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CHEMICAL DESICCATION AS A SCREENING METHOD FOR POST-ANTHESIS DROUGHT TOLERANCE IN WHEAT

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ABSTRACT

Identification of post-anthesis drought-tolerant genotypes of wheat is of interest to breeders developing cultivars for arid and semi-arid regions. This study was conducted to evaluate the chemical desiccation as screening method for post-anthesis drought tolerance in wheat. Eighteen spring wheat entries (*Triticum aestivum* L.) were tested for two consecutive seasons in field experiments by applying a desiccant (0.4% w/v KI) ten days after anthesis. Effects of the chemical desiccation were compared with the effects of post-anthesis drought stress and optimum water availability (non-treated plots). In both seasons, post-anthesis desiccation tended to be related to post-anthesis soil water deficit in terms of the extent of genotypic injury to grain weight (S_k) and to grain yield (S_y). The ranking of genotypes under chemical desiccation for grain weight and grain yield injuries was to much extent similar with ranking under drought (rank correlation of 0.86 for S_k, and 0.83 for S_y, $p < 0.01$). A strong linear relationship was revealed between S_k values caused by desiccation and by drought ($R^2 = 0.82$) and a similar linear relationship existed between their respective S_y values ($R^2 = 0.68$). The relationships among post-anthesis stress tolerance and most other studied plant traits appeared to be mediated mostly through grain weight where the post-anthesis stresses did not significantly affect grain number per spike. Small grain size was found to be the major plant trait associated with tolerance to post-anthesis stresses, desiccation and drought. The contrasting relationship between S_k and potential grain weight in one side and between S_k and grain number per spike in the other side indicated that selection for reduced grain size, as a post-anthesis drought-adaptive trait, does not necessarily involve a reduction in potential yield. A change in sink geometry by moving toward smaller grains combined with a large number of grains per spike seemed to be promising in sustaining potential yield under such post-anthesis stresses. It was concluded that the post-anthesis application of the desiccant over the plant canopy effectively mimics the post-anthesis water deficit. Therefore, the genotypic post-anthesis tolerance to drought, in terms of assimilate remobilization for grain filling, can be indirectly screened for by post-anthesis chemical desiccation of plants in a non-stressful environment.

Key words: *chemical desiccation, post-anthesis drought, wheat.*

1. INTRODUCTION

Post-anthesis drought is often limiting yield of rain-fed wheat under Mediterranean environments and in many arid and semi-arid regions of the world. Breeding for drought tolerance is difficult because stress environments are erratic in nature in addition to a lack of reliable methods for identifying genetic sources for stress tolerance (Ceccarelli and Grando, 1996). Wheat breeders and physiologists continue to work to identify specific plant traits that may contribute to increased adaptation and stabilized yield in areas prone to post-anthesis drought. The effect of drought on wheat grain yield may be analyzed in terms of yield components, some of which can assume more importance than others, depending upon the stress intensity and growth stage at which it develops (Giunta *et al.,* 1993). Grain weight is among the most adversely affected traits by post-anthesis drought presumably by reducing assimilate supply to developing grains (Austin, 1989; and Saadalla, 1994). Sizable amount of nonstructural carbohydrates accumulate in stems of cereal grains, including wheat, immediately prior to and after anthesis and although some of these carbohydrates are consumed in plant respiration, some are remobilized to the developing grains (McCaig and Clarke, 1982; Davidson and Chevalier, 1992; and Schnyder, 1993). When cereal crops are subjected to severe post-anthesis drought stress, grain growth is increasingly supported by the mobilization of stem reserves relative to transient photosynthesis. These reserves have been estimated to contribute from 10 to 12% of the final grain yield in wheat under normal conditions and more than 40% under drought or heat stress (Nicolas and Turner, 1993; and Blum *et al.*, 1991). Genotypic variation has been reported in wheat ability to utilize these reserves for grain support under stress (Hossain *et al.*, 1990; and Haley and Quick 1993).

