Evaluation of some Wheat Genotypes under Drought Stress in The Central Highland Area of Yemen

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ABSTRACT

Drought stress is a common problem in wheat (Triticum aestivum L.) production in Yemen. A field study was conducted during the 2004/2005 and 2005/2006 growing seasons at the farm of the Agriculture and Veterinary Medicine College, Thamar University, Thamar Governorate , to study the effect of water stress imposed at some different growth stages of some wheat genotypes. A split plot design with three replications was used. Four irrigation treatments (w1= full irrigation as recommended , w2= water stress at booting stage, w3= water stress at flowing stage and w4= water stress at dough ripe stage) were assigned to the main plots and five genotypes (Bhoth 13, Bhoth 14, bhoth 15, Saba and Gahran) were distributed at random within the sub plots. The results indicated significant various for most productivity traits such as (number of spikes / m^2 , number of kernels / spike, 1000-kernel weight, grain and biomass yield t /ha) as a result of water stress imposed at the different growth stages in both seasons of the studies. The genotype Bhoth 13 had the highest grain yield (3.7 t /ha), while Gahran had the lowest one (2.2 t / ha).

INTRODUCTION

The provision of irrigation and its economic use is of prime importance in the production of crops. The importance of the process for crop production is more acute under semi arid and arid climates where the sources of irrigation water are limited.

Wheat (Tritium aestivum L.) is one of the most important cereal crops in the world. It ranks the first of the world cereal crops followed by rice and maize (FAO, 2004). In the Yemen it is cultivated in 84 thousand ha (FAO, 2004). Plants vary in the timing of their high need for water; this need by different plant species depend on how much moisture stress are able to tolerant at any particular stage of growth. If water supply is actually inadequate, care should be taken at least to provide water at the critical stage of growth. Thus the knowledge of sensitive stage to water deficit by plants is very important for judicious water management.

Under dry areas the major limitation to cereal yields is the amount of available water. Drought tolerance in native plant species often defined as survival, but in crop species it should be defined in terms of productivity (Abd-El-moneim, 1999). However, quantification of drought tolerance should be estimated on grain yield under dry conditions in the absence of an understanding of specific mechanisms of tolerance. It is worth while that, relative yield of genotypes under drought and favorable environments seem to be starting point in identification of the related traits to drought and possibility of selecting suitable genotypes under dry areas.

Drought, during the vegetative growth stage, reduces the number of tillers and limits sink size (Sayed, 1987; Mohamed, 2005), while during anthesis, drought reduces grain yield by reduction of fertile flowers (Boyer, 1982; Oosterhuis and Cartwrite, 1983; Ghandorah, 1987). Moreover, drought stress during grain filling results in poorly filled grain and reduces the weight and number of kernels of wheat and, consequently, causes a reduction in yield productivity (Ghandorah et al., 1997).

The growth period most sensitive to drought stress, with impact on grain yield, is from double ridge to anthesis due to its negative impact on spikelet number and the kernels / spike (Shpiler and Blum, 1991). El-Kalla et al., (1994) reported that decreasing the available soil moisture content caused a significant decrease in spikes / m^2 , spike length, grain yield / plant, 1000-kernel weight as well as grain and straw yields / ha. Azraf- Ul – Hag et al., (1997) recorded significant differences in plant height and 1000-kernel weight. In addition drought stress from tillering to grain filling stages caused significant reduction in number of kernels / spike, seed index, grain yield and straw yield Eman (2000); Anton and Ahmed (2001); Mohamed, (2003).

The interaction between genotypes and irrigation treatments was significant for all studied traits except harvest index. Abd El – Moneim (1999) mentioned that significant differences were found among the bread wheat genotypes chosen for grain yield and its contributing characters.

Little information, concerning the influence of water stress on yield and yield components, is available, especially under the middle region of Yemen. The objective of this study was to evaluate the productivity of five genotypes under different water stress treatments imposed at different growth stages of wheat plant.

