Journal of Crop Nutrition Science

ISSN: 2423-7353 (Print) 2538-2470 (Online)

Vol. 9, No. 4, 2023

https://jcns.ahvaz.iau.ir/ OPEN ACCESS

Effect of Foliar Application of Auxin on the Growth Indices and Crop Production of Wheat Cultivars in Southwest of Iran (Ahvaz region)

Mohsen Salehinazar*[1], Tayeb Sakinejad[2]

1- *Expert, Sugarcane and By-product Development Company, Salman Farsi Sugarcane Cultivation and Industry Company.*

2- *Assistant Professor, Department of Agronomy, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran.*

RESEARCH ARTICLE	© 2015 IAUAHZ Publisher.
ARTICLE INFO.	**To Cite This Article:**
Received Date: *27 Aug. 2023* ***Received in revised form:*** *29 Sep. 2023* ***Accepted Date:*** *30 Oct. 2023* ***Available online:*** *31 Oct. 2023*	Mohsen Salehinazar, Tayeb Sakinejad. Effect of Foliar Application of Auxin on the Growth Indices and Crop Production of Wheat Cultivars in Southwest of Iran (Ahvaz region). ***J. Crop. Nutr. Sci.,*** 9(4): 23-35, 2023.

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: This study was designed and implemented with the aim of evaluating foliar application of different amounts of auxin hormone on the physiological traits and seed yield of wheat cultivars.

METHODS: Current research was conducted in the crop year of 1400-01 in Ahvaz city according 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 Mehrgan) and auxin hormone at three levels (including zero or control, 50 ppm and 100 ppm), which were placed in the main and sub plots, respectively.

RESULT: The results showed that the difference between cultivars and different amounts of auxin hormone consumption was statistically significant in terms of effect on total dry matter, leaf area index, crop growth rate and seed yield. The mutual effects of cultivars and auxin hormone had a significant effect on seed yield. The highest seed yield (with an average of 490.2 $gr.m^{-2}$) belonged to the Chamran 2 cultivar and the use of 100 ppm of auxin hormone, and the lowest seed yield (with an average of 360.6 $gr.m^{-2}$) belonged to the Mehrgan cultivar and no auxin application.

CONCLUSION: According to the test results, the use of 100 ppm of auxin hormone compared to other treatments significantly improved the growth and yield of Chamran 2 wheat seeds.

KEYWORDS: *Dry matter, Growth regulator, Hormone, Leaf area, Seed yield.*

***Corresponding Author:** Mohsen Salehinazar ✉ salehinazar.mohsen1860@gmail.com

1. BACKGROUND

Bread wheat with the scientific name (*Triticum aestivum L.*) from the family of cereals and the Triticum genus, is an annual herbaceous plant, which is one of the most important sources of production among cereals due to its high adaptability to different environmental conditions, high production rate and wide cultivated area among cereals, it is one of the most important sources of food production for humans in Iran and the world (Riahi *et al*., 2021). 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 performance (Toreti *et al*., 2019). 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 (Copur *et al*., 2010). The application of these hormones in low concentration regulates growth, differentiation and development, either by promotion or inhibition (Naeem *et al*., 2004), and allows physiological processes to occur at their normal rate (Gulluoglu, 2004). Growth regulators are organic compounds that are made in different plant cells and tissues and are transported throughout the plant through phloem vessels and have their effects in specific places. Among growth regulators, we can mention auxins, cytokinins, abscisic acid and ethylene (Guo *et al*., 2001). Meanwhile, auxin hormone (growth hormone) is essential for cell development and division in all parts of the plant and is effective in increasing the length of the cell wall, increasing the amount of DNA, synthesizing proteins and RNA, especially rRNA (Tian *et al*., 2018). Auxin exists in the plant in the form of indole-3-acetic acid. In general, all the different aspects of growth in plants, from germination to seed formation, are the result of the action of hormones, and the action of hormones causes the decrease and increase of enzymes in the plant (Bartel and Starder, 2018). In their research, by examining the use of auxin hormone on the yield and yield components of durum wheat, the researchers stated that auxin had a significant effect on seed yield, number of seeds per spike, leaf area index, biological yield and plant height and led to the increase and improvement of traits (Maghsodi *et al*., 2014). Guo *et al*. (2021) stated that wheat cultivars subjected to auxin hormone foliar application had higher seed weight and yield than those without hormones. Also, positive effect of auxin hormone on physiological traits of wheat reported by Khedr *et al*. (2021).

