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Consequence of Sprinkling with Nano Zinc and Nano Selenium as well as Potassium Silicate on Yields And Excellence of Wheat Grains under Water Stress Conditions

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ABSTRACT

Toward decide the consequence of treating with nano zinc and nano selenium as well as potassium silicate as foliar application on, yield and excellence of bread wheat grains underneath water stress situations during 2019 for each 2020 and 2020 for each 2021 seasons. The trials were conceded in a strip-plot layout with three repeats. Perpendicular plots were designated to three water stress transactions expressed as withholding watering *i.e.* normal watering (5 waterings "control treatment"), withholding the last one watering (4 irrigations) and withholding the last two watering (3 irrigations). The horizontal plots were allocated to eight foliar application transactions with nano zinc and nano selenium as well as potassium silicate. The obtained results showed that withholding last one or two waterings significantly decreased the whole examined traits of wheat in both time of year. Sprinkling wheat plants with sol of potassium silicate at the rate of 4 cm^3 for each L exceeded other studied foliar application transactions and produced the maximum amounts of growing characters, yield and its ingredients and grains excellence traits in both time of years. To sustain elevated yields and grains excellence at the identical time diminish water requirements, it could be suggested that sprinkling two times by potassium silicate at 4 cm^3 for each L in each sprinkling and withholding last watering (4 irrigations) under the environmental circumstances of Dekernis district, Dakahlia Governorate, Egypt.

Keywords: Wheat, water stress, withholding irrigation, foliar spraying, nano-zinc, nano-selenium, potassium silicate.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is several of the most valuable nutritious cereal produces in Egypt and all around the world for human nutrition as an important source of energy.

The greatest fear of global climatic change is drought. Worldwide, 61 % of countries receive rainfall of less than 500 mm annually and most wheat cultivation is condensated in such a semiarid region. In these regions, watering water applied to plants becomes the limiting factor and the ability of plants to improve their resistance to drought plays an important role under adverse environmental conditions. In Egypt, agriculture is expected to face less and less water availabilities in the near future. The wheat crop requires adequate water in all stages of its physiological development to attain optimum productivity. But like other cereal crops, there are critical points in its growing stages where lack of soil moisture greatly impacts grain yield. During grain filling in wheat plants are subjected to some unfavourable circumstances such as low winter rainfall, shortage of water watering and the need to withholding watering for saving water and early land evacuation for cultivating the following crop (Shehab El-Din and Ismail, 1997). Amoah *et al.* (2019) suggested that wheat plants employ physiological, biochemical and molecular mechanism under drought improving their ability to survive subsequent water stress in the later period of growing and development. Mehraban *et al.* (2019) stated that although drought stress affects most of the functions of plant growth, this consequence depends on the level of water stress, the long of time to which the plant is subjected to water stress. Genedy *et al.* (2020) exposed that under watering at all stages the maximum amounts of plant height, No. of spikes m^{-2}, No. of grains $spikes^{-1}$, 1000-grain weight, biological, grain and straw yields were recorded matched to shortage watering all through with withholding single watering at elongation, booting, and anthesis phases. Havrlentova *et al.* (2021) reported that drought is one of the most important factors that influences plant morphology, biochemistry and physiology, and finally leads to the decline in crops productivity and seed quality. Islam *et al.* (2021) stated that drought stress considerably decreased the grain filling duration by 15-24% and grain yield by 11-34%. Further, drought induced early leaf senescence and reduced total dry matter production indicate the minimum contribution of current assimilation to grain yield.

Nano-fertilizers at the nanometer scale (1–100 nm) are the majority important position of nanotechnology in agriculture. The use of nano-fertilizers rather than of common fertilizers, whereby nutrients are submitted to plants progressively and in a dominated manner. Meantime, nanotechnology increments fertilizer use efficiency, reduces contamination and hazards of chemical fertilizers (Naderi *et al.*, 2011).