MATERIALS AND METHODS:

Two field experiments were carried out during 2004/2005 and 2005/2006 winter seasons in the experimental farm of the Faculty of Agric. and Vet. Medicine, Thamar Univer. Thamar Governorate, to evaluate some wheat genotypes under water stress induced at certain developmental growth stages. The soil texture of the experimental site was clay in both seasons. A split plot design with three replications was used. The main plots were assigned to four moisture stress treatments (missing one irrigation at stem elongation; missing one irrigation at flowering stage; missing one irrigation at grain filling stage; without missing any irrigation). The sub plots were devoted to five wheat genotypes (Bhoth 13; Bhoth 14; Bhoth 15; Gahran; Saba)which were distributed at random within the sub plots. The experimental plot was 15 m^2, i.e. 5 m long and 3 m width. Wheat grains were drilled in rows 25 cm apart with a rate of 120 kg / ha. Sowing date was in the first week of January in both seasons. The normal agronomic practices of wheat production under Thamar region were applied. Phosphorous fertilizer (46% $P_2O_{5)}$ was added before planting at the rate of 100 kg / ha, whereas nitrogen fertilization (46% N) at the rate of 120 kg N / ha in two equal portions: at planting and before the first irrigation. All plots were irrigated just after planting and crown-root initiation stage (30 days after sowing) . Afterwards, water stress treatments were imposed to allow the plants either unstressed (control treatment) or stressed by missing an irrigation at the previous mentioned different growth sages.

At harvest time, the following characters were studied.

- Biomass yield (t/ha): plants of each sub-plot were harvested, weighted and recorded as t / ha.
- Grain yield (t/ha): plants of each sub-plot were threshed; grain yield was weighted and recorded as t / ha.
- Number of spikes / m^2: determined from m^2 taken at random from each Sub-plot to determine the means of the following three spikes characteristics.
- Number of spikelets / spike;
- Spike length (cm);
- Number of kernels / spike;
- 1000-kernel weight (g): measured of as an average weight of three random samples.
- Harvest index %, calculated as biomass yield / grain yield of each sub-plot.

All the data were statistically analyzed according to Steel and Torrie (1982) and least significant difference at 0.05 level of significance was used for comparing the treatment means.

RESULTS AND DISCUSSION:

Data presented in Tables (1 and 2) elucidate that number of spikes/ m^2 was significantly reduced when plants were subjected to water stress at booting and flowering stages compared to the control treatment (well irrigated) plants in both seasons of the study. This might be attributed to the lack of available water during these stages which depressed the number of spikes/plant (Mouris et al., 1983). The results are in agreement with Ghowdhury et al., (1988). Whereas, skipping irrigation during these stages had significant effect on spike length in 2004/2005 season. However, no obvious effect was found on spike length in 2005/2006 season. This result is in accordance with Jan and Sen (1978).

Concerning the difference between genotypes in number of spikes /m^2 it was found to be not significant in the first season whereas, in the second season it was significant Tables (1 and 2). Saba genotype had the highest value of spikes /m^2 but, Gahran produced the lowest among the genotypes. The interaction between the moisture regimes and genotypes was not significant on number of spikes /m^2 in the first season. However, the difference was significant in the second season.

Inducing water stress at any developmental growth stage caused a reduction in wheat plant height Tables (1 and 2). The reduction was significant in both growing seasons, except to that subjected to water stress at dough ripe stage, where the reduction did not reach the level of significant when compared to the non-stressed plants. The most reduction in plant height was found when plants were water stressed at booting stage. Ibrahim et al., (1995) reported that minimum plant height was obtained when plants were exposed to water stress at the booting stage, when the terminal internode of the main stem elongated carrying its spike. With respect to the variation among the genotypes, there was a significant different on plant height in both seasons. The highest value of plant height was achieved for Bhoth 13 followed by Saba genotype, while the lowest was found for Gahran. The interaction between moisture regimes and genotypes was not significant in both seasons. This shows that water regime and genotypes act independently on the previous studied character. Water stressed during booting and flowering stages reduced significantly spike length in the first season whereas, in the second season the difference did not reach to the level of significant.

Regarding the difference among the genotypes in spike length (cm) found to be significant in both seasons. Bhoth 13 produced the highest value of spike length in the first season followed by Saba. However, in the second season the highest value of this trait was found for Saba. Meanwhile, the lowest value was found for Gahrain in both seasons..

Exposing wheat plants to drought at booting, flowering and dough ripe stage reduced significantly number of spikelets and number of kernels/ spike in both seasons, except that water stress during dough ripe stage on spikelets number did not reach the level of significant in the second season. The reduction in kernels/spike was 27.5, 17.5 and 5.7% in the first season, whereas in the second season it was 15.9, 10 and 5.7%, when plants were stressed at booting, flowering and dough ripe stages, respectively, as compared with non-stressed plants. These results might owe much to the low appearance of florets. Bingham (1967) obtained that physiological process which was affected by moisture stress through the spiklets primordia development tell ovules fertilization which leads to reduction in kernels number/spike. In addition to this moisture sometimes caused a reduction in fertile spikelets. These results are in accordance with (Boyer, 1982; Ghandorah, 1987; Kandil et al., 2001; Mohamed, 2005).

