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The Response of two Wheat Cultivars *Triticum* spp to Cytokinin and Water Stress Treatments and their Interactions

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Abstract

This research had been conducted to investigate the response of two wheat cultivars to cytokinin and droughtness treatments through plant height, number of tillers per plant, flag leaf length, number of kernel per spike, weight of 100 kernels, protein, and total carbohydrates content of kernels. The maximum mean value for plant height was recorded for Sham-3 cultivar at 80 ppm which is significantly increased as compare to control, while the flag leaf length increased nonsignificantly at 40 ppm. Treatments with 40 and 80 ppm significantly decrease weight of 100 kernels for Mexipak cultivar, while in Sham-3 cytokinin at all concentrations significantly decreased weight of 100 kernels. It is obvious that cytokinin treatments with drought plants was less affective compared with normal irrigation with regard to carbohydrate content for Mexipak cultivars. In Sham-3, the results showed that the carbohydrate percentage in all cytokinin treated plants whether, drought or irrigated, were decreased significantly, while the weight of 100 kernels has not been changed in CK3D compare to the CK0N but increased significantly when compared with CK0D.

Keywords: Various wheat (*Triticum aestivum* L.), (*Triticum durum* L.), cytokinin, waterstress.

Introduction

Water is the most importing limiting factor for crop production in large areas of the world. If sufficient water is not available, application of fertilizers and high yielding crop varieties are useless. Drought conditions of soils have wide ranging effects on the morphological and physiological processes of plants. It generally causes a decrease in cytokinin transport from root to shoots and/ or an increase in leaf abscisic acid [1]. Hormones are chemical messengers regulating normal plant development as well as responses to the environment. Cytokinin is responsible for the formation of roots and buds and promotes cell division. It also tends to counteract the effects of aging and stress in plants [2].Wheat is a cereal grass of gramineae (poaceae) family and of the genus *Triticum* [3]. It is one of the worlds major food sources, wheat kernel in general contains 12% water, 70% carbohydrates, 12% proteins, 2%fat, 1.8% minerals and 2.2% crude fibers, thiamine, riboflavin, niacin, and small amount of vitamin (A) are also present [4].Water stress, which is caused by insufficient soil moisture, is among the chief causes of poor growth and yield production. It is responsible for slow growth and, in severe cases, dieback of stems. It is also makes plants more susceptible to diseases and less tolerant of insect feeding [5]. Water stress not only affects the morphology of the plant, but also severely modifies the metabolism. The extend of the modification depends upon the cultivars, duration and intensity

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of stress [6]. A decrease in soil water potential due to drought or salinity decreases the rate of leaf expansion, whereas root expansion is much less affected [7]. Prolonged water stress is always associated with the reduction in plant size. Recently it is clarified that water stress not only has a great effect on the reduction of kernels per spike but the effect extended also on the decrease of kernel weight as well as on the floret sterility [8]. Other studies showed that the CKs increased the number of grains and grain yield in their study on the effect of CKs and auxin in developing wheat grains [9]. It is also found that the exogenous application of CKs on wheat plants increased the rate of nitrate uptake by 21% to 42%, nitrate uptake capacity by 22%to 31%, maximum nitrate influx in roots by 43% to 70% and the activity of nitrate reductase in young leaves by about 100% [10]. Another work reported to compare CKs content and sensitivity in a selection of hexaploid wheat ***Triticum aestivum*** L. cultivars. Accumulation of zeatin riboside-type cultivars was greatest during light-growth in Tibet Dwarf cultivar, wheat with an extreme dwarf phenotype [11]. The recent study has been conducted to investigate the effect of droughtness condition, CKs, and their interaction on yield of two wheat cultivars as well as on the protein and carbohydrate contents.

