IRRIGATION WITHHOLDING AND POTASSIUM FOLIAR APPLICATION EFFECTS ON WHEAT YIELD AND QUALITY

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ABSTRACT

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A field experiment was carried out at Tag AL-Ezz, Agricultural Research Station Farm, Dakahlia Governorate, Agricultural Research Center, Egypt (+7 m altitude, $31^{O}36^{'}$ latitude and 30^{O} $57^{'}$ longitude), during 2006-2007 and 2007-2008 seasons to study the effect of irrigation withholding *i.e.* without (control treatment), withholding last irrigation and last two irrigations and potassium foliar application *i.e.* without (control treatment), 1.5 and 3.0 % K_2O, as well as, their interaction on growth, yield and its components and grain quality of wheat cultivar Sakha 93. Also, a laboratory experiment was conducted at Seed Technology Research Unit in Mansoura, Dakahlia Governorate, Field Crop Research Institute, Agricultural Research Center, Egypt, to determine the germination percentage and seedling vigor tests (seed quality) of seed produced from the field experiment. The results indicated that water stress during grain filling through withholding last or last two irrigations markedly reduced growth, straw and grain yields and its components as well as seed quality characters in both seasons. In contrary, slight increases in grain protein content were resulted from withholding treatments in both seasons. Foliar application of potassium at the rate of 3.0 % K_2O gave the highest values of all studied wheat characters followed by 1.5 % K_2O as compared with control treatment in both seasons. It can be concluded from this study that maximum values of grain and straw yields as well as quality of grains and seed could be achieved from wheat cultivar Sakha 93 giving five irrigations and sprayed with 3.0 % K_2O. In case of shortage irrigation at the end of plant life cycle, it can be withholding the last irrigation and compensate happened reduction by spraying plants with 3.0 % K_2O solution.

Keywords: ***Triticum aestivum L., Irrigation withholding, Water stress, Potassium foliar***

INTRODUCTION

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 (Deng *et al.*, 2004). In these regions, irrigation water applied to plants becomes the limiting factor (Shehab *et al.*, 1997) 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. During grain filling in wheat plants are subjected to some unfavourable conditions such as low winter rainfall, shortage of water irrigation and the need to withholding irrigation for saving water and early land evacuation for cultivating the following crop. Great attention has been given to irrigation efficiency during the last decades aimed to saving water. Although, drought can affect all growth stages of wheat plant grain filling is considered to be one of the most sensitive growth stages to water deficit stress (Bradford, 1994). Water stress induces greater partitioning of photosynthates to roots in cereals (Palata *et al.*, 1994 and Palata and Gregory, 1997). Drought during grain filling could be limiting the rate and duration of filling processes, causing small grain size, earlier physiological maturity (Gupta *et al.*, 2001), reduce number of grains, low grain weight and grain yield of wheat. However, reducing irrigation increases average grain protein content in winter wheat (Pierre *et al.*, 2008).

The response of a plant to environmental stress is determined by its nutritional status. One of the mechanisms for improving plant tolerance to drought is to apply K which seems to have a beneficial effect in overcoming soil moisture stress. Potassium fertilization mitigates the adverse effects of moisture stress in plants by increasing translocation and maintaining water balance within plants (Greenwood and Karpinets, 1997). Foliar fertilization of crops can complement and guarantee the availability of nutrients to crops for obtaining higher yields (Arif *et al.*, 2006). Spraying wheat plants with K before subjecting the plants to drought treatment diminished the negative effects of drought on growth and in turn increases yield per plant (El-Ashry *et al.* 2005) since, plants are able to utilize foliar-applied K and translocate it to almost all plants parts. Foliar application of potassium significantly increased number of spikes/m^2, number and weight of grains/spike, 1000 – grain weight, grain and straw yields of wheat (Sarkar and Bandyopadhyay, 1991; Abou El-Defan *et al.*, 1999 and El-Sabbagh *et al.*, 2002).