1000-kernel weight results in Tables (1 and 2) indicate that this trait was decreased significantly by exposing wheat plants to water stress at the different growth stages under study in both seasons. Similar results were reported by Eck (1988). The reduction in the value of 1000-kernel weight was 40.9, 34 and 26.4% in the first season, whereas it was 36.1, 21.5 and 15.4% in the second season, when wheat plants water stressed at booting, flowering and dough ripe stages, respectively, compared with non-stressed plants. The reduction in 1000-kerenel weight followed the same trend as those of number of spikes/ m^2, spike length, spikelets number and number of kernels/ spike. This decrement in 1000-kerenl weight was more pronounced whenever wheat plants were subjected to moisture stress at booting; such response might be due to lack of water absorbed, inadequate uptake of essential elements and/ or reduction in photosynthetic capacity under such unfavorable conditions (Kramer and Boyer, 1995 and Shangguan et al., 1999).

compensate the adverse effect caused by the exposure to drought conditions.

As for grain yield t/ ha results in Tables (1 and 2) reveal that grain yield was reduced significantly when plants were subjected to water stress at the different growth stages. The reduction of grain yield was 49, 33.3 and 13.6 % in the first season. However, it was 38.8, 28.3 and 9.2 % in the second season when plants were water- stressed at booting, flowering and dough ripe stages, respectively. Eman, (2000); Anton and Ahmed, (2001); Mohamed (2005) came to the same conclusion. The reduction in grain yield t/ ha due to missing irrigation at flowering might be attributed to low number and weight of spikes initiated under insufficient water conditions. Moreover, water stress to plants that were water- stressed at the beginning of reproductive period reduces assimilate translocation into the culm affecting the rate of grain growth until mid-grain filing.

Regarding the effect of water stress on biomass yield t/ha, data presented in tables (1 and 2) revealed that wheat plants subjected to water stress imposed at the different growth stages coused significant reduction

on biomass yield, except when water stress was imposed at dough ripe stage in the second season, where the reduction was not significant. The most reduction of biomass yield was recorded when plants were subjected to water stress at booting stage in both seasons compared to the non-stressed plants. The high reduction in biomass yield in this stage might be due to the reduction in plant height, number of spikes/ m^2, spike length and grain yield. This result concur with those of Abd-El-Gawad et al., (1993b) and McMaster et al., (1994) who reported that irrigation at late jointing is recommended due to its greater effect on tillers survival. This implies that developmental and physiological processes at late jointing stage are critical in determining final biological and grain yield and water stress should be avoided at this growth stage Eman (2000) and Kandil et al., (2001) came to the same conclusion.

The difference among genotypes in number of spikelets and number of kernels / spike, 1000-kernels weight, grain yield t/ ha and biomass yield t/ha did reach the level of significant. Data in Tables (1 and 2) indicated that Bhoth 13 had significant superiority in these traits followed by Saba genotype in both seasons. However, the lowest values were found for Gahran.

Regarding the interaction, data in Tables (3 and 4) raveled that a significant interaction was obtained between moisture regimes and genotypes in kernels/ spike, 1000-kernels weight, biomass yield and grain yield t/ha in both seasons. Bhoth 13 grown under adequate water supply (non-stressed plants) produced the highest values of these traits. On other hand, the lowest values in this regard were observed with Gahran genotype when grown under normal or stress conditions.

Table (1): Means of No. of sipkes/m^2, plant height , Spike length, No. of spikelets/ spike, No. of kernels / spike, 1000- kernel weight, Grain yield and Biomass yield of some wheat genotypes grown under different moisture regimes in 2004/2005 growing season.