Materials and Methods

This study has been conducted at the green house station on January 2003, College of science, University of Salahaddin-Erbil-Iraq. Two wheat cultivars (the seeds were obtained from agricultural Research Center/ Erbil) Mexipak-soft (*Triticum aestivum* L.) and Sham-3-hard (*Triticum durum* L.) were selected to be tested in this investigation to evaluate their status and responses to water stress and CKs treatments at 0, 40, 80, and 120 ppm concentration and one drought period of [14 day]. After many experiment on field capacity to determine how much water must be added to each pot during water stress process of 14-day four pots were saturated with water, and reweighed after 7 and 14-days to measure the quantity of water lost at those periods. The experiments were repeated and four replications were taken for each period. The water loss was then measured to be 250 ml this must be added to each pot after 14-days intervals to bring the soil moisture to each field capacity. After each drought periods, the pots were received the same quantity of water to bring the soil water capacity to 75%. This quantity of water had been determined during the pre-run experiment. to ensure germination, four seeds were sown in each plastic pot with 22cm in diameter and 30cm in height. The pots were filled with sandy loamy soil supplemented with 20 Kg/donum urea containing 45% nitrogen and 46% phosphorus elements as P_2O_5. After seed germination the number of seedling were reduced to one per pot in order to allow for more distribution of root mass in the soil and eliminating the competition factor. The plants were allowed to grow until 4-leaf stage which required a month period duration to reach such morphological stage. At this stage, the plants were sprayed twice in two-day intervals with cytokinin. Pots were distributed in the green house according to the factorial completely randomized design with four replicates for each treatment. The means were compared using the Least Significant Difference test (LSD) at the level of 5% as the degree of freedom [12]. Vegetative characteristics and crop yield were evaluated for each treatment. The plant height, number of tillers, flag leaf length, number of kernel per spike were used as parameters to evaluate the effects of

droughtness and CK_s treatments and finally weight of 100 kernels, total carbohydrate [13] and the protein content were determined for all treatments [14] and the protein content has been determined based on the determination of total nitrogen which has been multiplied by a factor of 6.25 for the content of protein (15). The physical and chemical analyses of soil used in this study were similar to that mentioned in our previous paper [16].

Results and Discussion:-

Cytokinin effects on phenological and yielding criteria of Mexipak and Sham-3 cultivars:

Results indicates that a maximum mean value for plant height was recorded for Sham-3 cultivars at 80 ppm concentration which is significantly increased as compare to control, while the plant height decreased in Maxipak cultivar consistently at all concentrations as compare to control. This response to CKs might be due to the variation of both cultivars table (1). However significant reduction was only recorded with 80 and 120 ppm concentration for Mexipak cultivars. It is also obvious from that maximum mean value for flag leaf length was recorded for Sham-3 cultivar at 40 ppm nonsignificantly in contrast to Mexipak which decreased significantly at 120 ppm as compared to control while nonsignificantly increased for Sham-3 at 40 and 120 ppm. As shown in table (1) the number of tillers in Mexipak cultivar was decreased non-significantly as compared to control. The CK_s regulate growth in variety of ways, such as regulation of cell division is perhaps the most obvious and important role [17]. It is not clear that CK_s might function separately or in combined with other synthesized hormones such as indole-3-acetic. The reason of saying that is the decrease in flag leaf length in Mexipak and increase in Sham-3

Table (1) Cytokinin effects on phenological, yielding criteria, and chemical content in kernels of Mexipak and Sham-3 cultivars: M: Mexipak, S: Sham-3, M0: control, S0: control, M1: 40 ppm cytokinin, M2: 80 ppm cytokinin, M3: 120 ppm cytokinin, S1: 40 ppm cytokinin, S2: 80 ppm cytokinin, S3: 120 ppm cytokinin

Treatments	Plant height (cm)	Number of tillers	Flag leaf length (cm)	Weight of 100 kernel (g)	Number of kernel/spike	Protein percentage (mg/g)	Total carbohydrates (%)
M0	66.25	2.50	13.00	2.56	43.00	10.85	69.17
M1	62.50	1.75	12.50	2.12	41.00	13.13	71.75
M2	53.00	1.75	13.00	2.08	40.50	9.36	69.58
M3	30.25	1.75	8.25	2.19	48.50	12.62	68.11
S0	55.00	1.50	13.50	3.61	27.25	11.64	65.71
S1	46.50	1.75	15.00	2.47	32.25	12.17	68.72
S2	69.50	1.50	9.25	3.19	36.25	13.91	76.40
S3	60.00	1.75	12.75	2.56	22.00	12.27	75.76
LSD (0.05)	10.05	1.69	2.21	0.37	18.31	6.64	2.68