Chemical desiccants have been suggested as an indirect simple method to simulate post-anthesis drought stress for small grains. Spraying plants (grown in the field under well-watered conditions) at a precise time after anthesis causes total destruction of the plant's photosynthetic activities and consequently allows assessment for genotypic ability for translocation-based grain growth (Royo and Blanco, 1998; and Blum 1996). Some genotypes had the ability to remobilize their stem reserves than others where the extent of injury to grain growth by chemical desiccation was smaller in the former than in the latter genotypes. Therefore, post-anthesis chemical desiccation of wheat was found to be a potentially useful method for differentiation among wheat genotypes with reference to the utilization of stem reserves as a source for grain growth in the absence of transient photosynthesis. Selection procedures for post-anthesis drought stress under field stress environments are mostly impractical due to uncontrolled field environment and the complicating effects of the genotypic variation in plant phonology. In this respect, post-anthesis chemical desiccation could be a potential simulator for post-anthesis stress of the photosynthetic system caused by drought and/or heat.

The objectives of this study were: i) to assess the feasibility of post-anthesis chemical desiccation for identifying post-anthesis drought-tolerant wheat genotypes, and ii) to study the relationships between injuries in grain weight and grain yield and among agronomic and physiological traits under post-anthesis desiccation in comparison with actual field drought conditions.

2. MATERIALS AND METHODS

A set of eighteen spring wheat (*Triticum aestivum* L.) entries were grown in the winter-spring seasons of 1998/99 and 1999/2000 at the Agricultural Research Station of King Saud University at

Dierab, near Riyadh (24° 42′ N, 44° 46′ E, 400 Alt.), Saudi Arabia. The location has a high evaporative demand as being hot and dry with a total seasonal precipitation of 105.6 and 109.2 mm in 1998/99 and 1999/2000, respectively. The soil type at the experiment site was silty loam (*Typic Torriorthents*). The entries included advanced breeding lines and genetically diverse cultivars known to have a wide range of yield potential, grain weight, and variable tolerance to drought (Table 1). The planting date was 22nd of November in both seasons where a layout of split-plot design in a randomized complete block arrangement with four replications was followed in both seasons. The main plots received three treatments: i) chemical desiccation, ii) post-anthesis drought stress, and iii) optimum irrigation as a non-stress control treatment. The tested entries were randomized in sub-plots; each consisted of 8 rows, 2 m long and 0.3 m apart with seeding rate of 300 grain/m^2. Wide borders (3m) were kept among the main plots receiving different irrigation treatment and among plots within the same main plot (2m) to minimize the underground water permeability and protect adjacent plots from chemical desiccation treatment. In the chemical desiccation treatment, the whole plant canopy was subjected to a spray application of potassium iodide (KI, 0.4% *W/v*) containing a wetting agent (0.2 ml/L detergent) 10 days after anthesis of each cultivar. The desiccant was applied at a rate of 125 ml/m^2 using a hand-held boom apparatus where the spaced rows (0.3 m apart) allowed spray penetration into the whole plant canopy. In the drought treatment, irrigation was halted after early heading stage resulting in a severe post-anthesis drought. Non-significant rainfall was received during grain filling period. Monitored soil moisture content showed percentage plant available water less than 20% (calculated as a percentage of the difference between soil water content at field capacity and its content at wilting point) emphasizing severe water deficit during grain growth period. In the non-stressed treatment, optimum irrigation was applied (the monitored soil water content showed a percentage of plant available water above 65%). All other agricultural practices were followed as recommended for wheat cultivation in the experimental site.

At anthesis, 20 main-tiller spikes per each sub-plot were tagged. The tagged spikes were collected at maturity where the number and weight of grains per spike were determined. Number of days to anthesis was recorded on a sub-plot basis as days from sowing to 50% anther extrusion. Plant height was estimated at maturity as the mean of three random measurements in each sub-plot. Days to physiological maturity were estimated on a sub-plot basis as the complete loss of the spike's green color (Angus, *et al.*, 1981). At harvest, grain yield was weighed from the central 4 rows in each sub-plot.

