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Impact of some growth regulators, antioxidants and micro-nutrients applied by different methods on productivity and quality of bread wheat

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ABSTRACT

Aim: The main objective of this study was to estimate the role of application procedures with indole-3-acetic acid (IAA), AsA, Folifert powder and their mixture on productivity and quality of bread wheat Misr 1 cultivar grains**.**

Materials and Methods: The factors under study were arranged in a strip-plot design including four replicates. The vertical plots were assigned to three different methods of treatment, i.e., seeds soaking, foliar spraying and seeds soaking combined with foliar spraying. The horizontal plots were assigned to seven materials without as control; treated with distilled water; ascorbic acid (AsA); commercial Folifert powder; AsA and indole-3-acetic acid (IAA);AsA and Folifert powder; IAA and Folifert powder.

Results: Results presented that seeds presoaking combined with foliar application was the best application procedures and produced highest averages of studied characters in both seasons. The combination of IAA (0.05 g/L) plus Folifert powder (3.75 g/L) was the best treatment and the maximum values of all studied characters. The mixture of AsA(0.1 g/L) plus Folifert powder (3.75 g/L)came at the second rank after above mentioned treatment.

Conclusion: It was concluded that soaking wheat seeds for 12 hours in a mixture solution of IAA0.1 g/L) plus Folifert powder (3.75 g/L) or the mixture of AsA plus Folifert powder at the same rates then directly sowing and followed by twice foliar application the first dose at 45 days from sowing and the second dose after two weeks from the first the productivity of bread wheat Misr 1 cultivar under the environmental conditions.

Keywords: Wheat, Soaking, Foliar spraying, Ascorbic acid (AsA), Indole-3-acetic acid (IAA), micronutrients.

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Introduction

Triticum aestivum vulgare L. (bread wheat) is used as a central ingredient in daily diets in Egypt. It easily processed into several types of food as bread, macaroni and sweets and straws for livestock feed. Egypt, one of the largest importers of wheat, efforts must be combined to upgrade local and close big gap between consumption and production. Wheat productivity can be achieved by rising cultivated area, using best of agronomic techniques, using promising cultivars and choose best methods to apply on seeds or wheat plants which can be used antioxidants like ascorbic acid, growth regulators such as indole-3-acetic acid and micronutrients such as Zn, Fe, Mn, Cu, B and Mo (Seadh et al., 2017).

The average of total cultivated area reached 3.35 million feddan with total production 9.00 million tons in Egypt. While in the world it reached about 513.84 million fed with total production 765.769 million tons (FAO, 2022). One of the most important for increase the productivity of wheat plants is ascorbic acid (AsA), which relates to longevity in plants and reduces the effect of oxidative stress. Thus, the endogenous level of AsA is implied to be central to the regulation of developmental senescence (Gadalla, 2009)**.** Moreover, indole-3-acetic acid (IAA) acts akey role on regulation plant growth. It involved in vascular tissue improvement, cell elongation, apical dominance, helps in adaptive reactions of the plant to several of stress factors and protein formation (Hanaa and Safaa, 2019).

The Egyptian soils suffer from the shortage of available rate of microelements as Boron (B)

Copper (Cu) Iron (Fe) Manganese (Mn) Molybdenum (Mo) Zinc (Zn). Micronutrients play a central role in biochemical, physiological, chemical, metabolic, geochemical, cell functions and enzymatic operations. Zinc (Zn) involved in N metabolism of the plant, amino acids in addition amides are accumulated and plants protein formation (Mahmoud et al., 2014). Iron (Fe) acts a main role in chlorophyll development, an ingredient of sure enzymes and proteins, energy transfer, and take part in nitrogen fixation. Manganese (Mn) is one of important micro-elements and take part in photolysis of water at photo system II that offers electrons needed for the onset of electron transport system meaningfully demonstrated the useful role of manganese throughout oxygen evolution step of photosynthesis (Tripathi et al., 2015). Boron (B) has a positive rolein cell wall formation, flowering, RNA metabolism, membrane integrity, cell wall syntheses, carbohydrate metabolism,may assist in the translocation of sugar, root growth, pollination also respiration. Copper (Cu) has auseful effect on decreasing respiration in pollen capability and its deficiency rises infertility of spikelet in a lot of unfilled grains (Aliet al., 2016).