Treatments \ Traits	No. of spikes $/m^2$	Plant height (cm)	Spike length (cm)	No. of spiklets/ spike	No. of kernels/ spike	1000- kernel weight (g)	Grain yield t/ ha	Biomass yield t/ ha
Moisture regimes (A)								
Non-stress	407 a	96.45 a	8.47 a	14.28 a	33.40 a	38.50 a	3.45 a	10.59 a
Stress at booting stage	352 c	91.59 c	6.98 b	12.92 c	28.19 c	24.50 c	2.31 c	8.91 d
Stress at flowering stage	374 bc	94.75 b	6.78 b	13.61 b	28.25 c	25.10 c	2.52 bc	9.43 c
Stress at dough ripe stage	394 ab	95.95 a	8.21 a	14.13 a	30.94 b	30.10 b	3.25 a	10.24 b
Genotypes (B)								
Bhoth 13	373 a	96.54 a	8.13 a	14.29 a	35.97 a	34.40 a	3.75 a	10.52 a
Bhoth 14	376 a	94.66 b	7.66 b	13.71 b	26.6 d	28.5 b	2.77 b	9.80 b
Bhoth 15	387 a	94.69 b	7.89 ab	14.1 a	28.4 c	20.82 c	2.92 b	9.24 c
Gahran	373 a	92.69 c	6.43 c	13..08 c	21.69 e	25.21 bc	2.16 c	8.93 d
Saba	393 a	94.85 b	7.78 ab	13.5 b	33.13 b	36.22 a	2.98 b	10.46 a
Interactions A X B	N.S	N.S	*	**	*	*	*	*

Means within a column followed by the same letter for each factor do not differ significantly at the 0.05 probability level according to $LSD_{0.05}$.
* Significant at the 0.05level of probability, N.s= not significant

Table (2): Means of No. of sipkes/m^2, Plant height spike length , No. of spikelets/ spike, No. of kernels/ spike, 1000- kernel weight, grain yield and biomass yield of some wheat genotypes grown under different moisture regimes in 2005/2006growing season.

Treatments / Traits	No. of spikes /m^2	Plant height (cm)	Spike length/ cm	No. of spiklets/ spike	No. of kernels/ spike	1000- kernel weight (g)	Grain yield t / ha	Biomass yield t / ha
Moisture regimes (A)								
Non-stress	384.07 a	98.05 a	9.93 a	15.94 a	33.23 a	40.01 a	3.81 a	11.52 a
Stress at booting stage	362.8 b	94.78 c	8.92 a	12.63 c	30.46 d	25.75 d	2.33 b	9.78 c
Stress at flowering stage	366.47 b	95.99 b	9.02 a	13.23 c	32.57 c	31. 39 c	2.73 b	10.33 b
Stress at dough ripe stage	378.33 a	97.37 a	9.20 a	14.21 b	34.16 b	33. 83 b	3.46 a	11.13 a
Genotypes (B)								
Bhoth 13	373.58 b	98.77 a	9.08 ab	15.46 a	34.41 a	42.16 a	3.58 a	11.12 a
Bhoth 14	371.25 b	95.74 b	9.14 ab	14.03 b	33.59 b	37.30 b	3.34 ab	10.72 b
Bhoth 15	374.92 ab	95.64 b	9.5 ab	13.48 b	34.71 a	25.76 e	3.06 b	10.70 b
Gahran	364 c	94.42 c	8.93 b	12.10 c	30.88 c	29.87 d	2.28 c	10.08 c
Saba	380.83 a	98.17 a	9.69 a	16.01 a	33.09 b	33.64 c	3.15 b	10.83 ab
Interactions A X B	**		**	*	**	**	**	**

Means within a column followed by the same letter for each factor do not differ significantly at the 0.05 probability level according to $LSD_{0.05}$.

** Significant at the 0.01 level of probability

Table (3): Means of Number of kernels/ spike, 1000-kernel weight (g), biomass yield and Grain yield t/ha of wheat as affected by moisture regimes and genotypes in 2004/2005 growing season.

Moisture regimes / Genotypes	Number of kernels/ spike				1000-kernel weight (g)				Biomass yield t /ha				Grain yield t/ha			
	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
Bhoth 13	39.77	30.26	36.13	37.73	45.4	27.5	28.8	35.9	11.5	9.4	10.0	11.1	5.12	2.77	2.96	4.6
Bhoth 14	29.38	20.26	24.39	26.96	39.2	22.4	25.4	26.0	10.2	9.1	9.7	10.2	4.24	1.47	3.12	3.23
Bhoth 15	28.68	21.02	23.74	27.13	27.8	16.0	16.6	18.7	10.2	8.4	8.9	9.5	4.14	2.20	2.3	2.61
Gahran	28.26	17.50	19.14	25.86	39.7	16.7	21.7	24.3	9.7	8.1	8.7	9.3	2.71	1.34	1.93	2.48
Saba	36.61	28.84	30.87	36.22	41.0	31.6	35.0	37.3	11.4	9.5	9.9	11.1	3.97	1.94	2.39	3.55
L. S. D 0.05	4.09				5.5				0.25				0.871			

W1 = Recommended irrigation;
w2 = water stress at stem elongation stage;
w3 = water stress at flowering stage;
w4 = water stress at milk stage.

