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Assess Effect of Auxin Hormone on Seed Yield and Its Components of Wheat (*Triticum aestivum* L.) Cultivars Under Warm and Dry Climate Condition

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RESEARCH ARTICLE

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ABSTRACT

BACKGROUND: Growth regulators are organic substances besides nutrients, synthesized in plants, causing alteration in their cellular metabolism. Synthesis of some plant hormones is adversely affected by environmental factors, which causes restriction on physiological processes of the plant and ultimately, limits their growth potential.

OBJECTIVES: Current research was done to evaluate plant growth regulator (Auxin Hormone) on crop production of Bread Wheat cultivars.

METHODS: This study was conducted via split plot experiment based on completely randomized block design (RCBD) with three replications. The treatments included wheat cultivars at three levels (Chamran 2, Behrang and Mehregan) and auxin hormone at three levels (including zero or control, 50 ppm and 100 ppm.ha^{-1}), which were placed in the main and sub plots, respectively.

RESULT: According result of analysis of variance effect of Auxin, cultivar and interaction effect of treatments (instead harvest index, number of seed per spike and 1000 seed weight) on all studied traits was significant at 1% probability level. Evaluate means comparison result indicated in different level of cultivar the maximum harvest index, number of seed per spike and 1000 seed weight was noted for Chamran 2 and minimum of that belonged to Mehregan cultivar. Compare different level of Auxin Hormone showed that the maximum and the minimum amount of harvest index, number of seed per spike and 1000 seed weight belonged to 100 ppm and control treatments. Assess means comparison result of interaction effect of treatments indicated maximum seed yield, biologic yield and number of spike per m^2 was noted for Chamran 2 and 100 ppm Auxin hormone and lowest ones belonged to Mehregan cultivar and nonuse of auxin treatment.

CONCLUSION: Finally, according result of current research foliar application 100 ppm Hormone with Chamran 2 Cultivar achieve highest amount of seed yield and its components and can be advised to producers in studied region.

KEYWORDS: *Crop production, Genotype, Harvest index, Seed weight, Spike*.

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1. BACKGROUND

Among the factors that affect the physiological, morphological and metabolic traits of the wheat plant are plant hormones or growth regulators, which through their influence on photosynthesis, respiration and the amounts of antioxidants in plant tissues and cells, cause regulation and coordination of processes and as a result increase plant yield (Toreti *et al*., 2019). The plant needs growth regulators in order to complete the growth, because of its important role in improving biological activity, as many researches and studies indicated that the treatment of plants with a specific growth regulator leads to the improvement of the plant structure and the yield quality and the production of seeds (Khalaf and Rajbo, 2006). Numerous phytohormones like abscisic acid (ABA), gibberellins (GAs), ethylene (ET), auxin (indole-3-acetic acid (IAA)), cytokinins (CKs), and brassinosteroids (BRs) that regulate plant development are also involved in controlling a variety of physiological and biological signaling and processes in the sessile plants. These cellular messengers may function as either adjacent or distant molecules from their positions of synthesis to respond against external stimuli or genetically automated progressive variations (Fahad *et al*., 2015). Auxin is effective in cell division, tissue growth, leaf area increase, formation of photosynthetic pigments, phototropism, gravitropism, terminal dominance, stimulation of lateral root growth, differentiation of vascular tissues, embryo development, aging, fruit formation and ripening (Naeem *et al*., 2004). Emam *et al*. (2013) by evaluate effect of auxin and cytokinin on crop production of bread and durum wheat under drought conditions reported foliar application of auxin and cytokinin under normal irrigation improved grain yield and its components. Therefore, it was concluded from this research that application of 40 $mg.L^{-1}$ auxin for bread wheat (Shiraz cv.) and 70 µmol cytokinin for durum wheat (Yavaros cv.) improved grain yield only under normal irrigation conditions. Mahrokh *et al*. (2016) by evaluate effect of growth regulator hormone on corn yield under different irrigation regime reported maize was tolerant to drought stress up to 50% field capacity in vegetative stage, but grain yield was decreased by 48.04% under drought stress condition in reproductive stage, and spraying cytokinin and auxin hormones in V8-V10 and silk emergence stages respectively, could prevent about 20% of decreasing of grain yield. Therefore, under drought stress condition, spraying cytokinin and auxin hormones in V8-V10 and silk emergence stage can be recommended as the best time for using these hormones respectively, because they can balance hormones rate disturbs under drought stress condition.