2. OBJECTIVES

This research was designed and implemented with the aim of evaluating foliar application of different amounts of auxin hormone on the physiological traits and seed yield of wheat cultivars.

3. MATERIALS AND METHODS

3.1. *Geographical and climatic condition information*

This research was conducted in the cropping year of 1400-1401 in a farm in Ahvaz city located in southwest of Iran at 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 studied soil, before any land preparation operations, samples were randomly collected from 0-30 cm soil depth from five points and after drying in air and passing through a two-millimeter sieve. soil samples were mixed together and a single sample was prepared and sent to 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. Some physical and chemical properties of field's 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 (A_0), 50 ppm (A_1) and 100 ppm (A_2)), 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, 1400. The cultivars used were modified Mehrgan, Chamran 2 and Behrang cultivars. The first irrigation was done one day after planting. Also, Tofordi 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*

The final harvest was done in May 1401, during the physiological maturity of the plant, from an area equivalent to 1.5 m^{-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.

3.6.2. *Measurement of physiological indices of growth*

In order to determine changes in leaf area index (LAI), crop growth rate (CGR), net absorption rate (NAR) and total dry weight (TDW), sampling was done in 2 stages of booting (43 zadox) and seeding (70 zadox). So that 5 plants were randomly separated from each plot.

3.6.2.1. *Dry matter accumulation (TDW)*

To determine the plant dry matter per unit area, the samples were placed in an oven for 48 hours at a temperature of 75°C and then weighed with a digital scale with an accuracy of 0.01 g (Kapur and Govil, 2004).

3.6.2.2. *Leaf Area Index (LAI)*

Leaf area index was measured in three stages (emergence of male inflorescence, beginning of seed formation and seed filling). At each stage, the surface of each leaf was calculated using the following equation (Sobhani, 2000):

S = 0.46 (L×W) + 0.00046 (L×W) 2 R2 ≥ 0.98**

where S is the surface of the leaf, L and W are the maximum length and width of the green corn leaf, respectively. After measuring the surface of all the leaves, the leaf surface index was calculated in different experimental treatments.

3.6.2.3. *Crop Growth Rate (CGR)*

The crop growth rate in grams per square meter per day was calculated using the following formula: CGR ($g. m^{-2}. d^{-1}$) = $(TDM_2 - TDM_1)/(T_2 - T_1) \times GA$

TDM = dry weight of the whole plant at each stage of sampling ($gr.m^{-2}$)

T_2-T_1 = time interval between two samplings (days)

GA = area occupied by the plant (m^{-2})

3.6.2.4. *Net assimilation rate (NAR)*

Net assimilation rate was calculated in grams per square meter of leaf surface per day using following formula:

NAR ($gr.m^{-2}.day^{-1}$) = (Ln (LAI_2) – Ln (LAI_1) / ($LAI_2 – LAI_1$) × CGR 2

CGR = crop growth rate ($gr.m^{-2}.day^{-1}$)

LAI = leaf area index

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. *Leaf Area Index (LAI)*

There was a significant difference between different cultivars and different amounts of auxin hormone in terms of leaf area index at the 1% of probability level, but the interaction effects of the treatments were not significant in this regard (Table 2). The highest leaf area index in the booting and seeding stage belongs to Chamran 2 cultivar with an average of 4.8 and 3.68, respectively, and the lowest leaf area index in the booting and seeding stage belongs to Mehrgan cultivar with an average of 4.07 and 3.11, respectively (Table 3). Also, the highest leaf area index in the booting and seeding stage is due to foliar spraying of 100 ppm of auxin hormone, respectively, with an average of 4.75 and 3.81, and the lowest leaf area index in the booting and seeding stage is due to the absence of auxin hormone (zero), with the average of 3.9 and 3, respectively (Table 3). The higher leaf area index in Chamran 2 cultivar compared to other cultivars can be attributed to more plant production per unit area, more leaf area and increased light absorption in this cultivar, which ultimately leads to an increase in the growth rate of the crop. The results of other researchs confirmed the results of this research (Ranjbar and Alavi Fazel, 2018). The leaf area index in the auxin hormone foliar treatment was significantly higher than the control treatment. It seems that the auxin hormone has increased the leaf area index by increasing the leaf durability, delaying the aging of leaves and preventing them from falling during the wheat seed filling stage compared to the absence of hormone application, which was consistent with the results of Mahrokh *et al.* (2019). In this regard, Mousavi *et al.* (2022) stated that the auxin hormone, by producing useful antioxidants in inhibiting oxygen free radicals, was able to delay cell damage to the thylakoid membrane and leaf aging and increase the leaf area index. As Maghsodi *et al.* (2014) stated in their research, as a result of the use of auxin hormone, the leaf area index and leaf surface durability of wheat increased and led to the delay of senescence in wheat leaves. These results were consistent with the results of Guo *et al.* (2021) and Shirinzadeh *et al.* (2017).