Seed development in wheat can be distinctively divided into three sequential phases: (1) histodifferentiation (Raghavan, 1986 and West and Harada, 1993); (2) embryo maturation which is characterized by cell expansion and a massive accumulation of storage protein, lipids and carbohydrates and which ends at physiological maturity and (3) seed maturation (Kermode, 1990 and Bewley and Black, 1994). Maximum seed viability and vigor coincided with physiological maturity, with viability and vigor declining thereafter (Harrington, 1972). Drought during the first 6-14 days after anthesis in cereals, reduce the storage capacity of grains by decreasing the number of endosperm cells and/or the number of amyloplastes initiated. Water stress inhibits enzyme activity thereby causing premature desiccation (Saini and Westagate, 2000). Nevertheless, a common cause in all these events is the eventual depletion of grain moisture to a level below which metabolism can not be continued (Nayyar and Walia, 2003) produce smaller seed with less germination percentage and less seedling vigor (Sharma and Anderson, 2003). Available moisture and nutrition during grain development are the two main factors influencing seed development. Application of NPK to the parent crop influence seed composition which can also affect embryo development and subsequently seed vigor (Sharma and Anderson, 2003). Seed from potassium deficient plants are small, shriveled and are more susceptible to diseases, suitable amount of K can be improved seed quality (Fusheng, 2006).

The objective of this study was to find out the effects of irrigation withholding and potassium foliar application on growth, yields and its components as well as grains and seed quality of wheat cv. Sakha 93 under the environmental conditions of Tag El-Ezz district, Dakahlia Governorate.

MATERIALS AND METHODS

A field experiment was carried out at Tag AL-Ezz, Agricultural Research Station Farm, Dakahlia Governorate, Agricultural Research Center, Egypt, during 2006/2007 and 2007/2008 seasons to study the effect of irrigation withholding and potassium foliar application, as well as, their interactions on growth, yield and its components and grain quality of wheat cultivar Sakha 93. In addition, a laboratory experiment was conducted at Seed Technology Research Unit in Mansoura, Dakahlia Governorate, Field Crop Research Institute, Agricultural Research Center, Egypt, to determine the germination and seedling vigor tests of seed produced from the field experiment.

A- Field experiment

The field experiment was laid out in a strip plot design with three replicates. The horizontal plots were allocated to three irrigation treatments as follows; control treatment (giving plants 5 irrigations), withholding last irrigation and withholding last two irrigations. The horizontal plots were separated by deeper channels. The vertical plots were assigned to three potassium foliar application treatments *i.e.* control treatment (without spraying), 1.5 and 3.0 % K_2O in the form of potassium sulphate (48 % K_2O). The foliar solution was prepared at both rates and applied at the level of 200 Liter/fed using hand sprayer twice after 30 and 50 days from sowing.

At preparing seedbed, both physical and chemical analyses of experiment soil were estimated according to Jackson (1973) and corresponding data are presented in Table 1. Each experimental unit was (3 m X 3.5 m) occupying an area of 10.5 m^2 (*i.e.* 1/400 fed). The preceding summer crop was rice (*Oryza sativa* L.) in both seasons.

Table 1. Physical and chemical soil characteristics of the experimental site during 2006/2007 and 2007/2008 seasons

Seasons	Physical characteristics								
	Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	Soil texture	$CaCO_3$ (%)	Water table (cm)	Field capacity (%)	Real density (g/cm^3)
2006/2007	5.9	33.1	25.4	35.6	Clay loam	2.52	98	35.2	2.64
2007/2008	6.1	32.7	24.9	35.3	Clay loam	2.49	101	34.6	2.62

Seasons	Chemical characteristics					
	pH soil paste	EC dSm^{-1}	Organic matter (%)	Available nutrients (ppm)		
				N	P	K
2006/2007	7.8	2.3	2.12	35.4	7.8	222
2007/2008	7.5	2.2	1.76	33.3	7.6	220

The nitrogen fertilizer in the form of ammonium nitrate (33.0 % N) was applied as soil application at the rate of 75 kg N/fed in two equal doses prior to the first and the second irrigations. Potassium fertilizer in the form of potassium sulphate (48 % K_2O) at the rate of 50 kg/fed was applied in one dose before the first irrigation. Calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation at the rate of 150 kg/fed. The cultivation took place on November 26th in the first and 22nd in the second seasons, respectively. Wheat grains at the rate of 60 kg/fed were manually broadcasted (Afir method). The common agricultural practices for growing wheat according to the recommendations for the region were followed, except the factors under study.

Studied characters

Growth and yield components characters

After 120 days from sowing (After heading stage), one square meter was randomly choice from each experimental plot to estimate the following characters: plant height (cm) and flag leaf area (cm^2).