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Zinc is well-known to have an essential task either as a metal component of enzymes or as a efficient, structural or controlling cofactor of a huge No. of enzymes (Grotz and Guerinot, 2006). Al-Juthery *et al.* (2019) revealed the importance of nano-element application especially with Fe, Zn and Cu. However, with the rise of awareness of nanoparticles toxicity and environmental concerns which is related to soil, plant and nonmaterial, further researches should be contacted and carefully evaluated before a final recommendation made to farmers for agricultural and food uses. Seadh *et al.* (2020 a and b) reported that the most excellent transaction to raise growing and grains excellence characters as well as yield and its characteristics was sprinkling wheat plants with nano zinc resol at 400 mg for each L. Adrees *et al.* (2021) suggested that foliar use of zinc oxide nanoparticles (ZnO NPs) might be an efficient way for increasing wheat growing and yields..

Selenium (Se) is regarded as one of the most important micronutrients in human and animal nutrition, but its importance for higher plants remains unproven. Se has numerous applications in food and feed via various biofortification methods. It can be found in different varieties of forms including selenite, selenate, nanoparticles of selenium (NPs-Se) and selenoproteins (Chauhan *et al.*, 2019). Ikram *et al.* (2020) found remarkable boost plant height and area of plant leaves has been observed when 30 mg for each L concentration of selenium nanoparticles (Se-NPs) was used.

Potassium (K) has the most important function in osmoregulation, photosynthesis, transpiration, stomatous open up and shut down and creation of protein, translocation of positive ion mad about basin organs and enzymes stimulation (Milford and Johnston, 2007 and Abido and El-Moursy, 2020). One of the most important facts is that silicon in the soil helps plants survive in circumstances of water shortage, as well as reduce transpiration in cubicles with a high-ranking intensity of silicon (Gao *et al.*, 2006). Laane (2018) revealed that Sprinkling with silicates are consequence ive as pesticides, while (stabilized) silicic acid sprays boost growing and yield and decrease biotic and abiotic stresses. The limited data on foliar silica-nano sprays show a tendency to decrease biotic stress and to stimulate a limited boost in growing and yield. Ghazi *et al.* (2021) concluded that sprinkling by potassium silicate at 1500 mg at period of 20, 45, and 60 days from wheat sowing is the best transaction to improve growing and yields.

Consequently, this examination was conventional to regulate the consequence of treating with nano zinc and nano selenium as well as potassium silicate as foliar application on yields and grains excellence of bread wheat Misr-1 cultivar beneath water stress circumstances under environments of Dakahlia Governorate, Egypt.

MATERIALS AND METHODS

During 2019 for each 2020 and 2020 for each 2021 seasons, deuce experiments were directed at a cloistered field in Dekernis district, Dakahlia Governorate, Egypt to decide the consequence of treating with nano zinc and nano selenium as well as potassium silicate as foliar application on yields and grains excellence of bread wheat Misr-1 cultivar beneath water stress circumstances.

The trials were conceded in a strip-plot layout with 3 repeats. The straight down plots were separated by deeper channels and assigned to three water stress transactions expressed as withholding watering *i.e.* normal watering (providing plants 5 waterings *i.e.* control treatment), withholding the last watering (providing plants 4 waterings) and withholding the last two waterings (providing plants 3 irrigations). The horizontal plots were allocated to eight foliar application transactions with nano zinc and nano selenium as well as potassium silicate *i.e.* without sprinkling (control treatment), sprinkling with watering water, sol of nano-zinc (Zn) at 200 and 400 mg for each L, sol of nano- selenium (Se) at 200 and 400 mg for each L and sol of potassium silicate at 2 and 4 cm^3 for each L in each spraying.

Each one experimental element was 3 × 3.5 m conquering an expanse of 10.5 m^2. The foregoing crop was rice in equally time of years.