4.2. *Total dry matter (TDW)*

According to the results of the analysis of variance table, there was a significant difference between different varieties and different amounts of auxin hormone consumption in terms of dry matter accumulation in the booting and seeding stage, but the interaction effects of the treatments were not significant for this trait (Table 2).

Table 2. Result analysis of variance of studied traits

S.O.V	df	Leaf Area Index (LAI)		Total Dry Matter (TDM)	
		Booting stage	Graining stage	Booting stage	Graining stage
Replication	2	0.11ns	0.02 ns	102.51 ns	95.2 ns
Cultivar	2	38.74**	29.11**	63904.2 **	80711.18**
Error I	4	0.34	0.21	5451.6	7320.04
Auxin hormone	2	40.05**	32.8**	83683.71**	72543.21**
Cultiva × Auxin hormone	4	0.09 ns	0.01 ns	561.5 ns	390.19ns
Error II	12	0.21	0.174	4894.08	6972.37
CV (%)		10.53	12.41	6.95	7.07

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

Continue table 2.

S.O.V	df	Crop Groth Rate (CGR)	Net Assimilation Rate (NAR)	Seed yield
		Booting stage until graining	Booting stage until graining	
Replication	2	1.1 ns	0.15ns	90.02ns
Cultivar	2	118.3 **	50.72**	160551**
Error I	4	5.75	1.09	3011.8
Auxin hormone	2	211.29**	68.24**	107516**
Cultiva × Auxin hormone	4	0.84ns	0.01ns	62840**
Error II	12	4.7	0.71	1759.5
CV (%)		13	12.30	10.06

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

The highest accumulation of dry matter in the booting and seeding stage is related to Chamran 2 cultivar with an average of 1199.5 and 1335.01 gr.m^{-2}, respectively, and the lowest total dry matter in the booting and seeding stage is in Mehrgan cultivar with an average of 800.07 and 1020.3 gr.m^{-2} was allocated (Table 3). Also, the highest total dry matter in the booting and seeding stage was obtained by foliar spraying with 100 ppm of auxin hormone, with an average of 1163.15 and 1300.09 gr.m^{-2}, respectively. The lowest total dry matter in the booting and seeding stage by not using auxin hormone (zero), with an average of 855.3 and 1089.7 gr.m^{-2}, respectively (Table 3). These results showed the high potential of Chamran 2 cultivar in using current resources as well as other factors that increase photosynthetic production and assimilates, which ultimately lead to more growth of plant organs and especially increase in biomass and seed yield by increasing the number and weight of seeds. On the other hand, we can mention the role of auxin hormone in delaying the senescence of leaves, that by increasing the durability of the leaf surface, the amount of material transfer and the net production of photosynthesis will increase during the growing season, and as a result, the growth rate will also be higher due to the high level of photosynthesis. Also, the lack of leaf shedding can have an effect on the amount of total dry matter of wheat, and therefore, with the increase in leaf area and lack of leaf loss, the weight of the plant and dry matter will also increase (Maghsodi *et al*., 2014). In this regard, Honeiri Haghighi *et al*. (2014) stated that the effect of different amounts of auxin on the dry matter accumulation of whole wheat was significant. Also, Mousavi *et al*. (2016) showed that the application of 15 ppm of auxin improved the physiological indicess of growth and caused a 16.11% increase in dry matter yield compared to the control. The reports of other researchers such as Ranjbar *et al*. (2018) and Zand *et al*. (2014) were also consistent with the results of this study.