2. OBJECTIVES

Current research was done to evaluate effect of plant growth regulator (Auxin Hormone) on crop production of Bread Wheat cultivars.

3. MATERIALS AND METHODS

3.1. *Geographical and climatic condition information*

This experiment was conducted in the cropping year of 2022-2023 in a farm in Ahvaz city located in Khuzestan province. Ahvaz is located at 48 degrees 40 minutes east longitude and 31 degrees 20 minutes north latitude and 22.5 meters above sea level. According to Demartin's climate classification, Ahvaz is classified as a hot and dry region.

3.2. *Agricultural soil characteristics*

To determine the characteristics of the soil of the test site, before any land preparation operations, samples were randomly collected from 0-30 cm soil depth from five points and after drying in the air and passing through a two-millimeter sieve. soil samples were mixed together and a single sample was prepared and sent to the soil science laboratory and some of its physical and chemical properties were determined. The results of soil analysis in the laboratory are shown in table 1.

Table 1. Physical and chemical properties of studied soil

Depth of soil sampling (cm)	Soil texture	pH	EC ($ds.m^{-1}$)	O.C (%)	N (%)	K (ppm)	P (ppm)
0-30	Clay loam	7.3	3.74	0.91	0.13	190	12.55

3.3. E*xperimental design information*

The experiment was carried out as a split plot in the form of a randomized complete block design (RCBD) with three replications. The experimental treatments include wheat cultivars at three levels [including Chamran (C_1), Behrang (C_2) and Mehregan (C_3)] and auxin hormone at three levels [including zero (A0), 50 ppm (A1) and 100 ppm (A2)], which They were placed in the main and sub plots, respectively.

3.4. *Land preparation operations*

The land preparation operation before planting started in the first half of November and included initial irrigation, plowing with a reversible iron bull, two perpendicular discs and a trowel for leveling the land. The experiment consisted of 27 plots, each plot having six lines, each five meters long, and the distance between the lines was considered to be 20 cm. The distance between repetitions was 1.5 meters, the distance between two subplots was 0.5 meters, and the distance between two main plots was 1 meter. Before planting, the total phosphorus required from the triple superphosphate source is based on 80 kg of pure phosphorus and nitrogen fertilizer from the urea source in the amount of 150 $kg.ha^{-1}$, half of which is spread with a disc in the field and the other half of nitrogen is distributed at the end of the tillering stage (beginning of stem growth). Auxin hormone solution was sprayed in the flowering stage (69 Zadox) in the determined amounts of 0, 50 and 100 cc and was measured with a special 20 liter spray pump in the early days and in the absence of wind in the plots. In order to increase the shelf life and effectiveness of the auxin hormone

on the plants, a sticky and waxy substance called Liquid Tween 20 with a ratio of 0.5% by volume, which is an auxin reagent, was used (Zand *et al*., 2014).

3.5. *Planting operations*

Planting was done manually at a depth of three centimeters with a density of 400 plants per square meter on November 20, 2022. The cultivars used were modified Mehregan, Chamran 2 and Behrang cultivars. The first irrigation was done one day after planting. Also, 2,4.D poison was used in the 3-leaf stage of weeds to control broad-leaved weeds. Weed control was done manually.