Haphazard soil examples were taken from the investigational area at a penetration of 0 - 30 cm since soil outward prior to soil planning to assess the physical and chemical soil advantages as displayed in Table 1.

Table 1. Physical and chemical soil properties of the investigational field throughout 2019 for each 2020 and 2020 for each 2021 time of years.

Soil analyses		2019 for each 2020 season	2020 for each 2021 season
A: Mechanical analysis:			
Coarse sand (%)		5.63	5.75
Fine sand (%)		18.47	18.55
Silt (%)		41.05	40.92
Clay (%)		34.85	34.78
Texture class		Clay loam	
B: Chemical analysis:			
E.C. ds. M^{-1} (1 : 5)		1.65	1.75
pH (1 : 2.5)		7.95	8.05
OM (%)		1.65	1.58
S.P. (%)		59.0	59.5
$CaCO_3$ (%)		4.75	4.85
Available (ppm)	N	38.33	36.45
	P	22.15	21.85
	K	766.95	755.85
Exctrable DTPA (ppm)	Zn	0.90	0.85
	Fe	3.55	3.45
	Mn	1.45	1.40
	Cu	0.12	0.15

The investigational field was so ready through 2 ploughings, compaction, division and later distributed interested in the investigational entities with measurements as heretofore revealed. Calcium super phosphate (15.5 % P_2O_5) was utilised throughout soil training at 150 kg for each fed.

Sowing was carried out on November 20th and 23rd in the 1st and 2nd seasons, in that order. Seeds were sown at 75 kg for each fed with the Afir transmit expertise. Nitrogen manure was used in the shape of ammonium nitrate (33.5% nitrogen) at 80 kg nitrogen for each fed as a pulverization in two equal doses before the 1st and 2nd irrigations. Potassium manure was applied in the shape of potassium sulfate (48% K_2O) at 50 kg for each fed by broadcast in a single dose before the first irrigation. The widespread agricultural traditions of wheat crop growing were followed permitting to the suggestions of the Ministry of Agriculture, except for the considerations under investigation.

Earliness was decided as the No. of days from planting to 50 % of plants in each plot heading.

Following 120 days from planting, 10 plants (main-stem) were randomly chosen from each plot to estimate:

- Total chlorophylls (SPAD).
- Flag leaf area in cm^2.
- Plant height (cm).

At harvesting, 10 plants (main-stem) were randomly designated from each plot to assess the following creatures:

- No. of spikes for each m^2.
- Spike long (cm).
- No. of spikelets for each spike.
- No. of grains for each spike.
- Grains weighing for each spike (g).
- 1000 – grain weighing (g).
- Grain yield (ardab for each fed).
- Straw yield (heml for each fed).

Total N was assessed by the advanced Kjeldahl – procedure allowing to A.O.A.C. (2019) in soil fertility tests and fertilizer excellence assessment laboratory, Faculty of Agriculture, Mansoura University, Egypt. Crude protein % was computed by reproducing the total N in wheat flour by means of 5.75.

K % in grains was governed utilizing a flame photometer permitting to Peterburgski (1968) in soil fertility tests and fertilizer excellence assessment laboratory, Faculty of Agriculture, Mansoura University, Egypt.

The whole data were statistically evaluated matching to ANOVA technique for the strip – plot layout by process of "MSTAT-C" Computer software bundle as distributed by Gomez and Gomez (1984). LSD technique as explained by Snedecor and Cochran (1980) was applied to assess the variations amongst transaction means at 5 % level of possibility.

RESULTS AND DISCUSSION

1. Consequence of water stress treatments:

Concerning the consequence of water stress as withholding last one or two waterings on growing traits, yield and its ingredients and grains excellence traits, the obtained results of this study indicated that these characters were significantly affected by water stress transactions in the dual time of year as shown in Tables 2 and 3.