4.3. *Crop Growth Rate (CGR)*

The crop growth rate was significantly different between different cultivars and the effect of different amounts of hormones was also significant on this component, but the mutual effects of cultivars and auxin hormone on this trait were not significant (Table 2). Chamran 2 cultivar had the highest growth rate with an average of 18.58 $gr.m^{-2}.day^{-1}$ and the lowest crop growth rate was obtained from Mehregan cultivar with an average of 14.8 $gr.m^{-2}.day^{-1}$ (Table 3). The highest crop growth rate belonged to foliar spraying of 100 ppm of auxin hormone with an average of 19.16 $gr.m^{-2}.day^{-1}$ and the lowest crop growth rate was due to the absence of auxin hormone (zero) with an average of 14.49 $gr.m^{-2}.day^{-1}$ (Table 3). The change in crop growth rate in wheat cultivars indicates that the maximum crop growth rate for all cultivars was achieved when the leaf area reached its maximum. The crop growth rate in Chamran 2 and Behrang cultivars was at a higher level due to the maximum leaf area and less shading compared to Mehrgan cultivars. But the more decreasing trend of the leaf area in Mehrgan cultivar was a sign of more shading of the leaves, and the leaves under the canopy were removed from the production cycle, and therefore the photosynthesis decreased and the crop growth rate also showed a lower value (Gardner *et al*., 1985). The studies of Kamaei *et al*. (2019) showed that the Chamran 2 cultivar was able to obtain the highest CGR due to having a higher LAI and durability of the leaf area. Also, reason for increase in CGR in treatments that received auxin hormone is the increase in the leaf area index. In this regard, Honeiri Haghighi *et al*. (2014) and Matlabnejad *et al*. (2015) also attributed positive role of auxin hormone. They have mentioned in increasing the crop growth rate. These researchers considered main reason for increase in LAI and CGR to the more uniform establishment of plants treated with auxin hormone, which was consistent with results of this research.

Table 3. Mean comparison effect of cultivars and Auxin hormone on studied traits

Treatments	Leaf Area Index		Total Dry Matter ($gr.m^{-2}$)	
	Booting stage	Graining stage	Booting stage	Graining stage
Cultivar				
C_1	4.8 a*	3.68a	1199.5a	1335.01a
C_2	4.20bc	3.30bc	1021.25b	1187.52b
C_3	4.07c	3.11c	800.07c	1020.3c
Auxin hormone				
A_0	3.90b	3b	855.3c	1089.7c
A_1	4.40ab	3.29ab	1000.71b	1150.24b
A_2	4.75a	3.81a	1163.04a	1300.09a

*Mean which have at least once common letter are not significant different at the 5% level using (DMRT).
C_1: Chamran2 cultivar, C_2: Behrang cultivar, C_3: Mehrang cultivar.
A_1: Non-consumption(control), A_2: consumption of 50ppm auxin, A_3: consumption of 100ppm auxin.

Continue table 3.

Treatments	Crop Groth Rate ($gr.m^{-2}.day^{-1}$)	Net Assimilation Rate ($gr.m^{-2}.day^{-1}$)	Seed yield ($gr.m^{-2}$)
	Booting stage until graining	Booting stage until graining	
Cultivar			
C_1	18.58 a	7.88 a	458.21a
C_2	16.79ab	6.52 bc	410.19a
C_3	14.8b	6.52 c	382.24c
Auxin hormone			
A_0	14.49 c	5.52 c	360.3c
A_1	16.53 b	7 b	409.8b
A_2	19.16 a	8.03 a	408.55a

*Mean which have at least once common letter are not significant different at the 5% level using (DMRT).
C_1: Chamran2 cultivar, C_2: Behrang cultivar, C_3: Mehrang cultivar.
A_1: Non-consumption(control), A_2: consumption of 50ppm auxin, A_3: consumption of 100ppm auxin.

