Variations in the pollinated percentage and antioxidant enzymes of Maize (*Zea mays* L.) depending on the cultivar and nitrogen phosphate fertilization

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Abstract:
The experiment was conducted during the spring and autumn season 2021 in Tal Afar city - Nineveh Governorate/ Iraq. the study included two factors: The first factor was cultivars (Rabee, Masarra), nitrogen and phosphor fertilization(DAP) containing nitrogen at 18% and phosphorous by 23%, (48% P2O5) bylevels 0, 150 and300 kg DAP. ha-1, application time 1/3 of the amount at field emergence, 1/3 when leaf 7 appears, 1/3 at the beginning of male inflorescence. The RCBD was used in the experiment, and the averages of treatments were compared by Duncan's multiple range test. The following traits were studied: the active antioxidant enzymes (SOD), (POX),(CAT), plant yield, actual pollinated percentage and Number of grains in row. The antioxidant enzymes were significantly affected by the spring season, as it increased compared to the autumn season, and the addition of DAP caused a significant decrease in all antioxidant enzymes, and the cultivar Rabea had a significantly higher content of antioxidant enzymes than the Masara cultivar. The highest significant mean of plant yield, No. row grains and actual pollinated percentage was achieved during the autumn season and with the cultivar Rabea and when the third level of DAP was added. While the lowest significant rate was achieved during the spring season when no DAP was added to the cultivar Massara.

[1] The research is from the master thesis of the first researcher.

Introduction:

The increasing global use of maize made it one of the staple foods, where the total production of maize exceeded the production of both wheat and rice crops [5], corn can be produced in Iraq twice in one year, and therefore plants suffer from a lack of nutrients, Specially that corn is considered one of the crops that depleting the soil [14], nitrogen and phosphorous affect the formation and effectiveness of pollen grains, and thus the fertility ratio [9] [16]. Research evidence is that the exposure of plants to abiotic stress affects stress enzymes and thus reduces plants resistance to abiotic stress [1], and among the factors affecting the activity of enzymes is nitrogen [10] and phosphorous [15]. Antioxidant enzymes in different cultivars [2] and growing season [8]. Also, the Number of days for the expulsion of silk and the duration of the anthesis silking interval is affected by the nitrogen and phosphorous content of plants [12] and also varies according to the cultivar [6] and the growing season [3]. The study aims to know the effect of nitrogen and phosphate fertilization, cultivar and cultivation season on the active oxidizing enzymes (Superoxide dismutase, Peroxidase, Catalase), pollinated percentage and yield of maize.

materials and methods:

The experiment was conducted during the spring and autumn season 2021 in Tal Afar City - Nineveh Governorate / Iraq, and the experiment includes two factors: cultivars (Rabee, Masarra), nitrogen and phosphor fertilization DAP (diammonium phosphate) containing nitrogen at 18% and phosphorous at 23%, (48% P2O5) [7] at levels 0, 150 and 300 kg DAP. ha^{-1}, add 1/3 of the amount at field emergence, 1/3 when leaf 7 appears, 1/3 at the beginning of male inflorescence. date of sowing spring planting 3/7/2021 and autumn 7/13/2021. Randomized Complete Block Design was used to application of the experiment, the experimental unit contains 4 rows with a length of (6 m) with a distance of 0.75 meters between one plant and another and the distance between one plant and another 20 cm, and with three replicates, the treatments are distributed to the experimental units randomly and the experimental units are separated from each other by a distance of 1.5 m and between the replicates 2 m to ensure that the added fertilizers are not transferred between the experimental units. Duncan's multi-range test is used to compare the means for each source of significant variance.

Effective SOD (Superoxide dismutase) was measured as reported by [3], effective POX (peroxide reductases) as reported by Quesada and Macheix [11] and effective CAT (Catalase) as reported by [13] in the Leaf under the ear. The actual pollinated percentage was measured using the following equation:

$$Actual\ pollinated\ percentage = \frac{Number\ of\ grain\ in\ ear}{Number\ of\ ovaries\ in\ ear} * 100$$

The number of ovaries during the fertilization period is calculated from 10 plants per experimental unit. These plants are not included in the calculation of the yield because they are damaged, but they are used in calculating the actual pollinated percentage. The individual plant yield was calculated as an average of ten plants.