Noteworthy, by withholding last one or two waterings growing characters, yield and its ingredients and grains excellence traits of wheat were significantly decreased in the dual time of year of. The maximum amounts of growing types, yield and its ingredients and grains excellence traits were produced when normal watering was done in the initial and next seasons. The second-best water stress transaction was withholding last watering concerning its consequence on growing characters, yield and its ingredients and grains excellence traits in both time of years. While, the lowest amounts of growing types, yield and its ingredients and grains excellence traits were derived from increasing watering stress by withholding last two waterings in the dual growing seasons.

The decreases reached about in grain (13.13 and 25.03 %) and straw (17.96 and 30.82 %) yields for each fed of wheat by withholding last or two irrigations, respectively as compared to normal watering over both time of year of this study.

These consequences might be caused by the adverse consequence s of water stress on growing of wheat as a result of typically decreases in leaf gas exchange parameters, photosynthesis rate, stomatal conductance, intercellular CO_2 concentration, transpiration rate as well leaf area, dry mass, relative water content and chlorophyll content. These consequences are in agreement with those reported by Mehraban *et al.* (2019), Genedy *et al.* (2020), Havrlentova *et al.* (2021) and Islam *et al.* (2021).

2. Consequence of sprinkling with nano zinc and selenium as well as potassium silicate:

On the topic of the consequence of foliar transactions *i.e.* without spraying, sprinkling with watering water, nano-zinc (Zn) at 200 and 400 mg for each L, nano-selenium (Se) at 200 and 400 mg for each L and potassium silicate at 2 and 4 cm^3 for each L on growing traits, yield and its ingredients and grains excellence traits, it was significant in the dual time of years. While, sprinkling nano zinc and selenium as well as potassium silicate insignificantly affected No. of days to 50% heading in both time of year as shown in Tables 2 and 3.

Sprinkling wheat plants with sol of potassium silicate at 4 cm^3 for each L exceeded other studied foliar application transactions and produced the maximum amounts of growing characters, yield and its ingredients and grains excellence traits in both growing seasons. The descending order of other studied foliar application transactions regarding its consequence on growing characters, yield and its ingredients and grains excellence traits was; sprinkling with sol of nano- selenium (Se) at 400 mg for each L, potassium silicate at 2 cm^3 for each L, nano- selenium (Se) at 200 mg for each L, nano-zinc (Zn) at 400 mg for each L watering water, nano-zinc (Zn) at 200 mg for each L and watering water in both time of years . On the opposite, control transaction gave the lowest amounts of growing characters, yield and its ingredients and grains excellence traits in the 1st and 2nd easons.

The increases in grain and straw yields for each fed of wheat by sprinkling with potassium silicate at 4 cm^3 for each L or nano- selenium (Se) at 400 mg for each L, potassium silicate at 2 cm^3 for each L, nano- selenium (Se) at 200 mg for each L, nano-zinc (Zn) at 400 mg for each L, nano-zinc (Zn) at 200 mg for each L and watering water reached about 22.16, 15.64, 12.75, 10.40, 8.08, 5.24 and 3.97 % as well as 27.83, 17.19, 14.73, 12.34, 8.25, 5.79 and 3.22 %, respectively as compared to control transaction over both time of year of this study.

These results by sprinkling with potassium silicate, nano- selenium (Se) or nano-zinc (Zn) may possibly due to that these ingredients may partially recompense for inadequate uptake by the roots, but requires sufficient leaf area to develop into consequence (Mengel and Kirkby, 2001). In addition, the role of silicon in tolerance water shortage, decreasing transpiration in cells, reduces micronutrient and metal toxicity and improve plant development (Regina and Katarzyna, 2011). Also, the beneficial role of foliar application with NPs-Se in enhance plant growing by activating the antioxidant system under nutrient deficiency (Naderi and Sharaki, 2013). Zinc plays an important role in the production of biomass, chlorophyll synthesis, pollen function and fertilization (Pandey *et al.*, 2006). These conclusions are in accordance with those reported by Al-Juthery *et al.* (2019), Ikram *et al.* (2020), Seadh *et al.* (2020 b), Adrees *et al.* (2021) and Ghazi *et al.* (2021).