4.4. *Net Assimilation Rate (NAR)*

The difference between cultivars and amounts of auxin hormone in terms of net assimilation rate was significant at the 1% probability level, but the mutual effects of these treatments on this trait were not significant (Table 2). The Chamran cultivar had the highest net assimilation rate with an average of 7.88 $gr.m^{-2}.day^{-1}$, and the lowest net assimilation rate belonged to the Mehr-gan cultivar with an average of 6.15

grams $gr.m^{-2}.day^{-1}$ (Table 3). The highest rate of net assimilation belonged to the 100 ppm foliar treatment of auxin hormone (with an average of 8.03 $gr.m^{-2}.day^{-1}$) and the lowest rate of net assimilation belonged to the treatment of no application of auxin hormone (zero) (with an average of 5.52 $gr.m^{-2}.day^{-1}$) (Table 3). Net assimilation rate is an estimate of the average photosynthetic efficiency of leaves in a plant or in a plant community (Gardner *et al*., 1985). During the growth period, Chamran 2 cultivar had the maximum rate of net assimilation, and after that, Behrang and Mehrgan cultivarss were in the next ranks. It seems that the Chamran 2 cultivar, having more leaf area and longer leaf surface durability, was able to make the maximum use of environmental facilities and produce more dry matter per surface unit. This increases the photosynthetic efficiency of this cultivar compared to other cultivars and makes this cultivar have a higher net assimilation rate. On the other hand, in the Mehrgan cultivars, due to the higher growth of aerial organs and more leaves, shading was more and the role of the lower leaves in photosynthesis was less. As a result, the photosynthesis efficiency of the plant community was low and the net assimilation rate was at a lower level. These results were consistent with the findings of Zahedian *et al*. (2016). In this study, the use of auxin hormone increased the rate of photosynthesis due to the increase in the leaf area index, which could be due to the faster expansion and closing of plant canopy (Honeiri Haghighi *et al*., 2014). In this regard, Mousavi *et al*. (2016) showed that the application of 15 ppm of auxin increased the net assimilation rate by 18% compared to the control treatment, which was consistent with the results of this study.

4.5. *Seed yield*

The effect of cultivars and consumption of different concentrations of auxin hormone and their interaction on seed yield was significant at the 1% of probability level (Table 2). The highest and lowest seed yield was related to Chamran 2 (with an average of 458.21 $gr.m^{-2}$) and Mehrgan cultivar (with an average of 382.24 $gr.m^{-2}$), respectively. The highest seed yield was attributed to foliar spraying of 100 ppm of auxin hormone (with an average of 480.55 $gr.m^{-2}$) and the lowest seed yield was assigned to the treatment of no auxin hormone (zero) (with an average of 360.3 $gr.m^{-2}$) (Table 3). The highest seed yield was given to the Chamran 2 cultivar and the 100 ppm hormone treatment (with an average of 490.2 $gr.m^{-2}$), and the lowest seed yield was given to the Mehrgan cultivar and the absence of auxin hormone (zero) (with an average of 360.6 $gr.m^{-2}$). This result indicates that the Chamran 2 cultivar has more ability to increase yield compared to other cultivars in terms of seed production and yield components. In this regard, Varga *et al*. (2001) also showed that there is a significant difference between different wheat cultivars in terms of seed yield. Also, Ranjbar and Alavi Fazel (2018) reported that Chamran 2 cultivar was able to produce high seed yield by producing higher leaf area index and height, it seems that this situation is mainly related to the allocation pattern of photosynthetic materials in this cultivar. In this regard, Zahedian *et al*. (2016) showed that the maximum seed yield belonged to the Chamran 2 cultivar. In general, choosing the appropriate cultivar for the region can significantly affect the growth, yield and yield components of the wheat plant and increase production and economic yield. In this regard, Nasiri Tabrizi *et al*. (2014) reported that the high seed yield in the Dehdasht cultivar was mostly due to the high 1000 seed weight and harvest index, which was consistent with the results of this research. The most important physiological changes of the plant in relation to the seed yield are related to the late aging of the plant and the long-term survival of the surface of the leaves. Garcia and Hanowy (1996) stated that the purpose of spraying nutrients during the period of seed filling is not only to solve the lack of nutrients in the soil, but also to increase the greening period and the activity of the leaves, which are the main organs of production and transport of photosynthetic materials for growth. Therefore, with the use of auxin, the amount of greening period of the plant and the transfer of photosynthetic materials to the seed is increased, as a result, the seed yield also increases. According to the reports of Maghsodi *et al*. (2014), the lowest yield of wheat seed was related to the treatment of not using auxin hormone, while the use of auxin hormone increased the yield of wheat seed by approximately 500 $kg.ha^{-1}$. According to the report of Khamdi *et al*. (2019), auxin foliar application affected the source-sink relationships at the whole plant level and increased wheat seed yield. The increase in the level of auxin hormone during seed development increased the number of endosperm cells, in addition, the rate of photosynthesis and its stability increased per unit of time. On the other hand, Guo *et al*. (2021) stated that foliar spraying of wheat cultivars with auxin hormone increased seed weight and seed yield. These results were consistent with the results of this research.