At harvesting time, one square meter was randomly selected from each experimental plot to estimate the following characters: spike length (cm), number of spikelets/spike, number of spikes/m^2, number of grains/spike and 1000 – grain weight (g).

Yields and grain quality traits

Grain yield (ardab/fed) was calculated by harvesting the all area of each experimental plot and left on air to dry, then it was threshed and the grains at 13 % moisture were weighted in kg then converted to ardab per fed (one ardab = 150 kg). Straw yield (t/fed); the resulted straw from each experimental plot was weighted in kg, then it was converted to tons per fed. Crude protein percentage in grains was chemically determined by improved Kjeldahl – method according to A.O.A.C. (1980).

All data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip plot design as published by Gomez and Gomez (1984) using the "MSTAT-C" computer software. The differences between treatment means were compared by New Least Significant Difference (N-LSD) method at the level of 5 % of probability as described by Waller and Duncan (1969).

B- Laboratory experiments

The germination test experiment was consisted of four replications of 100 seeds resultant from each treatment. 50 seeds were placed on two sheets of blotter paper in 14 cm Petri-dishes. The blotter paper was moistened with adequate distilled water. The Petri-dish was placed in a growth chamber (20 ºC). Standard germination tests were done according to A.O.S.A. (1993). Germination percentage was expressed by the percentage of seed germinating normally after 8 days. The four replications were used to evaluate the first count (the higher number of normal seedlings after 4 days is an indication of the better seed quality) according to Agrawal (1986). Shoot and root length (cm) were determined from 10 normal seedlings taken at random from each replicate at the end of standard germination test, then dried in a forced air oven at 110 ºC for 17 hours to obtain seedlings dry weight and expressed as milligrams (Agrawal (1986)). Collected data were subjected to the statistical analysis according to the technique of analysis of variance (ANOVA) for the factorial completely randomized design as published by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth and yield components

Irrigation withholding treatments *i.e.* control treatment (giving plants 5 irrigations), withholding last irrigation and withholding last two irrigations significantly affected spike length, number of spikelets/spike, number of grains/spike and 1000-grain weight in both seasons (Tables 2 and 3). Control irrigation treatment was associated with the highest values of growth and yield components with significant differences as compared with withholding last or last two irrigations in both seasons. Intensive water stress during grain filling (withholding last two irrigation) led to a reduction in growth and yield components which resulted in the lowest values of these characters in the two growing seasons. The reduction in growth and yield components due to water stress during grain filling might have been due to the inhibition in photosynthesis efficiency under insufficient water conditions (Siddique *et al.*, 1999). Similar results have been reported by Gupta *et al.* (2001).

Growth and yield components were significantly affected by potassium foliar application in both seasons (Tables 2 and 3). Spraying wheat plants with 3.0 % K_2O produced the highest values of growth and yield components followed by spraying plants with 1.5 % K_2O in both seasons; while control treatment (without potassium foliar application) gave the lowest values of these characters. This improvement in growth and yield component due to potassium foliar application may be ascribed to the role of potassium in improving many physiological growth processes and delay plant leaves senescence as well as increasing photosynthetic activity. These results are in line with those stated by Abou El-Defan *et al.* (1999) and El-Sabbagh *et al.* (2002).

There was significant interaction between irrigation withholding treatments and potassium foliar application on spike length, number of spikes/m^2 and 1000-grain weight in both seasons as well as number of grains/spike only in the second season (Tables 2 and 3). The highest values of growth and yield components were obtained from control treatment of irrigation (giving wheat plants 5 irrigation) in addition the highest level of potassium application (3.0 % K_2O) in both seasons. Contrary, the lowest values of these characters were produced from withholding last two irrigations and without potassium application (control treatment) in both seasons. Our results show that withholding last irrigation and spraying with 3.0 % K_2O solution markedly increased all growth and yield components, except spike length as compared with control treatment of both studied factors in the two growing seasons.