Table 2. No. of days to 50% heading, chlorophyll content, flag leaf area, plant height, No. of spikes for each m^2, spike long and No. of spikelets for each spike of wheat as exaggerated by water stress and foliar application transactions as well as their contact during 2019 for each 2020 and 2020 for each 2021 seasons.

Characters / Treatments	No. of days to 50% heading 2019/2020	No. of days to 50% heading 2020/2021	Chlorophyll content in flag leaf (SPAD) 2019/2020	Chlorophyll content in flag leaf (SPAD) 2020/2021	Flag leaf area (cm^2) 2019/2020	Flag leaf area (cm^2) 2020/2021	Plant height (cm) 2019/2020	Plant height (cm) 2020/2021	No. of s pikes for each m^2 2019/2020	No. of s pikes for each m^2 2020/2021	Spike long (cm) 2019/2020	Spike long (cm) 2020/2021	No. of spikelets for each spike 2019/2020	No. of spikelets for each spike 2020/2021
A- Water stress treatments:														
Normal watering (control)	98.62	95.02	24.95	23.86	72.77	69.58	132.9	127.1	558.2	533.8	19.55	18.69	23.08	22.07
Withholding last irrigation	98.00	92.82	24.53	22.92	69.21	64.68	127.6	119.2	520.2	486.1	19.07	17.82	21.37	19.97
Withholding last two irrigations	97.04	91.60	24.00	22.42	64.84	60.59	123.8	115.7	435.2	406.7	19.03	17.78	20.79	19.43
LSD at 5 %	0.37	0.37	0.29	0.30	0.05	0.04	0.4	0.3	18.6	17.9	0.02	0.03	0.16	0.15
B- Sprinkling with nano zinc (Zn) & selenium (Se) and potassium silicate:														
Without	97.22	92.51	20.79	19.58	67.76	63.85	127.0	119.7	371.8	350.3	19.04	17.94	20.33	19.15
Water	97.77	93.03	21.38	20.14	68.15	64.21	127.1	119.7	431.6	406.8	19.05	17.94	20.77	19.57
Nano-Zn (at 200 mg for each L)	97.77	93.03	23.71	22.33	68.50	64.54	127.7	120.3	472.3	444.9	19.06	17.95	21.55	20.31
Nano-Zn (at 400 mg for each L)	97.88	93.15	24.14	22.74	68.72	64.75	128.0	120.6	495.0	466.4	19.06	17.95	21.66	20.41
Nano-Se (at 200 mg for each L)	97.88	93.15	25.03	23.57	69.01	65.02	128.2	120.8	548.5	517.0	19.38	18.25	22.11	20.83
Nano-Se (at 400 mg for each L)	98.22	93.46	26.71	25.16	69.55	65.52	128.5	121.1	568.7	536.2	19.38	18.25	22.33	21.04
Potassium silicate (at 2 cm for each L)	98.11	93.36	25.60	24.11	69.25	65.25	128.3	120.9	554.2	522.5	19.38	18.25	22.33	21.04
Potassium silicate (at 4 cm for each L)	98.22	93.46	28.59	26.93	70.56	66.48	130.0	122.5	594.1	560.3	19.39	18.26	22.88	21.57
LSD at 5 %	-	-	0.45	0.43	0.09	0.08	0.5	0.5	14.9	13.9	0.03	0.04	0.32	0.57

Table 3. No. of grains for each spike, grains weighing for each spike, 1000-grain weight, grain and straw yields for each fed, crude protein and potassium (K) percentages in wheat grains as exaggerated by water stress and foliar application transactions as well as their interface during 2019 for each 2020 and 2020 for each 2021 seasons.