5. CONCLUSION

The results of this research showed that the studied cultivars were different from each other in terms of physiological growth indices, and in this sense Chamran 2 cultivar was superior to other cultivars. Changes in leaf area index, total dry matter, crop growth rate and net asimilation rate were affected by different levels of auxin hormone consumption. In the treatment of 100 ppm of auxin hormone, leaf area index, total dry matter, crop growth rate was higher than in the 50 ppm treatment. Yield was also affected by different levels of auxin hormone consumption. The quantitative increase trend of the traits in the treatments with hormone use was higher than in the treatment without hormone use. The highest seed yield was attributed to the Chamran 2 cultivar and the consumption of 100 ppm of auxin hormone with an average of 490.2 $gr.m^{-2}$, which showed an increase of about 26.4% compared to the Mehrgan cultivar and the absence of auxin hormone use. This result indicates that with the use of auxin hormone, the greening period of the plant and the transfer of photosynthetic materials to the seed increased, as a result of which the seed yield in Chamran 2 cultivar increased compared to other cultivars. The response of Chamran 2 cultivar to different treatments of auxin hormone application was positive compared to the control treatment (no hormone application). Therefore, the use of auxin hormone during the growing season led to an increase in plant growth and quantitative traits. Based on the results, the application of 100 ppm of auxin hormone compared to other treatments significantly improved the growth and yield of Chamran 2 wheat seed compared to other cultivars.

ACKNOWLEDGMENT

The authors thank all colleagues and other participants, who took part in the study.

FOOTNOTES

AUTHORS' CONTRIBUTION: All authors are equally involved.

CONFLICT OF INTEREST: Authors declared no conflict of interest.

FUNDING/SUPPORT: This study was done by support of Department of Agronomy, Islamic Azad University, Ahvaz Branch.

REFRENCES

Copur, O., U. Demirel. and M. Karakus. 2010. Effects of several plant growth regula-tors on the yield and fiber quality of cotton (*Gossypium hirusutum* L.). Notulae Botani-cae Horti Agrobotanici Cluj. 38: 104-110.

Gardner, F. P., R. B. Pearce. and R. L. Mitchell. 1985. Physiology of Crop Plants. Iowa State University Press, Ames 1985. 327 pp.

Garsia, R. and J. J. Hanowy. 1996. Foliar fertilization of Soybeans during the seedfilling period. Agron. J. 68: 653- 657.

Gulluoglu L. 2004. Determination of usage of plant growth regulators in soybean (*Gly-cine max* Merr) farming under Harran plain conditions. J. Faculty Agri. 8: 17-23.

Guo, L., M. Ma, L. Wu, M. Zhou, M. Li. and B. Wu B. 2021. Modified expression of wheat enhances seed weight yield potential by accumulating auxin in wheat. Plant Biotech. J. 8: 11-20.

Honeiri Haghighi, R., T. Sakinejad. and Sh. Attarzadeh. 2014. Investigating the effect of auxin hormone application in different growth periods on the performance and components of wheat yield. International conference on sustainable development, solutions and challenges, focusing on agriculture, natural resources, environment and tourism, Tabriz.

Kamaei, H., H. R. Eisvand, M. Daneshvar. and F. Nazarian Daneshvar. 2019. Effect of potassium and Zinc foliar application on growth physiological indices, chlorophyll fluorescence parameters and yield of two bread Wheat cultivars under late planting date. Iranian J. Field Crops Res. 17(3)55: 441-455.

Kapur, P. and Govil S. R. 2004. Experimental plant ecology. CBS publishers and Distributors. New Delhi. India.

Khamdi, N., M. Nabipour, H. Roshanfekr. and A. Rahnama. 2019. Effect of seed priming and application of cytokinin and auxin on growth and seed yield of wheat (*Triticum aestivum* L.) under Ahvaz climatic conditions. Iranian J. Crop Sci. 21(1): 31-44.

Khedr, R., S. Sorour, S. Aboukhadran. and M. Shafev. 2021. Alleviation of salinity stress effects on agro-physiological traits of wheat bi auxin, glycine betaine, and soil additives. Saudi J. Biol. Sci. 89-94.