3.6. *Measured traits*

3.6.1. *Seed yield and its components*

The final harvest was done in May 1401, during the physiological maturity of the plant, from an area equivalent to $1.5m^{-2}$ of each plot and after removing the margins, it was done manually. After harvesting, the spikes in the final harvest area were counted and threshed to separate the seed from the spike. Then, the seed production of each plot is determined by the weight of the seed yield. In order to determine the number of spikes per area unit, the spikes were taken from an area of 1 m^2 of then three middle lines of each plot after considering half a meter of beginning and end of each line as the margin and after counting the spikes their mean was considered as the number of spikes per area unit. As many as 10 spikes were randomly selected from the middle lines of each plot and the number of seeds was counted carefully and their mean was recorded. Two 500-seed samples were randomly selected from the produced seeds by each plot and if the weight difference of the two samples was less than 5%, the total weight of the two samples was considered as 1000-seed weight. After full maturity of the seeds, the spikes were taken from the 3 middle lines of each plot in an area of 1 m^2 and the seed yield of each plot with moisture of 14% was calculated per area unit and then was recorded. Harvest index (HI) was calculated according to formula of Gardener *et al*. (1985) as follows:

Equ.1. HI= (Seed yield/Biologic yield) ×100.

3.7. *Statistical Analysis*

Data analysis was done using SAS statistical software (Ver.8) and comparison of averages was done using Duncan's test at 5% level. The graphs were drawn by Excel software.

4. RESULT AND DISCUSSION

4.1. *Seed yield*

According result of analysis of variance effect of Auxin, cultivar and interaction effect of treatments on seed yield was significant at 1% probability level (Table 2). Mean comparison result of different level of cultivar indicated that maximum seed yield (458.21 $g.m^{-2}$) was noted for Chamran 2 and minimum of that (382.24 $g.m^{-2}$) belonged to Mehregan cultivar (Table 3). Auxin foliar spraying can affect the amount of tuber formation, the average weight of the tuber and, as a result, the yield of potatoes (Kolachevskaya *et al*., 2019).

Table 2. Result analysis of variance of measured traits

S.O.V	df	Seed yield	Biologic yield	Harvest index	No. spike per m^2	No. seed per spike	1000 seed weight
Replication	2	90.02^{ns}	250.4^{ns}	0.31^{ns}	8.52^{ns}	0.94^{ns}	2.32^{ns}
Cultivar (C)	2	160551**	270476**	400.1**	11597**	299.1**	700.09**
Error I	4	3011.8	11381.5	15.27	1150.5	18.43	17.02
Auxin Hormone (H)	2	107516**	190961**	201.8**	10841.3**	246.1**	603.3**
C × H	4	62840**	205312**	0.06^{ns}	12237.1**	0.07^{ns}	0.81^{ns}
Error II	12	1759.5	10007.4	10.32	940.8	15.07	13.79
CV (%)		10.06	8	9.83	8.2	10.90	9.60

$^{ns, *}$ and **: no significant, significant at 5% and 1% of probability level, respectively.

As for Duncan classification made with respect to different level of Auxin Hormone maximum and minimum amount of seed yield belonged to 100 ppm (480.55 g.m^{-2}) and control (360.30 g.m^{-2}) (Table 3). Rastogi *et al*. (2013) reported that growth hormones, whether alone or in combination, have a major impact in the stimulation of various growth parameters in linseed. They were concluded that plant growth hormones could be successfully employed for enhancement of seed yield, directly or indirectly, through its components. Based on the findings, it is recommended the use of a combined dose of auxin and gibberellins (1 mg.lit^{-1} + 400 mg.lit^{-1}) for seed yield, and auxin alone at 0.5 mg.L^{-1} doses for vegetative growth, in order to enhance yield in this important oil seed crop. Evaluation means comparison result of interaction effect of treatments indicated maximum seed yield (490.2 g.m^{-2}) was noted for Chamran 2 and 100 ppm Auxin hormone and lowest one (360.6 g.m^{-2}) belonged to Mehregan cultivar and nonuse of auxin treatment (Fig.1).