Characters / Treatments	No. of grains for each spike 2019/2020	No. of grains for each spike 2020/2021	Grains weighing for each spike (g) 2019/2020	Grains weighing for each spike (g) 2020/2021	1000-grain weighing (g) 2019/2020	1000-grain weighing (g) 2020/2021	Grain yield (ardab for each fed) 2019/2020	Grain yield (ardab for each fed) 2020/2021	Straw yield (heml for each fed) 2019/2020	Straw yield (heml for each fed) 2020/2021	Crude protein (%) 2019/2020	Crude protein (%) 2020/2021	K (%) 2019/2020	K (%) 2020/2021
A- Water stress treatments:														
Normal watering (control)	88.08	84.23	6.050	5.785	67.71	64.75	23.79	22.75	17.92	17.14	11.29	10.80	2.641	2.525
Withholding last irrigation	75.12	70.20	6.024	5.632	64.71	60.48	20.90	19.54	14.87	13.90	10.65	9.95	2.245	2.097
Withholding last two irrigations	67.70	63.27	5.503	5.146	62.67	58.57	18.04	16.86	12.54	11.72	9.87	9.22	1.718	1.606
LSD at 5 %	0.32	0.30	0.086	0.081	0.09	0.08	0.30	0.28	0.21	0.19	0.03	0.02	0.095	0.088
B- Sprinkling with nano zinc (Zn) & selenium (Se) and potassium silicate:														
Without	73.77	69.56	5.701	5.374	63.73	60.04	19.05	17.96	13.59	12.82	10.37	9.77	1.984	1.872
Water	74.11	69.88	5.701	5.374	64.36	60.64	19.81	18.67	14.03	13.23	10.46	9.77	2.057	1.941
Nano-Zn (at 200 mg for each L)	75.44	71.13	5.713	5.387	64.71	60.96	20.05	18.90	14.38	13.56	10.52	9.85	2.102	1.983
Nano-Zn (at 400 mg for each L)	76.11	71.76	5.716	5.389	64.72	60.98	20.59	19.41	14.71	13.88	10.55	9.92	2.147	2.024
Nano-Se (at 200 mg for each L)	77.44	73.01	5.928	5.584	65.25	61.47	21.03	19.83	15.27	14.40	10.60	9.94	2.206	2.082
Nano-Se (at 400 mg for each L)	79.88	75.31	6.038	5.687	65.61	61.80	22.03	20.77	15.93	15.02	10.70	10.05	2.256	2.128
Potassium silicate (at 2 cm for each L)	78.33	73.85	6.037	5.686	65.38	61.59	21.48	20.25	15.59	14.71	10.66	9.99	2.233	2.107
Potassium silicate (at 4 cm for each L)	80.66	76.05	6.041	5.688	66.49	62.64	23.27	21.94	17.38	16.38	10.96	10.08	2.626	2.473
LSD at 5 %	0.55	0.54	0.108	0.105	0.42	0.39	0.34	0.32	0.30	0.29	0.04	0.03	0.130	0.125

3. Consequence of interaction:

Normal watering of wheat plants (providing plants 5 irrigations) and Sprinkling two times with potassium silicate at 4 cm^3 for each L lead to obtain the maximum amounts of grain and straw yields for each fed of wheat in both time of year as shown from data graphically demonstrated in Figs 1 and 2. This transaction followed by normal watering of wheat plants and sprinkling two times with nano- selenium (Se) at 400 mg for each L, then normal watering of wheat plants and sprinkling with potassium silicate at 2 cm^3 for each L in both time of years. It was worthy to mentioned that withholding last watering (providing plants 4 irrigations) and sprinkling two times with potassium silicate at 4 cm^3 for each L significantly exceeded grain yield for each fed of wheat as compared with normal watering (providing plants 5 irrigations) without foliar application which usually done by most farmers in both time of years, as shown from data graphically illustrated in Fig 9. Alternatively, the lowest amounts of grain yield for each fed of wheat were resulted from withholding last two waterings (providing plants 3 irrigations) without Sprinkling in the dual growing seasons. These consequences are in concurrence with those obtained by Adrees *et al.* (2021)