Tab.1: Average temperature and relative humidity.

Mean	2021							
	4	5	6	7	8	9	10	11
Temperature	33	37	42	44	43	38	34	26
relative humidity	62.4	41.2	31.5	24.7	27.8	32.5	38.1	60.8

Tab.2: Soil chemical and physical analysis.

Season	PH	EC	N%	P(PPM)	K(PPM)	Organic Matter%	soil texture
Spring	8.4	0.80	0.054	5.434	88	3.20	sandy clay loam
Autumn	8.3	1.0	0.070	4.862	15	5.43	

Results and discussion:

antioxidant enzymes:

the date in (Tab.3) pointed that the antioxidant enzymes rise significantly in the spring compared to the autumn season This may be due to the difference in air temperature and relative humidity (Tab.1), and thus plants are exposed to more abiotic stress during the spring season. The content of the antioxidant enzymes in Rabea cultivar increased significantly compared with the cultivar Massarra, which may be due to the fact that the cultivar Massarra is more resistant to abiotic stress, and this explains its excelled in plant yield of seeds, actual pollinated percentage and No. row seeds (Tab.4). We also find that DAP fertilizer led to a significant decrease in antioxidant enzymes, especially since the soil content of nitrogen and phosphorous is low (Tab.2). Therefore, compensating for the deficiency leads to the removal of abiotic stress resulting from the lack of nutrients. There was no significant difference between the second and third levels of DAP fertilization for all antioxidant enzymes. The interaction between the spring season and the absence of DAP fertilizer and the cultivar Rabee gave the highest significant value of antioxidant enzymes, amounting to 92 of SOD, 63.4 POX and 6.1 CAT, The lowest significant rate was in the interaction between the autumn season and the third fertilization level with the cultivar Rabea, and the concentrations of antioxidant enzymes were 66.8 SOD, 41.6 POX and 4.2 cat, and it did not differ significantly from the interaction between the autumn season and the second fertilization level with the cultivar Rabih.

grain yield (gm.plant^{-1}): The grain yield of the autumn season significantly excelled 131.1 gm compared to the spring season of 117.4 gm (Tab. 4). This may be due to the difference in temperature and relative humidity (Tab. 1) and their impact on the occurrence of abiotic stress. The cultivar Massarra achieved the highest significant rate (127.3 gm) compared with the cultivar Rabea (121.3 gm) and this is due to genetic differences between the two cultivars. There was no significant difference with the second level, The best yield was achieved in the autumn season when the third level of DAP fertilizer was added to the cultivar Massarah, and it reached 144.7 g, while the lowest significant rate was in the spring season when the cultivar was not treated with DAP, and it amounted to 108.6. This is due to the difference in the actual fertilization percentage and the No. row grains in ear.

Actual pollinated Percentage: The pollinated Percentage for the autumn season was 99.2% compared to 94.0% for the spring season (Tab.4)This may be due to the effect of temperature and relative humidity (Tab.1) on pollen grains and stigmas, and consequently on the occurrence of the process of pollination of the ovaries. The cultivar Rabea achieved the highest significant percentage of actual pollinated (97%) compared with the cultivar Rabea (96.2%). This is due to genetic differences between the two varieties and their interaction with environmental conditions. Fertilization with DAP led to a significant increase in plant yield, where the third level achieved the highest significant rate (98.1%), and there was no significant difference with the second level (98%), The ovaries were fertilized by 100% in the autumn season for both cultivars when adding DAP fertilizer at the second and third levels, but in the spring season there was a decrease in ovaries fertilization, and without DAP fertilizer to the cultivar Massara gave the lowest significant rate (88.7%).

Tab.3: Effect of DAP fertilizer and cultivar on antioxidant enzymes.