So, this study was focused to decide the main roles of application methods with antioxidant, growth regulator and micro-elements as well as their mixture on the productivity and grains quality of bread wheat Misr 1 cultivar under conditions of Dakahlia Governorate, Egypt.

Materials and Methods

Two field experiments were conducted during 2018/2019 and 2019/2020 seasons at Experimental Farm, Faculty of Agriculture, Mansoura University, Egypt, to study the effect of application methods, antioxidant, growth regulator and micro elements as well as their mixture on growth, yield and its attributes and grain quality of bread wheat Misr 1 cultivar. The experiments were carried out in a strip-plot design with four replicates. The vertical plots were assigned to application methods with antioxidant, growth regulator and micro elements as well as their mixture i.e. (seeds soaking, foliar spraying and seeds soaking combined with foliar spraying.

In soaking application method, seeds of wheat were soaked for 12 hours and then directly sowing. While, in foliar spraying method, wheat plants were sprayed with studied treatments by hand sprayer (for experimental plots) until saturation point two times after 45 and 60 days from sowing. The foliar solution volume was 200 liter/fed. While the horizontal plots were allocated to treatments with (without as control; distilled water; solution of ascorbic acid (AsA) at the rate of 0.1 g/L; Solution of Folifert powder as a source of Zn, Fe, Mn, Cu, B and Mo at the rate of 3.75 g/L; solution of AsA and indole-3-acetic acid (IAA) at the rate of 0.1 g/L + 0.05 g/L, respectively; solution of AsA and Folifert powder at the rate of 0.1 g/L + 3.75 g/L, respectively; treated with IAA and Folifert powder at the rate of 0.05 g/L + 3.75g/L, respectively)

The soil was characterized as a clayey soil with an electrical conductivity (EC) of 1.75 dS/m and a pH of 7.80.Each experimental unit was (3×3.5 m) giving 10.5 m^2,1/400 feddan (one feddan= 4200 m^2). Calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation at the rate of 150 kg/fed. Nitrogen fertilizer in the form of ammonium nitrate (33.5 % N) was applied at the rate of 80 kg N/fed as broadcasting in two equal doses prior with 1st and 2ndirrigations. Potassium fertilizer in the form of potassium sulphate (48 % K_2O) at the rate of 50 kg/fed was applied broadcasting with the 1st irrigation. Wheat seeds at the rate of 75 kg/fed were sown by using broadcasting Afir method on 25th and 23rd November in the first and second seasons, respectively.

Ten plants were randomly choice from each sub–plot after 120 days from sowing to estimate the following characters, number of days to heading (days); total chlorophylls (SPAD) it was estimated by using SPAD-502 (Minolta Co. Ltd., Osaka, Japan; flag leaf area (cm^2)it was calculated by using the following formula according to Gardner et al. (1985): a = L × W × 0.75 Where; a= Flag leaf area, L= Length of flag leaf and W= Maximum width of flag leaf; plant height (cm).

At harvesting, one square meter was randomly selected from each sub– plot to estimate, number of spikes/m^2; spike length (cm); number of spikelets/spike; number of grains/spike; grains weight/spike (g); 1000–grain weight (g); grain yield (ardab/fed): it was calculated by harvesting whole plants in each sub-plot and air dried, then threshed and the grains at 13% moisture were weighted in kg and converted to ardab per feddan (one ardab = 150 kg); straw yield (heml/fed): the straw resulted

from previous sample was weighted in kg/plot, and then it was converted to heml per feddan (one heml= 250 kg/fed).

Grains chemicals components detected included crude protein percentage in grains (%) according to A.O.A.C. (2007) and total carbohydrates percentage in grains (%) according to Sadasivam and Manickam (1996).

According to strip plot design, all data were statistically analyzed (Gomez and Gomez, 1984) by using MSTAT-C Computer software package. Least significant difference (LSD) method was used to test the differences between treatment means as described by Snedecor and Cochran (1980).