Table (4): Means of Number of kernels/ spike, , 1000-kernel weight (g), Biomass yield t/ha and Grain yield t/ha of wheat as affected by moisture regimes and genotypes in 2005/2006 growing season.

Moisture regimes / Cultivars	Number of kernels/ spike				1000-kernel weight (g)				Biomass yield t/ha				Grain yield t/ha			
	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
Bhoth 13	37.00	31.37	34.5	34.78	46.1	39.13	40.9	42.5	12.5	10.1	10.8	11.2	4.78	2.61	2.89	4.06
Bhoth 14	36.3	30.6	33.13	34.33	44.5	30.03	34.83	39.83	11.6	10.0	10.3	11.0	4.22	2.05	3.22	3.89
Bhoth 15	38.33	31.17	34.0	35.33	30.76	23.57	24.3	24.4	11.5	9.8	10.4	11.1	3.33	2.67	2.89	3.33
Gahran	34.17	28.5	29.53	31.7	35.43	25.83	26.63	31.6	11.5	9.3	9.6	10.5	2.67	1.89	2.11	2.45
Saba	35.33	30.67	31.7	34.67	43.27	30.17	30.3	30.83	11.6	9.9	10.5	11.4	4.06	2.44	2.55	3.56
L. S. D 0.05	1.610				3.150				0.67				0.813			

W1 = Recommended irrigation;
w2 = water stress at stem elongation stage;
w3 = water stress at flowering stage;
w4 = water stress at milk stage.

REFERENCES

Abd- El- Gawad, A. A.; N. A. Noureldine; M. A. Ashoub and M. A. Kashabah (1993b). Studies on consumptive use and irrigation scheduling in relation to nitrogen fertilization on wheat 2- response of wheat yield and its attributes. Annals Agric. Sci. Ain Shams Univ. Cairo, 38 (1):173-181.

Abd El- Moneim, A. M. (1999). Evaluation of some bread wheat genotypes for drought tolerance under different levels of water supply. Egypt. J. Appl. Sci.; 14 (6): 95-116.

Anton, N. A. and A. H. Ahmed (2001). Productivity of barley plant under deficit and foliar application of potassium. J. Agric. Sci. Mansoura UNiv., 26 (6):3341-3357.

Azraf –Ui- Hay.; Naeam, M. and Bul- Akhtar (1997). Effect of different depth of irrigation on the grain yield of promising late sown wheat cultivars. Rachis., 16(1/2): 77-80.

Bingham, J. (1967). Investigation on the physiology of yield in winter wheat by comparisons of varieties and artifical variation in grain number. J. Agric. Sci. Camb. (68):411-422.

Boyer, J. S., (1982). Plant productivity and environmental. Science 218:443-448.

Eck, H. V. (1988). Winter wheat response to nitrogen and irrigation. Agron. J., 80 (6):902-906.

El-kalla, S. E.; A. A. Leilah; A. H. Basiouny and Samira, M. Hussien (1994). Effect of irrigation and foliar nutrition treatments on growth and yield of some wheat cultivars under El- Arish area conditions. Broc. Six. Technology of Agron., Al-Azhar, Univ., Cairo, Egypt, 4:365-378.

Eman, S. S. (2000). Yield and yield attributes of wheat in relation to nitrogen and withholding irrigation at different stages of growth. Annals Agric. Sci., Ain Shams Univ. Cairo, 45 (2):439-452.

Ghandorah, M. O., (1987). Response of wheat triticale cultivars to water stress. J. Coll. Agric., King Saud Univ. 9:59-72.

Ghandorah, M. O.; El-Shawaf, I. I; Moustafa, Kh. A.; Gadallah, A. M. (1997). Evaluation of some early generation of bread wheat genotypes grown under heat and water stress at the central region of Saudi Arabia. Arab. Gulf. J. Science. Res., 15(2):505-523.

Ghowdhury, R. K.; Arya, A. S. and Paroda, R. S. (1988). Drought susceptibility indices and grain yield in bread wheat. Genetica Agraia, 42 (2):177-186.