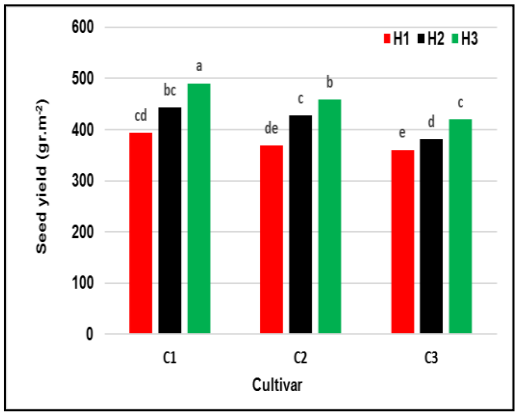

Fig.1. Mean comparison interaction effect of treatment on seed yield (Means with similar letters in each column are not significantly different by Duncan's test at 5% probability level, C_1: Chamran 2, C_2: Behrang, C_3: Mehregan, H_1: Control, H_2: 50 ppm.ha^{-1}, H_3: 100 ppm.ha^{-1}).

Gibberellin acid consumption in period of vegetative growth compared to apply hormone at other growth stage had the highest grain filling rate. It seems that when the plant receives the gibberellin acid during the vegetative growth period, due to the positive effect that gibberellin on division and growth and expansion of various organs of the plant, the production of photosynthetic materials also increases, which leads to increased grain filling rate (Fitals, 2016).

4.2. *Biologic yield*

Result of analysis of variance revealed effect of cultivar, Auxin and interaction effect of treatments on biologic yield was significant at 1% probability level (Table 2). According result of mean comparison maximum of biologic yield (1374.3 $g.m^{-2}$) was obtained for Chamran 2 and minimum of that (1189.09 $g.m^{-2}$) was for Mehregan cultivar (Table 3). Keshavarzi *et al*. (2014) by evaluate the effects of plant hormones (auxin and gibberellin) on corn crop production reported the effects of hormone gibberellin on trait (fresh weight of leaf, stem fresh weight, plant height, fresh weight forage, per hectare, and ear length) were significant.

Table 3. Mean comparison effect of treatment on measured traits

Treatment	Seed yield ($g.m^{-2}$)	Biologic yield ($g.m^{-2}$)	Harvest index (%)	No. spike per m^2	No. seed per spike	1000 seed weight (g)
Cultivar						
C1	458.21a	1374.3a	33.34a	410.6a	39.28a	43.12a
C2	410.19b	1246.25b	32.91ab	376.02b	36.78bc	38.25b
C3	382.24c	1189.09c	32.14b	345.7c	34.19c	34.62c
Auxin Hormone						
H1	360.3c	1126.68c	31.97b	339.66c	32.01b	35.70c
H2	409.8b	1270.55b	32.25b	383.52b	38.16a	39.0b
H3	480.55a	1412.42a	34.02a	408.8a	40.1a	41.30a

*Mean which have at least once common letter are not significant different at the 5% level using (DMRT).
C_1: Chamran2, C_2: Behrang, C_3: Mehregan.
H_1: Non-use (control), H_2: 50 $ppm.ha^{-1}$, H_3: 100 $ppm.ha^{-1}$.

The results of the interaction were significant for forage yield and fresh weight per plant but were not significant for other traits. Mean comparisons of auxin hormone showed that most quantitative traits (leaf fresh weight, stem fresh weight, fresh forage weight and fresh weight per plant) related to hormone auxin application of 100 and 150 ppm which are not statistically different. Mean comparisons showed that hormone gibberellin greatest attributes related to the application of 100 and 150 ppm. Results for quality traits (protein and carbohydrate ear stems and leaves) showed that increasing concentrations of the hormone increases the amount of quality traits. Evaluation mean comparison result indicated in different level of Auxin Hormone the maximum biologic yield (1412.42 $g.m^{-2}$) was noted for 8 $kg.ha^{-1}$ and minimum of that (1126.68 $g.m^{-2}$) belonged to control treatment (Table 3). Seeds inside a pod do not have the same physiological value. This non-uniformity occurs due to unfavorable environmental conditions during seed embryo development, and as a result, in the pod, only one of the fertile eggs becomes a mature seed. In the next stage or at the end of the pod elongation stage, if the conditions are unfavorable, two or three seeds will appear. At the beginning of the rapid grain filling period, the unequal physiological value of the seeds leads to different seed sink capacity of a pod, thus leading to the formation of seeds of different sizes (Patarx, 2019). Assess means comparison result of interaction effect of treatments indicated maximum biologic yield (1422.67 $g.m^{-2}$) was noted for