at 40 ppm concentrations. This proves again that not all plants might react or respond to the external addition of plant regulators. The number of kernel per spike has increased non- significantly in Mexipak at 120 ppm. While in Sham-3 the non-significant increase occurred at both 40 and 80 ppm. It is also clear from the same table that CKs at 40 and 80 ppm significantly decreased the weight of 100 kernels as compared to control for Mexipak, while in Sham-3, CKs at all concentrations significantly decreased the 100 seed weight. In some reviews, it has been reported that the exogenous CK_s treatments might increase CK_s activity and degradation, thus the composition and concentration of CKs in the site of action might be quite different in the site of application [18]. The cytokinin treatments have enhanced the carbohydrates quantity nonsignificantly in Mexipak at 40 ppm. While in Sham-3 this increment has occurred significantly at 40, 80 and 120 ppm table (1). With regard to protein content, CK_s has promoted the synthesis and accumulation of protein in both cultivars at all concentrations in a non-significantly manner except 80 ppm Mexipak. It is worth mentioning that CKs in general delay the senescence of plant and thus prolonging. The persistency of chlorophyll. The treatment of CKs causes the expansion of the plant organ due to the newly synthesized plant cell components and organelles. Thus it is obvious from previous explanation that the CKs can not achieve such activities unless it has causes a promotion of protein synthesis including the newly synthesized enzyme. This process can be magnified during the water stress and the increase production and of proline amino acid [19]. The kernel size and their compositions are always affected by the environmental conditions especially by temperature and water stress [20].

Interaction between cytokinin and drought period on Mexipak and Sham-3 cultivars

The results are shown in table (2, 3) that the drought process as being implicated in this study resulted in significant increase in tillers number per plant and total carbohydrates while the plant height and protein percentage decreased significantly in both cultivars.

It is believed that drought is reducing plant growth through inhibition of various physiological and biochemical processes, such as photosynthesis, respiration, translocation, ion uptake, nutrient metabolism and hormones [21]. Water stress reduces the rate of photosynthesis through limiting CO_2 diffusion due to reduced stomata conductivity, which reduces intracellular CO_2 concentration [22]. Water stress affects the plants in many ways. The reduction of mitotic activity of mesophyll cells in the meristematic zone is one of the water stress activity [23]. The availability of water for biological roles is essential for normal plant growth. It acts as solvent and transport medium, as electron donor in photosynthesis, and as evaporative coolant. It may be assumed that all plants have encoded capability for stress perception, signalizing and response, but plant species as well as genotypes within a species may vary in sensitivity and response to the decrease in cell water potential caused by drought [24]. Our prospective is to adapt plants, especially crop plants such as wheat to tolerate the droughtness until maturity.

The interaction between drought and cytokinin treatments nonsignificantly decreased plant height at all treatments but decreased tiller number significantly for both cultivars table (2, 3). The flag leaf length has increased non-significantly for

both cultivars at all treatments except CK_1D treatment where flag leaf length increased significantly at Mexipak cultivar table (2). The weight of 100 kernels increased significantly at CK3D and nonsignificantly for bothe CK1D and CK2D for Sham-3 table (3) while this character has been decreased significantly for Mexipak at both CK2D and CK3D and nonsignificantly increased at CK1D with regard to number of kernels/spike has increased nonsignificantly for Mexipak at both treatments CK2D and CK3D with exception for CK1D treatment table (2). It seems that there are a great variation genetically between these two cultivars which represents both hard and soft varieties which means that there must be some variation in between metabolism in both cultivar this is why some times the results revealed some variation with respect to these two cultivar responses to cytokinin treatments. Best on the above interpretation we have found that Sham-3 was completely differs in response to cytokinin treatments in comparison to Mexipak with regard to the number of kernel/spike. In general the protein synthesis accumulation have been decreased in both cultivars at all concentrations except CK1D

Table (2) Cytokinin effects on phenological, yielding criteria, protein and total carbohydrate content in kernels of Mexipak cultivar: N: normal irrigation, D: drought period 14-day, CK: Cytokinin, CK0: control, CK1: 40 ppm, CK2: 80 ppm, CK3: 120 ppm