Table (1):Identification and brief description of the studied wheat entries.

ID	Entry	Source	Relative Height [□]	Days to Anthesis	Days to Physiological Maturity
1	Yecora Rojo[Φ]	U.S.A	3	91	131
2	West Bread[Φ]	U.S.A	2	87	129
3	Giza 155	Egypt	5	105	136
4	Giza 160	Egypt	4	100	132
5	Sakha 69	Egypt	3	102	134
6	Sakha 8	Egypt	3	93	133
7	Waverly	U.S.A	2	110	138
8	Blanca	U.S.A	3	112	139
9	Sonnora 64	Mexico	3	97	131
10	Inia 66	Mexico	2	99	135
11	Shenap 70	Pakistan	3	108	140
12	Namiah	Jordan	5	114	146
13	Norin 28	Japan	1	93	131
14	Kloka	Germany	3	103	146
15	L_1[‡]	F7-line	3	103	132
16	L_2[‡]	F7-line	4	102	135
17	L_3[‡]	F7-line	3	106	130
18	L_4[‡]	F7-line	3	104	138

[Φ] Introduced and widely grown cultivars in Saudi Arabia.

[□] 1 = shortest to 5 = tallest.

[‡] Advanced breeding lines derived from crossing Giza 155 by Inia.

2.1. Statistical Procedures

The relative genotypic injury to final grain weight among the studied genotypes by desiccation and drought stresses was calculated as susceptibility index (S_k) following Clark *et al.*, (1992) as:

$$S_k = [\,(1-K_s/K_n) / (1-K_{ms}/K_{mn})\,] \times 100.$$

where K_s is stressed and K_n is non-stressed genotypic mean grain weight, and K_{ms} is stressed and K_{mn} non-stressed environment mean grain weight.

Similarly, a susceptibility index was calculated on grain yield basis (Sy) as:

$$S_y = [\,(1-Y_s/Y_n) / (1-Y_{ms}/Y_{mn})\,] \times 100.$$

where Y_s is stressed and Y_n is non-stressed genotypic mean yield, and K_{ms} is stressed and K_{mn} is non-stressed environment mean yield.

Genotypic differences in the studied traits were tested by standard analysis of variance and LSD procedures using Statistical Analysis Software (SAS; SAS institute Inc. 1992). Combined analysis of variance as outlined by Gomez and Gomez (1984) was followed for analyzing traits measured over seasons. Simple correlation coefficients were calculated among yield, grain weight, and other traits under desiccation, drought, and control treatments. Spearman's rank-correlation coefficient (Steel and Torrie, 1980) was applied to describe the relationship between the susceptibility indices of desiccation and drought after ranking the genotypic values of the two indices.