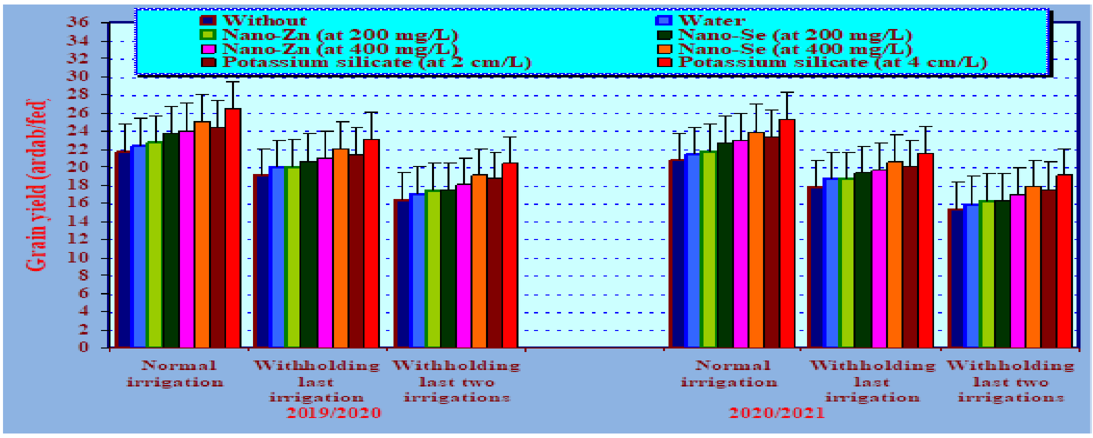

Fig. 1. Grain yield (ardab for each fed) of wheat as exaggerated by the interface between water stress and foliar application transactions during 2019 / 2020 and 2020 / 2021 seasons.

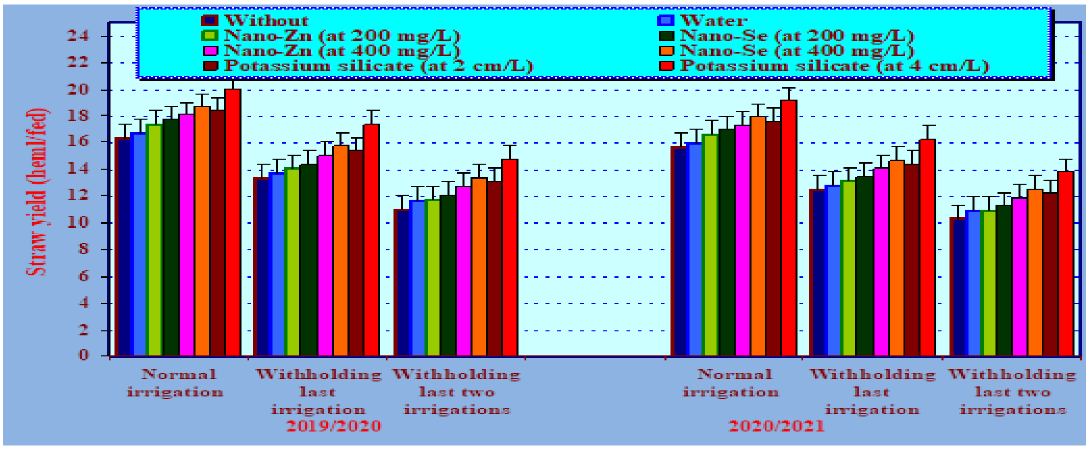

Fig. 2. Straw yield (heml for each fed) of wheat as exaggerated by the interface between water stress and foliar application transactions during 2019 / 2020 and 2020 / 2021 seasons.