Yields and grain quality

Grain and straw yields/fed as well as grain protein percentages were significantly affected due to water stress treatments in both seasons (Table 3). The highest values of grain yield (19.61 and 19.48 ardab/fed) and straw yield (4.91 and 4.79 t/fed) were produced from control treatment (without water stress) in the first and second seasons, respectively. The reduction in grain yield as a result of withholding last and last two irrigations amounted by 10.49 % and 25.84 % as an average over both seasons, respectively. Also, straw yield decreased (13.19 % and 26.39 % as an averages over both seasons, respectively) due to withholding last and last two

irrigation. On the other hand, water stress treatments led to slight increases in grain protein content, whereas the highest values were resulted from withholding last two irrigations in the two growing seasons. This effect of water stress during grain filling on grain and straw yields may be due to the reduction in rate and duration of filling processes and causing small grain size consequently reducing yield components (number of spikes/m^2, number and weight of grains/spike and 1000-grain weight). Similar results were detected by Pierre *et al.* (2008).
Foliar application of potassium had a significant effect on yields and grain quality in both seasons (Table 3). The highest increases in grain yield were resulted from foliar spray with 3.0 % K_2O which reached 4.17 % and 10.24 % as compared with spraying with 1.5 % K_2O and without potassium spraying as an average over both seasons, respectively. Foliar application with 3.0 % K_2O caused a significant increase in straw yield which were 6.11 % and 16.53 % as compared with 1.5 % K_2O and control treatment as an averages over both seasons, respectively. The similar trend was noticed with respect grain protein percentage. These increases may be ascribed to the role of foliar spray with potassium on increasing photosynthetic activity which accounts much for high translocation of photoassimilates from leaves to the grains. Similar findings were stated by Sarkar and Bandyopadhyay (1991), Abou El-Defan *et al.* (1999), El-Sabbagh *et al.* (2002) and El-Ashry and El-Kholy (2005).
With respect to the effect of interaction between both studied factors, there was significant effect on yields and grain quality in both seasons (Table 3). The highest values of grain and straw yields/fed were produced from giving wheat plants 5 irrigation (control treatment) in addition spraying with 3.0 % K_2O in both seasons. On the other hand, the lowest values of both grain and straw yields were resulted from withholding last two irrigations and without potassium foliar application in both seasons. Noteworthy, withholding last irrigation and application the highest level of potassium (3.0 % K_2O solution) exceeded control treatment of both studied factors in yields, moreover increased grain protein percentage. Thus, it can be save the last irrigation of wheat crop and compensated the incident reduction in yields and quality by using potassium as foliar application (3.0 % K_2O).

Seed quality

Seed quality characters (of the resultant grains) *i.e.* germination percentage, first count, shoot and root lengths and dry weight of 10 seedlings were markedly affected by irrigation withholding treatments in both seasons (Table 4). Water stress during grain filling through withholding last or last two irrigations reduced all studied seed quality parameters, whereat the highest values of these traits were resulted from plants grown without water stress in both seasons. On the other side, the lowest quality of wheat seed was resulted from withholding last two irrigations in the two growing seasons. The reduction in wheat seed quality parameters may be due to eventual depletion of grain moisture which produces a significantly smaller endosperm, premature seed with potentially reduced germination percentage and seedling vigor. Similar conclusion was noticed by Saini and Westagate (2000) and Sharma and Anderson (2003).

Potassium foliar application exhibited a significant effect on germination percentage, first count, shoot and root lengths and dry weight of 10 seedlings in both seasons (Table 4). Using the highest levels of potassium (3.0 % K_2O) as foliar spray solution obtained the best seed quality measurements of wheat followed by spraying with 1.5 % K_2O solution as compared with control treatment in both seasons. Such enhancement in seed quality parameters may be attributed to the role of potassium in increasing translocation of photoassimilates from leaves to the grains. These results are partially agreed with those found by Fusheng (2006) and Sharma and Anderson (2003).

The interaction between irrigation withholding treatments and potassium foliar application had a significant effect only on germination % and 10 seedlings dry weight in both seasons. The highest values of germination % and 10 seedlings dry weight were produced from without irrigation withholding (control treatment) and spraying with 3.0 % K_2O solution, which were 98.6 and 98.0 % as well as 158.6 and 157.0 mg in the first and second seasons, respectively. While, the lowest values of these characters were resulted from withholding last two irrigations and without potassium foliar application in both seasons. It could be noticed that withholding last irrigation and spraying with 3.0 % K_2O solution produced highest values of germination %, root length and 10 seedlings dry weight as compared with without irrigation withholding and potassium foliar application in both seasons.