Treatments	Plant height (cm)	Number of tillers	Flag leaf length (cm)	Weight of 100 kernel (g)	Number of kernel/spike	Protein percentage (mg/g)	Total carbohydrates (%)
CKoN	58.50	1.5	13.00	2.81	37.75	11.65	61.94
CKoD	48.00	3.5	10.82	2.10	22.50	5.67	66.75
CK1N	57.50	1.5	30.10	2.72	40.00	13.49	67.20
CK1D	44.75	2.0	17.75	2.24	19.00	5.62	70.78
CK2N	30.00	2.5	26.00	2.34	45.25	9.15	48.50
CK2D	42.50	1.5	11.00	0.99	30.25	5.41	54.68
CK3N	35.00	2.0	31.00	2.13	46.50	12.34	67.62
CK3D	42.00	2.0	11.25	1.15	30.25	3.40	55.90
LSD (0.05)	7.32	0.83	2.65	0.77	11.06	5.34	2.86

Table (3) Cytokinin effects on phenological, yielding characters, protein and total carbohydrate content in kernels of Sham-3 cultivar: N: normal irrigation, D: drought period 14-day, CK: Cytokinin, CK0: control, CK1: 40 ppm, CK2: 80 ppm, CK3: 120 ppm

Treatments	Plant height (cm)	Number of tillers	Flag leaf length (cm)	Weight of 100 kernel (g)	Number of kernel/spike	Protein percentage (mg/g)	Total carbohydrates (%)
CKoN	57.50	1.75	12.75	2.56	66.25	10.47	70.00
CKoD	45.00	2.50	9.07	2.12	62.50	4.01	74.98
CK1N	59.75	1.75	13.00	2.08	53.00	11.42	66.54
CK1D	43.75	0.50	11.50	2.19	30.25	4.07	62.99
CK2N	28.25	1.25	13.50	3.61	55.00	11.37	58.16
CK2D	40.50	0.50	10.12	2.47	46.50	3.64	45.66
CK3N	31.00	1.25	16.62	3.19	69.50	8.63	55.40
CK3D	40.00	1.75	10.25	2.56	60.00	3.56	54.91
LSD (0.05)	8.75	0.10	2.98	0.37	12.44	2.47	2.54

treatments this percentage has been increased nonsignificantly for Sham-3. This phenomenon of variation is one of the evidences which might support our previous speculation with regard to cultivar variation in response to external factor .The reduction of total carbohydrates content the reduction was similar to protein mode in both cultivars at all treatments except at CK1D treatment the percentage of carbohydrates has been increased for Mexipak only. It is obvious that the CK1D has the same effect in responses on protein and carbohydrates synthesis in both cultivars. We also conclude that not only the hormonal structure is importance but also the proper concentration might be very critical. The results of this study have clarified that hormones in general play an important role in keeping the plant to resist the droughtness or at least to reduce the major affect of such damages resulted from the unavailability of water. In this respect, CKs, in general prolonged the chlorophyll and the leaves as well as enhancing it is synthesis. These metabolic processes always required protein synthesis and such increase in protein has been manifested at 40 ppm CKs treatment [25]. It is worth mentioning also that CKs treatments of plant cells cause the enhancement of mineral absorption and translocation towards the site of action. And this might explain our result with regard to increase the number of kernels because of the abolishment of most ovules in embryos after anthesis and fertilization might be due to unavailability of nutrition coming from phloem vessels such as sugars, amino acids, vitamins and minerals. The addition of Cks might balance the hormonal status in plant cell; because during water stress the concentration of photosynthetic enzyme declined in response to drought [26]. It has been reported that during the water stress the biological parameter of crop is severely affected, thus altering the positive functions of amylase, protease, reducing and non-reducing sugars, protein and total amino acids but the interference such drought plants with external hormone treatments might affect such metabolic processes mentioned above as being manifested by this study.

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وەڵام دانەوەی دوو چەشنی گەنمی جیاواز(*Triticum spp*) بۆ خەستی سایتۆکاینین و باری ئاو وە کارلێکردن لە نێوانیاندا.

فەیسەڵ عبدالقادر سەکری، وەزارەتی خوێندنی باڵاو توێژینەوەی زانستی ، هەولێر.

شیرین عبدالکریم ئەمین، بەشی بایۆلۆجی, کولێجی زانست ، زانکۆی سەلاحەدین .