CONCLUSION

It can be accomplished that normal watering of wheat (providing plants 5 irrigations) and sprinkling with potassium silicate at 4 cm^3 for each L to maximize growth, yields and grain quality. To continue elevated productivity and grains excellence simultaneously diminish water requirements, it could be suggested that withholding final watering and sprinkling with potassium silicate at 4 cm^3 for each L under the ecological circumstances of Dekernis district, Dakahlia Governorate, Egypt.

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تأثير الرش الورقي بالنانو زنك والنانو سيلينيوم وسيليكات البوتاسيوم على إنتاجية وجودة حبوب قمح الخبز تحت ظروف الإجهاد المائي

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يهدف هذا البحث إلى دراسة تأثير أنسب معاملات الرش الورقى بالنانو زنك والنانو سيلينيوم وسليكات البوتاسيوم بمعدلات مختلفة تحت ظروف معاملات الإجهاد المائى. لتحقيق الغرض من البحث فقد أقيمت تجربتان بمركز دكرنس ، محافظة الدقهلية ، مصر خلال موسمى ٢٠١٩ /٢٠٢٠ و ٢٠٢٠ /٢٠٢١ . نفذت كل تجربة فى تصميم الشرائح المتعامدة فى ثلاثة مكررات. احتوت كل تجربة على أربعة وعشرون معاملة مكونة من ثلاثة معاملات للإجهاد المائى وثمانية معاملات للرش الورقى بالنانو زنك والنانو سيلينيوم وسليكات البوتاسيوم بمعدلات مختلفة. إشتملت الشرائح الرأسية على ثلاثة معاملات للإجهاد المائى متمثلة فى الري العادي (إعطاء النباتات ٥ ريات ، "معاملة المقارنة")، منع الرية الأخيرة (إعطاء النباتات ٤ ريات) ومنع الريتين الأخيرتين (إعطاء النباتات ٣ ريات). أما الشرائح الأفقية فقد إحتوت على ثمانية معاملات للرش الورقى بالنانو زنك والنانو سيلينيوم وسليكات البوتاسيوم بمعدلات مختلفة (بدون رش ورقي، الرش الورقى بماء الرى، محلول النانو زنك بمعدل ٢٠٠ و ٤٠٠ملجم / لتر ماء ، محلول النانو سيلينيوم بمعدل ٢٠٠ و٤٠٠ ملجم * لتر ماء وسليكات البوتاسيوم بمعدل ٢ و٤ سم٣ / لتر ماء في كل رشة. أظهرت النتائج أنه نتيجةً لمنع آخر رية أو ريتين لمحصول القمح فإن صفات النمو والمحصول ومكوناته وصفات جودة الحبوب قد انخفضت بشكل معنوي في كلا موسمي الدراسة. يتضح من النتائج المتحصل عليها من هذه الدراسة أن الرش الورقي لنباتات القمح بمحلول سيليكات البوتاسيوم بمعدل ٤ سم٣ / لتر في كل رشة قد تجاوز معاملات الرش الورقي الأخرى المدروسة وأنتج أعلى القيم لصفات النمو والمحصول ومكوناته وصفات جودة الحبوب في كلا موسمي النمو.من نتائج هذه الدراسة يمكن التوصية بالري العادي لنباتات القمح (إعطاء النباتات ٥ ريات خلال موسم النمو) والرش الورقي بسيليكات البوتاسيوم بمعدل ٤ سم٣ / لتر في كل رشة للحصول على أقصى القيم لصفات النمو والمحصول وجودة الحبوب. بينما للحفاظ على الإنتاجية العالية وجودة الحبوب وفي نفس الوقت تقليل الاحتياجات المائية، يمكن التوصية بمنع الرية الأخيرة (إعطاء النباتات ٤ ريات) والرش الورقي مرتين بسيليكات البوتاسيوم بمعدل ٤ سم٣ / لتر في كل رشة تحت الظروف البيئية لمركز دكرنس بمحافظة الدقهلية – مصر.