (Zn_2) in both seasons 1st and 2nd, respectively. On the other hand the least no. of rows/ear (15.0

Sowing dates showed a significant influence on number of grains/row in the 1st season. The hightes number of grains/row produced from early sowing date D_1 (31.2) followed by D_3 (29.1) without any significant difference between them.On contrary, the 2nd season showed a non-significant effect on number of grains. **Kharazmshi et al (2015)** indicated that the earlier planting of maize plant produced the higher values of number of grains /row.

Ascorbic Acid (As) revealed a significant effect on number of grains in both seasons. The highest application level of As_2 showed the highest number of grains of (30.5 to 30.6). However, the control level resulted in 27.0 and 26.5 grains at the 1st and 2nd seasons, respectively. Similar results were

Sowing dates significant differed in weight of grains per ear in both seasons. Mean values of grains weight per ear, indicates that early sowing date D_1 produced significantly the heaviest of grains weight per ear (120.7 gm and 110.2gm) for the 1st and 2nd seasons. Came to similar trend **Ahmed et al (2011)** and **Buriro et al (2015).** Significant differences were observed among Ascorbic Acid (As) applications in both seasons. Increasing the application level of As from control As_0 to As_2 caused significant increases in grains weight per ear from 85.2 to 119.4gm and from 68.8 to 92.3gm at the 1st and 2nd seasons, respectively. These results are in agreement

Sowing dates reveals a significant influence on weight of 100 grains in only second season. Mean values of weight of 100 grains, indicates that early sowing date D_1 produced control As_0 to As_2 caused significant increases in weight of 100 grains from 29.2 to 30.5 gm and from 24.12 to 25.6 at the 1st and 2nd seasons, respectively. yield components could be attributed to its role as a cofactor for enzymes involved in photosynthesis, hormone biosynthesis, and the regeneration of antioxidants.These results are in agreement with the results of **Abo-Marzoka et al (2016)** who showed that 100-grains weight is highly significant when ascorbic acid was applied with highest levels of ascorbic acid (200 ppm).

be due to the reason that because it had prolong period for growth and development and grain filling period and faster growth of late sown crop has affected the grain size and produced lighter grains. These results are in agreement with the results of **Ahmed et al (2011)** who found that higher thousand grains weight (235 g) was attained by the early sowing (6th June) while lower thousand grains weight (153 g) was recorded from the late sown crop (26th July).

Ascorbic Acid (As) affected the weight of 100 grains significantly in both seasons. Increasing the application level of As from

Table 3. Effect of sowing dates , ascorbic acid, zinc and their interactions on 100-gain weight and some ear characters.

Trait	No. of row/ear ..No..		No of grains/row ..No..		Ear grains eight (g)		100-grain weight (g)	
	2019	2020	2019	2020	2019	2020	2019	2020
A- Sowing dates								
D_1	15.6	15.8	31.2	29.6	120.7	110.2	31.1	26.3
D_2	14.9	14.1	26.4	28.4	97.2	87.8	31	21.3
D_3	15.2	14.9	29.1	27.6	92.8	40.9	28.9	22.4
B- Ascorbic acid								
As_0	14.8	14.3	27	26.5	85.2	68.8	29.2	24.1
As_1	15.2	15.1	29.1	28.6	106.1	77.8	30.4	24.9
As_2	15.6	15.4	30.5	30.6	119.4	92.3	30.5	25.6
C- Zinc (Zn)								
Zn_0	15	14.7	28.1	27.5	92.7	74.2	30.6	24.9
Zn_1	15.4	14.9	29.1	28.5	105	81.6	30.6	25.1
Zn_2	15.3	15.2	29.5	29.7	112.9	83.2	59.5	24.7
L.S.D at 5%								
A								
B	0.23	0.19	2.63	ns	2.37	1.45	Ns	1.08
C	0.15	0.08	2.08	1.86	1.71	1.84	1.10	1.05
A×B	0.19	0.13	ns	1.29	2.27	1.72	0.83	ns
A×C	0.26	0.14	ns	ns	2.97	3.19	Ns	ns
B×C	ns	ns	ns	ns	3.93	2.97	Ns	ns

Weight of 100 grains of Maize was affected by levels of Zinc (Zn) in only first season. Application of the second level of Zn (Zn_1) resulted in increase weight of 100 grains to (30.6 gm and 25.1 gm) at the 1st and 2nd seasons, respectively. These results may be due to the role of zinc as an essential

component for the activity of some dehydrogenases, proteinases and alcohol dehydrogenase. These results are in agreement with the results of **El-Badawy and Mehasen (2011)** who reported that the spraying of zinc sulphate led to significant increase 100-kernel weight of maize.