هەرێمی کوردستان\عێراق

پوختە

وەڵام دانەوەی دوو رەگەزی گەنمی جیاواز بۆ خەستی سایتۆکاینین و باری ئاو وە کارلێکردن لە نێوانیاندا لە رێگەی درێژی رووەك، ژمارەی گونە گەنم/ رووەکێك، درێژی گەڵای ئاڵا، ژمارە تۆ/گونەگەنمێك، کێشی 100 تۆ، رێژەی سەدی پێکهاتەی پرۆتین و بری کاربۆهیدراتی گشتی لە تۆدا. ئەنجامی لێکۆلینەوەکە دەری خست کە سایتۆکاینین بە خەستی 80 بەش لە ملیۆنێك بووە هۆی زیادەیەکی بەرجەستەیی لە درێژی رووەك بۆ رەگەزی شام3 بەڵام سایتۆکاینین بە خەستی 40 بەش لە ملیۆنێك زیادکردنێکی بەرجەستەیی نەبوو لەسەر درێژی گەڵای ئاڵا . سایتۆکاینین بە خەستی 40 وە 80 بەش لە ملیۆنێك بووە هۆی کەمکردنی بەرجەستەیی لە کێشی 100 تۆ بۆ رەگەزی مکسیباك بەڵام بۆ رەگەزی شام3 کێشی 100 تۆ کەمکردنێکی بەرجەستەیی بە خۆوە بینی بەرامبەر خەستیەکانی سایتۆکاینین. وەهەروەها رووەکی مامەڵە کراو بە خەستی سایتۆکاینین لەگەڵ ماوەی وشکی کاریگەری کەمتر بوو لەسەر پێکهاتەی کاربۆهیدراتی گشتی بۆ رەگەزی مکسیباك بەڵام بۆ رەگەزی شام3 بینرا کە خەستی سایتۆکاینین لەگەڵ ماوەی وشکی یان ئاودانی ئاسایی بووە هۆی کەمکردنی پێکهاتەی کاربۆهیدراتی گشتی بەشێوەیەکی بەرجەستەیی بەڵام کێشی 100 تۆ کاریگەرییەکی بەرچاوی نەبوو بەرامبەربە مامەڵەی CK3D بە بەراوووردکردن لەگەڵ CK0N بەڵام کەم بووەوە بە شێوەیەکی بەرجەستەیی بەبەراوووردکردن لە گەڵ مامەڵەی CK0D بۆ رەگەزی شام3.

استجابة صنفي من الحنطة (*Triticum spp*) لمعاملتي السايتوكاينين والجهد المائي والتداخل بينهما.

فيصل عبدالقادرسكري, وزارة التعليم العالي والبحث العلمي.

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اقليم كردستان\ العراق.

الخلاصة

تم اجراء هذا البحث بهدف معرفة استجابة صنفين من الحنطة لمعاملات السايتوكاينين والجفاف من خلال طول النبات، عدد السنابل/ نبات، طول ورقة العلم، عدد البذور/ سنبلة، وزن 100 حبة، النسبة المئوية للبروتين ومحتوى الكربوهيدرات الكلي في الحبوب. دلت النتائج بأن اعلى معدل لطول النبات قد سجل لصنف شام3 عند تركيز 80 جزء بالمليون والتي ازدادت بصورة معنوية مقارنة بمعاملة المقارنة بينما طول ورقة العلم ازداد بصورة غير معنوية عند تركيز 40 جزء بالمليون وان وزن 100 حبة قد انخفضت معنوياً لصنف مكسيباك عند تركيزي 40 و80 جزء بالمليون على التوالي بينما انخفضت بصورة معنوية عند جميع التراكيزلصنف شام3. اظهرت النتائج بان معاملات السايتوكاينين مع مدة الجفاف كان اقل تأثيرا مقارنة بالري الأعتيادي لمحتوي الكربوهيدرات الكلي لصنف مكسيباك بينما لصنف شام3 فان النباتات المعاملة بالسايتوكاينين مع مدة الجفاف او الري الأعتيادي قد ادى الى انخفاض محتوى الكربوهيدرات الكلي بصورة معنوية وكذلك وزن مئة حبة لم يظهر اي تغيير عند المعاملة CK3Dمقارنة بظروف CK0N ولكن انخفضت بصورة معنوية مقارنة بمعاملة CK0D.

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