Treatment		SOD activity (unit.mg protein^{-1})	POX activity (unit.mg protein^{-1})	CAT activity (µmol H_2O_2 reduced gFW^{-1})
Season				
-spring		80.2 a	48.6 a	4.8 a
-Autumn		69.8 b	44.9 b	4.4 b
Cultivars				
-Masruh		73.3 b	44.5 b	4.4 b
-Rabie		76.7 a	49.0 a	4.8 a
DAP				
-1		82.4 a	57.6 a	5.3 a
-2		71.3 b	41.5 b	4.3 b
-3		70.7 b	41.3 b	4.3 b
Interaction				
- Season spring				
Masruh	1	83.6 b	57.3 b	5.3 b
Masruh	2	75.8 e	40.8 g	4.2 fg
Masruh	3	75.9 e	40.7 g	4.2 fg
Rabie	1	92.0 a	63.4 a	6.1 a
Rabie	2	77.4 d	44.8 d	4.5 e
Rabie	3	76.7 d	44.7 d	4.5 e
- Season Autumn				
Masruh	1	76.4 de	51.7 c	4.7 d
Masruh	2	64.6 g	38.5 h	4.1 g
Masruh	3	63.3 g	38.0 h	4.1 g
Rabie	1	80.1 c	57.7 b	5.1 c
Rabie	2	67.4 f	41.8 f	4.3 f
Rabie	3	66.8 f	41.6 f	4.2 fg

number of row grain per ear: The autumn season achieved the highest significant average of 29.2 grains, and this is due to the high percentage of actual pollinated (Tab.4), the low temperature and high relative humidity during flowering (Tab.1), while the spring season reached 23.2 grains of the row. There were no significant differences between the cultivars in the number of grains in row, despite the difference in the actual pollinated percentage, due to the difference in the No. ovaries that were fertilized and developed to reach the stage of mature seeds. DAP fertilizer achieved a significant increase in comparison with no addition, as it gave the third and second level 27, 26.8 grains, respectively, in without DAP it achieved 25.7 grains. This is due to the role of DAP fertilizer in increasing the actual pollinated percentage (Tab.4).The highest significant number of grains in row resulted from treating the cultivar Masara with the third level of DAP during the autumn season (30.3 grains) and it did not differ significantly from the treatment of the cultivar Masara with the third level of DAP in the autumn season as well as with the spring cultivar, and this is due to the high percentage of Actual pollinated that has reached 100%, because of the decrease in actual fertilization in spring, this led to a decrease in the number of row grains for ear, where the lowest significant rate of grains row reached 21.7 when the cultivar Rabea was not treated with DAP, and it did not differ significantly with the cultivar Massarah to which DAP was added, and it amounted to 21.8.

Tab.4: Effect of DAP fertilizer and cultivar, on plant yield and Actual pollinated percentage for spring and autumn seasons .

Treatment		Grain(gm). Plant^{-1}	Actual pollinated percentage	No. Grain in Row
Season				
-spring		117.4 b	94.0 b	23.2 b
-Autumn		131.1 a	99.3 a	29.2 a
Cultivars				
-Masruh		127.3 a	96.2 b	26.6 a
-Rabie		121.3 b	97.0 a	25.8 a
DAP				
-1		114.9 b	94.3 b	25.7 b
-2		128.0 b	98.0 a	26.8 a
-3		131.4 a	98.1 a	27.0 a
Interaction				
- Season spring				
Masruh	1	110.8 j	88.7 f	21.8 e
Masruh	2	120.1 g	95.5 d	24.2 d
Masruh	3	124.4 e	95.7 cd	24.6 d
Rabie	1	108.6 k	91.0 e	21.7 e
Rabie	2	118.5 h	96.4 c	23.5 d
Rabie	3	122.1 f	96.5 c	23.6 d
- Season Autumn				
Masruh	1	120.7 g	97.5 b	28.7 b
Masruh	2	143.1 b	100 a	30.1 a
Masruh	3	144.7 a	100 a	30.3 a
Rabie	1	113.7 i	98 b	27.5 c
Rabie	2	130.1 d	100 a	29.3 ab
Rabie	3	134.5 c	100 a	29.3 ab

Conclusions:

The autumn season contributed to an increase in the Number of fertilized ovaries, and thus achieved the highest percentage of actual pollinated, and consequently, the yield of plant grains and the No. Grain in Row increased. The decrease in yield, actual fertilization, and the number of grains in row during the spring season is due to the increase in antioxidant enzymes and plants' exposure to abiotic stress. Fertilization with DAP gave a significant increase in plant yield, number of grains in row and actual fertilization rate as a result of neutralizing the harmful effect of nutrient deficiency and this is what we notice from the effect of DAP fertilizer on antioxidant enzymes.

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