CONCLUSION

From obtained results, the maximum values of grain and straw yields as well as quality of grains and seed were resulted from giving wheat plants 5 irrigations and sprayed with 3.0 % K_2O solution. When shortage of irrigation water at the end of plant life cycle (withholding the last irrigation) it could be compensated the reduction in yields and quality through spraying with 3.0 % K_2O solution under the environmental conditions of Tag El-Ezz district, Dakahlia Governorate.

Table 2. Plant height, flag leaf area, spike length and number of spikelets/spike as affected by irrigation withholding, potassium foliar application and their interaction during 2006/2007 and 2007/2008 seasons

Treatments		**Characters**							
		Plant height (cm)		**Flag leaf area (cm^2)**		**Spike length (cm)**		**No. of spikelets/ spike**	
		2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008
A-Irrigation withholding									
Without (control)		109.0	106.7	38.8	37.9	11.2	11.2	21.1	20.9
Withholding last irrigation		108.2	106.3	38.5	37.1	10.4	10.3	20.4	20.2
Withholding last two irrigations		108.2	105.6	38.0	36.9	10.1	10.1	20.0	19.8
N-LSD 5 %		NS	NS	NS	NS	0.2	0.1	0.1	0.1
B-Potassium foliar application									
Without (control)		105.6	103.5	36.2	35.0	10.4	10.4	20.1	19.9
1.5 % K_2O/fed		108.7	106.1	38.5	37.6	10.6	10.5	20.5	20.4
3.0 % K_2O/fed		111.2	108.9	40.7	39.3	10.7	10.7	20.8	20.6
N-LSD 5 %		1.3	1.0	0.1	0.2	0.1	0.1	0.1	0.1
C- Interactions									
Without	Without	106.9	104.0	36.4	35.5	11.0	11.1	20.7	20.5
	1.5 % K_2O/fed	108.5	106.6	38.7	38.3	11.2	11.2	21.1	21.1
	3.0 % K_2O/fed	111.8	109.5	41.5	40.0	11.4	11.4	21.4	21.3
Withholding last irrigation	Without	105.2	103.6	36.2	34.8	10.2	10.2	20.1	19.9
	1.5 % K_2O/fed	108.4	106.2	38.6	37.4	10.4	10.2	20.4	20.3
	3.0 % K_2O/fed	111.1	109.0	40.5	39.1	10.6	10.4	20.8	20.6
Withholding last two irrigations	Without	104.8	103.0	35.9	34.6	10.0	10.0	19.6	19.5
	1.5 % K_2O/fed	109.2	105.5	38.3	37.2	10.2	10.2	20.0	19.8
	3.0 % K_2O/fed	110.7	108.3	40.0	38.9	10.2	10.2	20.3	20.0
N-LSD 5 %		**NS**	**NS**	**NS**	**NS**	**0.1**	**0.1**	**NS**	**NS**

Table 3. Number of spikes/m^2, number of grains/spike, 1000-grain weight, grain and straw yields as well as protein percentage as affected by irrigation withholding, potassium foliar application and their interaction during 2006/2007 and 2007/2008 seasons