3.2. Yield of maize at harvest:

1. Biological yield per feddan:

Ascorbic Acid (As) affected the biological yield/fed significantly in both seasons. Increasing the application level of As from control As_0 to As_2 caused significant increases in biological yield/fed from 6.02 to 7.16 ton with increasing percentage of 18.9% and from 5.63 to 7.28 ton with increasing percentage of 29.3 % at the 1st and 2nd seasons, respectively. Similar results were obtained by **Qasim et al (2019).**

Biological yield/fed of maize was significantly affected by levels of Zinc (Zn) in the 1st and 2nd seasons. Application of the second and third levels of Zn resulted in a significant increase in biological yield/fed at the 1st and 2nd seasons, respectively.Many other reports support our obtained results such as **Mohsin et al (2014)** and **Shahab et al (2016).**

2. Grain yield/feddan :

27.15 % and from 2.31ton to 3.06 ton with increasing percentage of 32.9 % at the 1st and 2nd seasons, respectively. These results are in line with those obtained by **Adeem and Ahmed (2017).**

Grain yield/fed. of Maize was considerably affected by levels of Zinc (Zn) in both seasons. Application of the highest level of Zn (Zn_2) resulted in a significant increase in grain yield/fed. from 2.47 ton to 2.73 ton at the second season, while the level of Zn (Zn_1) gave the highest grain yield/fed.at the 1st seasons. This results are in harmony with those obtained by **Mehasen and Saeed (2006)** and **Tabrizi et al (2009)** who found that Foliar application of ZnSO4 increased kernel number by 35% against the kernel number in control. Foliar application of ZnSO4 achieved highest yield of 16,040 kg/ha, 37.52% higher than control.

The results indicate that sowing dates were highly significantly in their biological yield /fed. in both seasons. The highest averages of biological yield/fed, i.e 7.95 ton and 7.08 ton, were obtained from early sowing date in the two successive seasons. These results may be due to the superiority of early sowing date in plant height, grains and strow yield/feddan than other two sowing dates. It might be due to the reason that early sown crop had a longer growth period with long days and short nights to avail more sunlight as compared with the late sown crop. These results are in agreement with the results of **Ahmed et al (2011)** Who reported that the higher biological yield (12010 kg ha-1) was obtained by the earliest sown crop (6th June) while lower biological yield (7533 kg ha-1) was recorded from the late crop sown which was planted on 26th July.

Highly significant differences in averages of grain yield due to Sowing dates effect were obtained in both seasons as shown in Table (23). Results revealed that early sowing date D_1 produced significantly the highest values of grain yield/fed. at (3.54 and 2.92 ton) for the 2019 and 2020 seasons, respectively. While the lowest value of grain yield/fed. were found at third sowing date. The early sown crop has higher grain yield because drop of temperature and unfavorable conditions for growth at late sowing had decreased the grain yield. These results are in harmony with those reported by **Ahmed et al (2011)**.

Ascorbic Acid (As) affected the grain yield/fed. significantly in both seasons. Increasing the application level of As from control As_0 to As_2 caused significant increases in grain yield/fed. from 2.48 ton to 3.15 ton with increasing percentage of

Table 4. Effect of sowing dates, ascorbic acid, zinc and their interactions on Biological and grain yield (ton/fed).

Trait	Biological yield	Grain yield

	(ton/fed) 2019	2020	(ton/fed) 2019	2020
A- Sowing dates				
D_1	7.94	7.07	3.54	2.92
D_2	6.14	6.82	2.51	2.85
D_3	5.64	5.24	2.31	2.05
B- Ascorbic acid				
As_0	6.02	5.63	2.47	2.31
As_1	6.55	6.23	2.74	2.45
As_2	7.16	7.28	3.14	3.06
C- Zinc (Zn)				
Zn_0	5.96	6.21	2.55	2.47
Zn_1	6.88	6.46	2.95	2.61
Zn_2	6.88	6.47	2.87	2.73
L.S.D at 5%				
A	0.003	0.003	0.003	0.002
B	0.002	0.002	0.003	0/002
C	0.002	0.002	0.002	0.002
A×B	0.003	0.003	0.006	0.003
A×C	0.004	0.003	0.004	0.003
B×C	0.004	0.003	0.004	0.003
A×B×C	0.007	0.005	0.007	0.005

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تأثير الرش الورقي بتركيزات مختلفة من حامض الاسكوربيك والزنك على المحصول ومكوناته في الذرة الشامية تحت الأجهاد الحراري

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*** قسم المحاصيل- كلية الزراعة – جامعة الفيوم**

أقيمت تجربة حقلية خلال موسمى 2019 و 2020 بمزرعة كلية الزراعة – جامعة الفيوم – بمنطقة دار الرماد محافظة الفيوم وذلك لدراسة انتاجية الذرة الشامية هجين ثلاثى 374 اجاسيد للإجهادات الحرارية وتقليل تأثير الإجهاد بواسطة مضادات الأكسدة مثل حمض الاسكوربيك والزنك كسماد معدنى .

اشتملت التجربة على العوامل الآتية:

1- مواعيد الزراعة :

1- 1 مايو

2- 1 يونيو

3- 1 يوليو

2- معاملات الاسكوربيك

1- معاملة المقارنة (رش بالماء +مادة ناشرة)

2- حمض الاسكوربيك (الرش ثلاث مرات بعد 40، 50، 60 يوم من الزراعة بتركيز 150 جزء فى المليون وإضافة مادة ناشرة لمحلول الرش).