Results and Discussion

Effect of application methods: Application contained three different methods; seed soaking, foliar spraying and seed soaking combined with foliar spraying. It was clearly seen that, soaking seeds combined with foliar spray was the best method on growth characters *i.e.* number of days to heading (days), total chlorophylls (SPAD), flag leaf area (cm^2) and plant height (cm) and yield and its components *i.e.* number of spikes/m^2, length of spike (cm), number of grains per spike and grains weight/spike (g) one-thousand grains weight (g), grain yield (ardab/fed), straw yield (ton/fed) and grains quality *i.e.* crude protein percentage in grains (%) and total carbohydrates percentage in grains (%). It was followed by foliar spray method and finally, soaking wheat seeds came last(Tables1, 2, 3and 4).These results may back to physiological performance of plants and several benefits of foliar application method as quick and effective reaction to plant needs Yassen *et al.* (2010). These results are in partial compatible with those recorded by Ali and Elbordiny (2009).

Table 1. Means number of days to heading, total chlorophylls, flag leaf area and plant height as affected by application methods and treatment with antioxidant, growth regulator, micro-nutrients and their mixture as well as their interaction over both seasons.

Characters / Treatments	Number of days to heading (days)	Total chlorophylls (SPAD)	Flag leaf area (cm^2)	**Plant height (cm)**
A- Application methods:				
Soaking	88.21	20.67	37.65	125.7
Foliar	91.17	23.76	38.91	127.5
Soaking + Foliar	93.14	24.54	43.72	133.4
LSD at 5 %	0.94	2.02	3.99	3.1
B- Treatment with some materials:				
Without	87.16	19.05	35.02	115.3
Distilled water	88.50	20.70	36.97	123.3
Ascorbic Acid (AsA)	89.75	22.05	38.51	128.6
Micronutrients	90.75	23.03	39.58	130.9
AsA + IAA	91.25	24.25	41.39	132.6
AsA + Micronutrients	93.75	25.58	42.94	134.4
IAA + Micronutrients	94.75	26.26	46.25	137.1
LSD at 5 %	0.73	3.35	1.57	1.9
C- Interaction (F. test):	*	*	*	*

Effect of application treatment with some materials: With reference to the effect of ascorbic acid (AsA), indole-3-acetic acid (IAA) and commercial Folifert powder on growth characters, yield and its components and grains quality characters, It could be noticed that , the combination of IAA and micronutrients powder at the rate of 0.05 g/L + 3.75 g/L, respectively was the best treatment and the maximum values of growth characters *i.e.* number of days to heading (days), total

chlorophylls (spad), flag leaf area (cm^2) and plant height (cm) and yield and its components *i.e.* number of spikes/m^2, length of spike (cm), number of grains per spike and grains weight/spike (g) one-thousand grains weight (g), grain yield (ardab/fed), straw yield (ton/fed) and grains quality *i.e.* crude protein percentage in grains (%) and total carbohydrates percentage in grains (%) as shown in(Tables1, 2, 3 and 4). The combination AsA + micronutrients at the rate of 0.1 g/L + 3.75 g/L, respectively came the second rank after aforementioned treatment. While the minimum values were obtained from control treatment (without-treatment). The favorable effect of treating wheat with ascorbic acid (AsA), indole-3-acetic acid (IAA) and microelements on yield and quality may be due to the role of microelements positively affected on the leaves area of wheat microelements might has plays a vital function in division of cells in leaves and B act a main role in assimilates translocation Saleem *et al.* (2020). The impact of AsA may be back to the necessary role, which reflected on a better growth and spike length. The antioxidant productions against oxidative stress, it acts a key function in photosynthesis (Mohamed and Abo-Marzoka, 2017). These results resemble those reported by Seadh *et al.* (2009), Bameri *et al.* (2012), Fawy and Attia (2013), El-Metwally *et al.* (2015) and Seadh *et al.* (2015).

Table 2. Means number of spikes, spike length, number of spikelets/spike and number of grains/spike as affected by application methods and antioxidant, growth regulator, micro-nutrients and their mixture as well as their interaction over both seasons.