Treatments		**Characters**											
		Number of spikes/m^2		**Number of grains/ spike**		**1000-grain weight (g)**		**Grain yield (ardab/ fed)**		**Straw yield (t/fed)**		**Protein (%)**	
		2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008
A-Irrigation withholding													
Without (control)		383.1	373.3	67.6	66.5	44.6	44.1	19.61	19.48	4.91	4.79	12.4	12.2
Withholding last irrigation		376.9	364.8	63.8	62.2	41.4	40.8	17.50	17.48	4.27	4.15	12.5	12.3
Withholding last two irrigations		372.0	363.1	58.8	57.4	37.1	36.2	14.56	14.43	3.65	3.50	12.6	12.4
N-LSD 5 %		NS	NS	1.2	0.3	0.3	0.5	0.25	0.07	0.03	0.07	0.1	0.1
B-Potassium foliar application													
Without (control)		336.0	328.4	60.8	59.1	39.2	38.0	16.31	16.30	3.95	3.79	11.7	11.5
1.5 % K_2O/fed		378.2	365.3	63.2	62.2	40.9	40.6	17.34	17.17	4.30	4.20	12.8	12.6
3.0 % K_2O/fed		417.8	407.5	66.2	64.7	43.0	42.4	18.02	17.92	4.57	4.45	13.1	12.9
N-LSD 5 %		7.5	3.9	0.9	0.7	0.6	0.3	0.23	0.06	0.03	0.05	0.1	0.1
C- Interactions:													
Without	Without	342.6	341.3	64.7	62.8	41.9	41.5	18.18	18.24	4.51	4.36	11.6	11.5
	1.5 % K_2O/fed	381.3	366.6	67.6	66.7	44.4	43.8	19.90	19.61	4.96	4.90	12.7	12.3
	3.0 % K_2O/fed	425.3	412.0	70.6	70.0	47.6	47.2	20.75	20.58	5.25	5.10	13.0	12.9
Withholding last irrigation	Without	337.3	322.6	61.5	60.0	39.9	38.9	16.87	16.80	3.97	3.85	11.6	11.4
	1.5 % K_2O/fed	377.3	365.3	63.6	62.4	41.4	41.4	17.43	17.31	4.23	4.14	12.8	12.7
	3.0 % K_2O/fed	416.0	406.6	66.5	64.2	42.8	42.1	18.20	18.34	4.60	4.47	13.1	12.9
Withholding last two irrigations	Without	328.0	321.3	56.2	54.6	35.8	33.8	13.88	13.85	3.37	3.15	11.8	11.5
	1.5 % K_2O/fed	376.0	364.0	58.6	57.6	37	36.7	14.68	14.60	3.70	3.57	12.9	12.7
	3.0 % K_2O/fed	412.0	404.0	61.5	60.0	38.6	38.0	15.12	14.85	3.87	3.77	13.1	13.0
N-LSD 5 %		**7.2**	**4.3**	**NS**	**0.7**	**0.4**	**0.4**	**0.33**	**0.13**	**0.04**	**0.06**	**0.1**	**0.1**

Table 4. Germination percentage, first count, shoot length, root length and 10 seedlings dry weight as affected by irrigation withholding, potassium foliar application and their interaction during 2006/2007 and 2007/2008 seasons

Treatments		Germination (%)		First count		Shoot length (cm)		Root length (cm)		10 seedlings dry weight (mg)	
		2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008
A-Irrigation withholding											
Without (control)		97.7	97.4	97.0	95.0	10.6	10.5	10.3	10.1	152.6	151.2
Withholding last irrigation		96.6	96.0	93.2	91.0	9.4	9.1	9.9	9.6	142.4	141.0
Withholding last two irrigations		92.8	92.3	89.3	88.1	7.7	7.5	8.9	8.7	116.3	109.6
N-LSD 5 %		0.4	0.5	0.9	0.7	0.1	0.2	0.1	0.1	1.6	1.0
B-Potassium foliar application											
Without (control)		94.8	94.4	91.4	89.0	8.8	8.6	9.4	9.1	131.6	128.7
1.5 % K_2O/fed		95.8	95.4	93.3	91.6	9.2	8.9	9.7	9.5	136.7	134.2
3.0 % K_2O/fed		96.5	95.9	94.7	93.4	9.8	9.6	10.0	9.8	143.0	139.0
N-LSD 5 %		0.4	0.5	0.9	0.7	0.1	0.2	0.1	0.1	1.6	1.0
C- Interactions											
Without	Without	96.6	96.3	95.3	93.0	10.2	10.1	10.0	9.7	146.2	145.1
	1.5 % K_2O/fed	98.0	98.0	97.6	95.0	10.5	10.4	10.3	10.2	153.2	151.6
	3.0 % K_2O/fed	98.6	98.0	98.0	97.0	11.2	11.0	10.6	10.4	158.6	157.0
Withholding last irrigation	Without	96.0	95.6	92.0	89.0	8.9	8.6	9.5	9.2	137.3	135.4
	1.5 % K_2O/fed	96.6	96.0	93.0	91.3	9.4	9.0	9.9	9.7	142.1	141.3
	3.0 % K_2O/fed	97.3	96.6	94.6	92.6	9.9	9.7	10.2	9.9	148.0	146.3
Withholding last two irrigations	Without	92.0	91.3	87.0	85.0	7.4	7.1	8.6	8.3	111.5	105.5
	1.5 % K_2O/fed	93.0	92.3	89.3	88.6	7.6	7.3	8.9	8.7	115.0	109.7
	3.0 % K_2O/fed	93.6	93.3	91.6	90.6	8.2	8.0	9.3	9.0	122.6	113.6
N-LSD 5 %		**0.7**	**1.0**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**2.9**	**1.8**

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