Maghsodi, B., B. Jafari Haghighi. and A. R. Jafari. 2014. Effect of micronutrient elements and hormone auxin on yield and yield components of durum wheat. Journal of Plant Ecophysiology. 6(16)16: 13-26.

Mahrokh, A., M. Nabipour, H. A. Roshanfekr. and R. Choukan. 2019. Response of some seed maize physiological parameters to drought stress and application of auxin and cytokinin hormones. J. Environ. Stresses Crop Sci. 12(1): 1-15.

Matlabnejad, M., T. Sakinejad. and A. R. Shokoohfar. 2015. The effect of auxin hormone on the yield forage Sorghum cultivar Speedfed under low irrigation conditions. The 13th Iranian Congress of Soil Sciences (fertility and plant nutrition).

Mousavi, S. B., S. Sayfzade, H. Jabbari. and A. R. Valadabadi. 2022. The effect of auxin foliar application in two irrigated safflower cultivars under drought stress. J. Crop Improvement. 24(2): 3268-378.

Mousavi, S. Gh. R., M. Fazli-Rostampour, T. Sakinejad. and S. V. Mousavi. 2015. Investigating the changes in the physiological indicators of mung bean growth under the influence of superabsorbent and auxin levels. The fourth national conference on the application of new technologies in engineering sciences, Torbat Heydarieh. 17p.

Naeem, M., I. Bhatti, R. H. Ahmad. and M. Y. Ashraf. 2004. Effect of some growth hormones (GA3, IAA and Kinetin) on the morphology and early or delayed initiation of bud of lentil (Lens culinaris Medik). Pak. J. Bot. 36: 801-809.

Nasiri Tabrizi, M., A. R. Dadkhah, A. A. Moveidi. and M. Kheirkhah. 2014. Investigating the effect of different late sowing dates on seed yield and yield components and agronomic and quality traits of bread and durum wheat varieties. Master's thesis. University Agriculture Shirvan. Faculty of Agriculture and Natural Resources. 110 p.

Ranjbar, M. and M. Alavi Fazel. 2018. Effect of heat stress on yield and yield components and dry matter transfer of wheat cultivars in Ahvaz. Master's thesis. Islamic Azad University of Ahvaz. 146 pages.

Riahi, M., A. Mostajeran. and M. Miroliaei. 2020. Investigation of salinity stress effect on germination of 18 strains wheat. J. Iranian Plant Eco-Physiol. Res. 15(58): 1-10.

Shirinzadeh, A., H. Heidari Sharif Abad, G. Nourmohammadi, E. Majidi Haravan. and H. Madani. 2017. Effect of planting date on growth periods, yield, and yield components of some bread wheat cultivars in Parsabad

Moghan. Intl. J. Farming and Allied Sci. 6(4): 109-119.

Sobhani, A. 2000. Guide for determination of leaf surface index of agricultural plants. Promotional magazine. Agricultural Education and Promotion Research Organization. Ministry of Agriculture.

Starder L. and B. Bartel. 2008. A new path to auxin. Nature Chemichal Biol. 4(6): 337-339.

Tian, H., L. V. Bingsheng, T. Ding, M. Bai. and Zh. Ding. 2018. Auxin-BR intraction regulates plant growth and development. Frontiers in Plant Sci. 8: 22-56.

Toreti, A., O. Cronie. and M. Zampieri. 2019. Concurrent climate extremes in the key wheat producing regions of the world. Sci. Reports. 9(1): 1-8.

Varga, B., I. Svecngak. and I. Pospisil .2001. Winter wheat cultivars performance as affected by production systems in Croatia. Agron. J. 93: 961–966.

Zahedian, M., M. Alavi Fazel. and A. L. Aine. 2016. The effect of planting dates on the yield of bread wheat cultivars in Ahvaz weather conditions. The second national conference on non-active defense in agriculture, natural resources and environment with a sustainable development approach, Tehran, Mehr Arvand Institute of Higher Education, Center for Sustainable Development Solutions.

Zand, B., A. Sorooshzadeh, F. Ghanadi. and F. Moradi. 2014. Effect of zinc (Zn) and auxin (IBA) foliar application on phytohormonal variation and growth of Corn (*Zea mays* L.). Iranian J. Plant Biol. 6(22): 63-76.