Ibrahim, M. E.; S. E. Esmail and F. M. Dawoud (1995). Effect of irrigation regime, nitrogen and phosphorous fertilization on yield, quality and rate of water loss from excised leaves as indicator to drought resistance in wheat. J. Agric. Res. Tanta Univ. 22 (1): 1-22.

Jan, P. K. and Sen, H. (1978). Effect of different stages of irrigation on the growth and yield of wheat. Indian J. Agron., 23 (1):19-22.

Kandil, S. A.; M. S. A. Abo El-Kheir and El-Zeiny, H. A. (2001). Response of some wheat cultivars to water stress imposed at certain growth stages. Egypt. J. Appl. Sci., 16 (1):82-98.

Kramer, P. J. and Boyer, J. S. (1995). Water relations of plants and soils. Academic press, San Diego, New York, Boston, London, Sydney, Tokyo, Toronto, 360-380.

McMaster, G. S.; W. W. Wilhelm and Bartling, N. S. (1994). Irrigation and culm contribution to yield and yield components of winter wheat. Agron. J., 86: 1123-1127.

Mohamed, A. H. (2003). Effect of irrigation and nitrogen fertilization on wheat yield. Ph. D. in Agric. Sci. (Agronomy) Faculty of Agric. (Saba Basha) Alex. Univ. Egypt.

Mohamed, A. H. (2005). Evaluation of two wheat cultivars under different moisture stress and nitrogen fertilization. Egypt. J. Plant Breeding (1): 49-64.

Moursi, M. A.; Nour, N. A.; El-Bagouri, O. H. and El-Sayed, A. A. (1983). Effect of drought conditions at different stages of plant age on growth, yield and grain quality. Egypt Soc. Crop. Sci. 303-315.

Oosterhuis, D. M. and Cartwrite, P. M., (1983). Spike differential and floret survival in semi-dwarf spring wheat as affected by water stress and photoperiod. Crop Sci. 23:711-716.

Sayed, H. I., (1987). Genotype-environment interaction, Heritability estimates and interrelationships for some traits in wheat. Arab Gulf J. Science. Res. Agric. Biol. Sci. B5 (1):35-46.

Shangguan, Z.; M. Shao and Dyckmans, J. (1999). Interaction of osmotic adjustment and photosynthesis in winter wheat under soil drought. J. Plant Physiol., 154:753-758.

Shpiler, L., and A. Blum (1991). Heat tolerance to yield and its components in different wheat cultivars. Euphytica 51: 257-263.

Steel, R. G. D. and T. H. Torrie (1982). Principles and procedures of statistics Mc Graw-Hill. International Book company 3rd . London, P. 633.

الملخص العربي

تقييم بعض التراكيب الوراثية لمحصول القمح تحت ظروف الجفاف في منطقة المرتفعات الوسطى من اليمن.

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أجري هذا الحث في المزرعة التجريبية بكلية الزراعه والطب البيطري جامعة ذمار اليمن خلال موسمي ٢٠٠٤/٢٠٠٥ و ٢٠٠٥/٢٠٠٦م وذلك بهدف تقييم بعض التراكيب الوراثية لمحصول القمح- بحوث١٣ – بحوث١٤ – بحوث١٥ – جهران وسبا للاجهاد المائي الناتج عن حذف رية عند مرحلة الحبل و طرد السنابل أو طور النضج العجيني وعدم تعطيش النباتات عند المراحل المختلفة (معاملة المقارنة). أوضحت النتائج أن صفات النمو ومحصول الحبوب ومكوناته قد نقصت معنوياً نتيجة تعريض النباتات للاجهاد المائي وكان هذا التاثير السلبي واضحاً ومرتفعاً عند مرحلة الحبل تلية مرحلة طرد السنابل في كلا الموسمين. كما أظهرت النتائج وجود اختلافات معنوية بين لاتراكيب الوراثية لجميع صفات المحصول ومكوناته وظهر بوضوح تفوق الصنف بحوث١٢ في معظم الصفات تحت الدراسة على جميع التراكيب الوراثية ويلية صنف سبا مقارنة بينما كان الصنف جهران أكثر االتراكيب حساسية للاجهاد المائي في مراحل النمو المختلفة. مما تقدم يمكن القول ام الصنفين بحوث ١٣ وسبا أكثر ملائمة تحت ظروف الجفاف في منطقة المرتفعات الوسطى من اليمن.