Chamran 2 and 100 ppm Auxin hormone and lowest one (1152.70 g.m^{-2}) belonged to Mehregan cultivar and nonuse of auxin treatment (Fig.2).

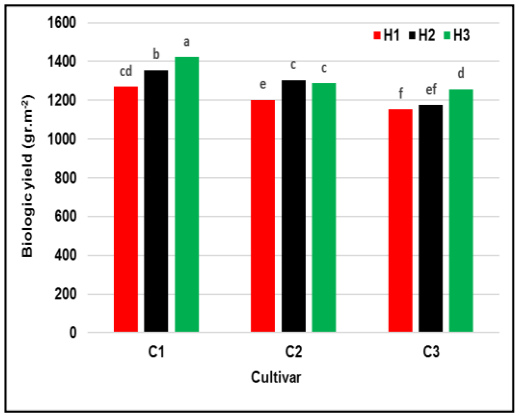

Fig.2. Mean comparison interaction effect of treatment on biologic yield (Means with similar letters in each column are not significantly different by Duncan's test at 5% probability level, C_1: Chamran 2, C_2: Behrang, C_3: Mehregan, H_1: Control, H_2: 50 ppm.ha^{-1}, H_3: 100 ppm.ha^{-1}).

4.3. *Harvest index*

Two useful terms used to describe the allocation of dry matter in plants are biological yield and economic yield. The term biological yield is used to denote the accumulation of dry matter in a plant system, and economic yield or agricultural yield is used to describe the volume or weight of the organs that make up the crop and have economic or agricultural value. That ratio of biological yield that constitutes economic yield is called the coefficient of harvest or the yield of efficiency or the coefficient of displacement (Tianam, 2019). According result of analysis of variance effect of cultivar and Auxin on harvest index was significant at 1% probability level but interaction effect of treatments was not significant (Table 2). Assessment means comparison result indicated in different level of cultivar the maximum harvest index (33.34%) was noted for Chamran 2 and minimum of that (32.14%) belonged to Mehregan cultivar (Table 3). Compare different level of Auxin Hormone showed that the maximum and the minimum amount of harvest index belonged to 100 ppm (34.02%) and control (31.97%) treatments (Table 3).

4.4. *Number of spike per m^2*

Result of analysis of variance revealed effect of cultivar, Auxin and interaction effect of treatments on number of spike per m^2 was significant at 1% probability level (Table 2). Evaluation mean comparison result revealed in different level of Cultivar the maximum number of spike per m^2 (410.6) was noted for Chamran 2 and minimum of that (345.7) belonged to Mehregan cultivar (Table 3). Between different levels of Auxin hormone, the maximum number of spike per m^2 (408.8) was observed in 100 ppm and the lowest one (339.66) was found in control treatment (Table 3). Assess means comparison result of interaction effect of treatments indicated maximum number of spike per m^2 (415.4) was noted for Chamran 2 and 100 ppm Auxin hormone and lowest one (340.6) belonged to Mehregan cultivar and nonuse of auxin treatment (Fig.3). Davani *et al*. (2017) by assess effect of planting pattern and auxin and Cytokinin on Corn yield reported It is concluded that furrow planting with Cytokinin application in V8-V10 stage (50 g.l^{-1}) and Auxin in silking stage (10 g.l^{-1}) reduced effects of salinity on plant

and produced the highest grain yield and its components.