3- حمض الاسكوربيك (الرش ثلاث مرات بعد 40، 50، 60 يوم من الزراعة بتركيز 300 جزء فى المليون وإضافة مادة ناشرة لمحلول الرش).

ج- معاملات الزنك:

1- معاملة المقارنة (رش بالماء +مادة ناشرة)

2- الرش مرة واحدة بالجرعة كاملة 400جم/فدان من كبريتات الزنك بعد 30 يوم من الزراعة .

3- الرش مرتين حيث يتم تقسيم الجرعة الكاملة 400 جم من كبريتات الزنك على مرتين كل منها 200 جم من كبريتات الزنك /فدان الأولى بعد 30 يوم من الزراعة والثانية بعد 50 يوم من الزراعة .

تم تصميم التجربة فى تصميم قطع منشقة مرتين فى ثلاث مكررات. معاملات مواعيد الزراعة وضعت فى القطع الرئيسية بينما معاملات الاسكوربيك احتلت القطع الفرعية ووضع معاملات الرش بالزنك فى القطع تحت الفرعية.

مساحة القطعة التجريبية 10.5م^2 (3 متر × 3.5متر) عرض الخط 70سم والمسافة بين الجور 25 سم . والمحصول السابق قمح فى كلا الموسمين وقد تم تنفيذ المعاملات الموصى بها.

يمكن تلخيص أهم النتائج فى الآتى:

1- النمو الخضرى عند 65 ، 80 يوم من الزراعة :

1- أظهرت النتائج أن معاملات مواعيد الزراعة لها تأثير معنوى على خصائص النمو . وكان للزراعة المبكرة فى اول مايو افضل النتائج حيث أعطت النبات الاعلى ارتفاعا وأقصى عدد لاوراق النبات واكبر مساحة لاوراق النبات وأثقل وزن جاف للنبات عند عمر 65 ، 80 يوماً من الزراعة فى كلا الموسمين.

2- لمواعيد الزراعة تأثير معنوى على عدد الأيام من الزراعة حتى ظهور 50% من النورات المذكرة . أدت الزراعة المبكرة فى الأول من مايو إلى أطالة فترة النمو الخضرى وتأخير المدة بالأيام من الزراعة حتى ظهور 50% من النورات المذكرة .

3- أظهرت النتائج أن معاملات حامض الاسكوربيك عكست تأثيرات إيجابية على صفات خصائص النمو الخضرى حيث أدى استخدام المعدل الأعلى (300مليجرام /لتر) إلى أفضل القيم من ارتفاع النبات ، وعدد اوراق النبات، ومساحة أوراق النبات، والوزن الجاف للنبات.

4- للرش بالزنك تأيثر معنوى على صفات النمو الخضرى من ارتفاع النبات ، وعدد اوراق النبات، ومساحة أوراق النبات، والوزن الجاف للنبات. استخدام 400جم/الفدان من سلفات الزنك مقسمة على جرعتين متساويتين والرش عند 30، و50 يوم الزراعة اعطى اعلى القيم للصفات المذكورة .

2- المحصول ومكوناته :

1- حققت الزراعة المبكرة فى الأول من مايو تأثيرا معنويا على أقصى ارتفاع للكوز، أقصى طول وقطر للكوز، وأثقل وزن لكيزان النبات وأقصى عدد لصفوف الكوز ولحبوب الصف .

2- أظهرت النتائج وجود تأثير معنوى بين معاملات حامض الاسكوربيك على خصائص الكوز مثل (ارتفاع الكوز، وطول الكوز، وقطر الكوز، ووزن كيزان النبات، وعدد صفوف الكوز، وعدد الحبوب بالسطر). فى كل من الموسمين.

3- ادى استخدام الزنك كسماد معدنى رشا على المجموع الخضرى لتأثير معنوى على صفات الكوز مثل (ارتفاع الكوز، وطول الكوز، وقطر الكوز، ووزن كيزان النبات، وعدد صفوف الكوز، وعدد الحبوب بالسطر). فى كلا الموسمين.

4- أظهرت النتائج أن لمعاملات مواعيد الزراعة تأثير معنوى على محصول الحبوب والمحصول البيولوجى للفدان وكذلك معامل الحصاد . أعطت الزراعة المبكرة فى اول مايو أعلى القيم.

5- وجد أن لاضافة حامض الاسكوربيك تأثير معنوى على محصول الحبوب والمحصول البيولوجى للفدان وكذلك معامل الحصاد . واعطى الرش بالمعدل الاعلى من حامض الاسكوربيك أعلى القيم.

6- كما وجد ان هناك تأثيرا معنويا بين معاملات سلفات الزنك على المحصول ومكوناته وكان المستوي الثالث 400جم/الفدان من سلفات الزنك مقسمة على جرعتين متساويتين والرش عند 30، و50 يوم الزراعة اعطى اعلى القيم للمحصول ومكوناته. .