Characters / Treatments	Number of spikes /m^2	Spike length (cm)	Number of spikelets /spike	Number of grains/ spike
A- Application methods:				
Soaking	196.7	10.72	19.88	56.77
Foliar	216.0	10.83	20.51	57.07
Soaking + Foliar	232.1	11.12	20.30	58.08
LSD at 5 %	2.0	0.18	NS	NS
B- Treatment with some materials:				
Without	175.5	10.30	18.45	50.82
Distilled water	183.4	10.42	19.21	53.96
Ascorbic Acid (AsA)	222.4	10.65	19.69	56.21
Micronutrients	225.1	10.80	20.29	58.16
AsA + IAA	228.5	11.00	20.82	59.30
AsA + Micronutrients	232.0	11.22	21.01	60.46
IAA + Micronutrients	237.6	11.81	22.15	62.22
LSD at 5 %	1.9	0.16	0.46	2.81
C- Interaction (F. test):	*	*	NS	NS

Table 3. Means of grains weight/spike, 1000–grain weight, grain and straw yields/fed of as affected by application methods and antioxidant, growth regulator, micro-nutrients and their mixture as well as their interaction over both seasons.

Characters / Treatments	Grains weight/spike (g)	1000–grain weight (g)	Grain yield (ardab/fed)	Straw yield (ton/fed)
A- Application methods:				
Soaking	3.28	59.43	15.80	3.014
Foliar	3.36	61.84	18.34	3.269
Soaking + Foliar	3.50	65.71	19.96	3.776
LSD at 5 %	NS	0.54	0.13	0.234
B- Treatment with some materials:				
Without	2.53	52.05	14.71	2.746
Distilled water	3.13	58.44	14.99	2.984
Ascorbic Acid (AsA)	3.36	63.10	17.85	3.238
Micronutrients	3.52	64.84	18.30	3.408
AsA + IAA	3.60	65.24	19.16	3.581
AsA + Micronutrients	3.66	66.10	20.24	3.662
IAA + Micronutrients	3.86	66.53	20.97	3.852
LSD at 5 %	0.16	0.83	0.14	0.170
C- Interaction (F. test):	*	*	*	*

Table 4. Means of crude protein and total carbohydrates percentage as affected by application methods antioxidant, growth regulator, micro-nutrients and their mixtureas well as their interaction over both seasons.

Characters / Treatments	Crude protein (%)	Total carbohydrates (%)
A- Application methods:		
Soaking	11.36	30.96
Foliar	12.16	37.52
Soaking + Foliar	12.90	38.25
LSD at 5 %	0.03	0.05
B- Treatment with some materials:		
Without	10.67	29.67
Distilled water	10.78	33.25
Ascorbic Acid (AsA)	11.43	35.54
Micronutrients	12.04	35.72
AsA + IAA	12.81	36.42
AsA + Micronutrients	13.36	38.11
IAA + Micronutrients	13.91	40.31
LSD at 5 %	0.19	0.10
C- Interaction (F. test):	*	*

Effect of interaction:

About the effect of interaction, there are a significant influence of the interaction between application methods and treatments on most of studied characters over both seasons as showed in (Tables 1, 2, 3 and 4). The application method of seeds soaking combined with foliar spraying with IAA + micronutrients were the best treatment and produced the maximum averages of grain and straw yield over both seasons as illustrated (Fig 1 and 2). The second-best interaction was the application of AsA + micronutrients treatment. On the other hand, the minimum values were obtained from control treatment. These results are in good accordance with those of Bakry et al. (2013), Yousof (2014), Diab et al. (2017), Abido and El-Moursy (2020) and Hegab et al. (2020).