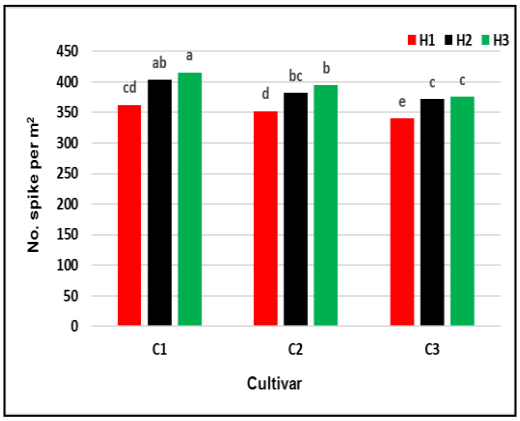

Fig.3. Mean comparison interaction effect of treatment on number of spikes per m^2 (Means with similar letters in each column are not significantly different by Duncan's test at 5% probability level, C_1: Chamran 2, C_2: Behrang, C_3: Mehregan, H_1: Control, H_2: 50 ppm.ha^{-1}, H_3: 100 ppm.ha^{-1}).

4.5. *Number of seed per spike*

According result of analysis of variance effect of Auxin and cultivar on number of seed per spike was significant at 1% probability level but interaction effect of treatments was not significant (Table 2). Mean comparison result of different level of cultivar indicated the maximum and the minimum amount of number of seed per spike belonged to Chamran 2 (39.28) and Mehregan cultivar (34.19) (Table 3). Among different level of Auxin maximum number of seed per spike (40.1) was obtained for 100 ppm and minimum of that (32.01) was for control treatment (Table 3). Ibrahim *et al*. (2007) by studied influence of some bioregulators (Gibberellic acid or GA, Indole acetic acid or IAA, benzyl adenine at the rate of 100 ppm or growth retardant IAA at the rate of 100 ppm) on agronomic traits of *Vicia faba* reported application of all the used treatments led to significant changes in the following items: plant height, average number of leaves, leaf area per plant and the dry weight of the shoot in both seasons. Application of benzyl adenine, IAA caused reduction in the flower abscission percentage and then producing the highest number of pod setting during the two seasons. All the used treatments of bioregulators caused marked changes in the seed yield and its components per plant (pod length, number of pods/plant, number and weight of seeds per pod as well as weight of 100 seeds).

4.6. *1000 seed weight*

Result of analysis of variance showed effect of cultivar and Auxin on 1000 seed weight was significant at 1% probability level but interaction effect of treatments was not significant (Table 2). Mean comparison result of different level of cultivar indicated that maximum 1000 seed weight (458.21 $gr.m^{-2}$) was noted for Chamran 2 and minimum of that (382.24 $gr.m^{-2}$) belonged to Mehregan cultivar (Table 3). As for Duncan classification made with respect to different level of Auxin Hormone maximum and minimum amount of 1000 seed weight belonged to 100 ppm (480.55 $gr.m^{-2}$) and control (360.30 $gr.m^{-2}$) (Table 3). The increase in the number of pods per plant and the mass of 100 seeds can be related to the better production of the parameters responsible for the overall increase in seed yield. High levels of gibberellic acid have improved the grain yields of many legumes, including beans. The increase in grain yield in some cereals is mainly

due to the increase in harvest index, in other words, the plant does not produce excess dry matter, but allocates a large part of the dry matter to the economic yield of seed (Zianto, 2016).

5. CONCLUSION

Finally, according result of current research foliar application 100 ppm Hormone with Chamran 2 Cultivar achieve highest amount of seed yield and its components and can be advised to producers in studied region.

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FOOTNOTES

AUTHORS' CONTRIBUTION: All authors are equally involved.

CONFLICT OF INTEREST: Authors declared no conflict of interest.

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