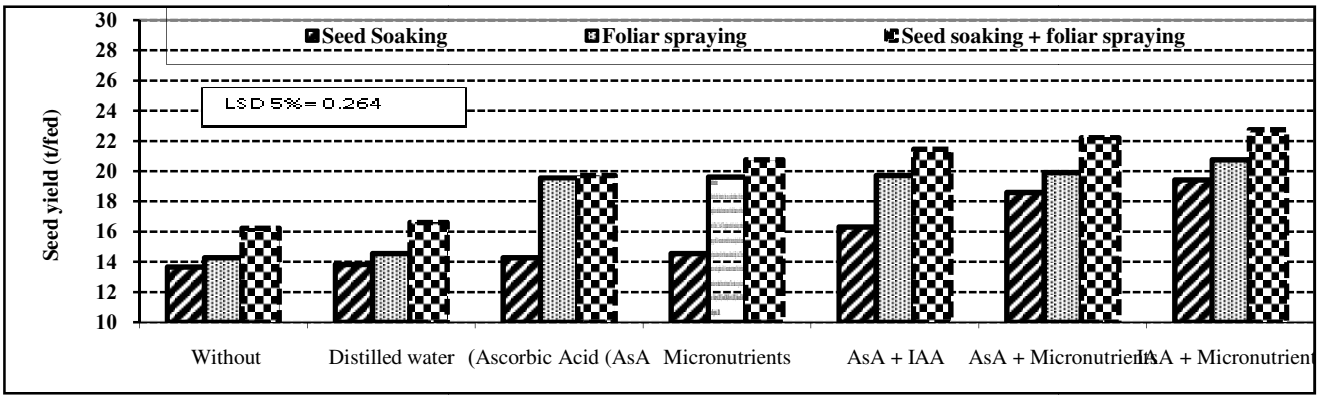

Fig. 1: Grains yield (ton/fed)as affected by application methods antioxidant, growth regulator, micro-nutrients, and their mixture as well as their interaction over both seasons.

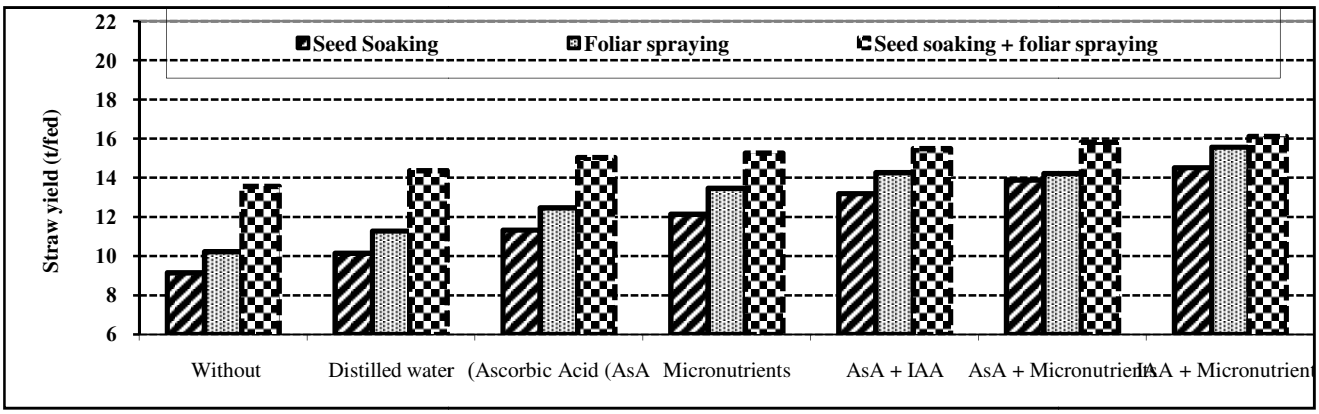

Fig. 2: Straw yield (ton/fed) as affected by application methods antioxidant, growth regulator, micro-nutrients, and their mixture as well as their interaction over both seasons.

Conclusions

Soaking wheat seeds for 12 hours in a solution of IAA and micronutrients or soaking wheat seeds for 12 hours in a solution of AsA and micronutrients ,then directly sowing followed by twice after 45 and 60 days from sowing with a solution of the same studied materials and rate which, seeds were soaked into enhanced growth, yield and its attributes and grain quality of bread wheat Misr 1 cultivar in all tested methods of application under the environmental conditions of Dakahlia Governorate, Egypt.

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