3. RESULTS AND DISCUSSION

Analysis of variance (not shown) indicated significant differences ($p < 0.01$) for grain weight and grain yield among the studied entries in both seasons and within treatments with significantly higher genotypic grain weight and grain yield under non-stressed comparing to desiccation and drought treatments. The susceptibility indices for grain weight (S_k) and for grain yield (S_y) are presented in Tables 2 and 3, respectively, where tolerant entries, with low relative reduction in grain weight or yield, had S_k or S_y values lower than 100% in the referred environments. A year-to-year comparison of the genotypic S_k and S_y indicated a reasonable degree of consistency for both stress indices where most of the genotypes tended consistently to have S_k and/or S_y lower than 100 % (tolerant) or higher than 100 % (susceptible) in both seasons (Tables 2 and 3). The mean genotypic S_k under desiccation and over the two seasons ranged from 56.3% for Blanca (the most tolerant) to 138.4% for Sakha 69 (the most susceptible), while the respective mean S_k under drought ranged from 48.6 % for Yecora Rojo to 145.3 % for Shenap (Table 2). Fischer and Maurer (1978) reported reasonable agreement between S_y calculated separately between experiments for most of the wheat genotypes in their study. Clark *et al.*, (1984) reported some year-to-year shifts in the S_y values. However, the genotypic S_k ranking in our study was to some extent similar for both desiccation and drought with rank correlation of 0.862 ($p < 0.01, n = 18$). Significant genotypic rank correlation was also revealed for the respective S_y values (rank correlation $= 0.836, p < 0.01, n = 18$). A strong linear relationship was revealed between S_k due to desiccation and its respective due to water deficit over the two seasons (R^2 = 82; Fig. 1). Furthermore, a similar linear relationship existed between S_y caused by desiccation and that by drought (R^2 = 0.68, Fig. 2). Blum and Pnuel (1990) reported highly significant association among S_k values of wheat cultivars due to desiccation and due to drought. In our study, the high R^2 value between S_k due to desiccation and its respective due to drought in addition to the highly significant rank correlation between the two indices emphasize relatively consistent effects of both stresses on grain weight as being the most affected yield component by post-anthesis stresses (Kobata *et al.*, 1992). Previous researchers indicated varying genotypic ability of maintaining heavy grains under post-anthesis desiccation to be dependent upon varying ability of remobilizing assimilate reserves from stems to developing grains (Hossain *et al.*, 1990; and Herzog, 1982). Others reported similar genotypic variation existed within cereal crop species in their ability to sustain grain growth by assimilate reserves mobilization; *i.e.*, Blum *et al.*, (1997) in sorghum, McCaig and Clark (1982) in oats, Haley and Quick (1993) in winter wheat, Royo and Blanco (1998) in *triticale*, and Schnyder (1993) in barley.

Prominent relationships between S_k, due to post-anthesis stresses, and several plant traits are illustrated in Table 4. Among the most meaningful relationships are the highly significant associations across genotypes between the non-stressful (potential) grain weight and each of S_k due to desiccation (0.692, $p < 0.01$, $n = 18$) and S_k due drought (0.605, $p < 0.01$, $n = 18$), where the genotypes with non-stressful heavy grains tended to be more stress susceptible. Thus, selection for smaller grains will most probably improve tolerance to post-anthesis stress in terms of sustaining least injury to grain filling.

Table (2): Mean percentage and rank of means for grain weight-based susceptibility index (S_k) under post-anthesis stresses of chemical desiccation (Des) and drought (Dry).

Entry	S_k (Des)		S_k (Dry)		Mean		Rank of Mean‡	
	1999/98	2000/99	1999/98	2000/99	S_k (Des)	S_k (Dry)	S_k (Des)	S_k (Dry)
	(%)							
Yecora Rojo	59.0	61.5	47.6	49.6	60.3	48.6	16	18
West Bread	54.1	68.1	87.7	91.9	61.1	89.8	15	11
Giza 155	134.2	132.3	125.2	115.9	133.2	120.5	3	6
Giza 160	122.2	124.4	91.7	110.6	123.3	101.1	6	9
Sakha 69	134.6	142.1	127.4	134.2	138.4	130.8	1	4
Sakha 8	98.1	99.7	92.2	88.1	98.9	90.2	10	10
Waverly	70.9	70.5	56.1	63.0	70.7	59.6	13	16
Blanca	54.3	58.2	66.4	73.1	56.3	69.8	18	14
Sonnora 64	92.5	76.5	89.7	66.0	84.5	77.8	11	12
Inia 66	102.3	96.6	116.3	112.1	99.5	114.2	9	8
Shenap 70	126.4	139.5	145.9	144.8	133.0	145.3	4	1
Namiah	140.6	135.8	143.8	144.6	138.2	144.2	2	2
Norin 28	60.5	58.9	72.3	69.2	59.7	70.8	17	
Kloka	119.8	126.3	144.0	133.4	123.0	138.7	7	3
L_1	60.5	68.4	52.8	62.7	64.5	57.8	14	17
L_2	106.4	104.7	115.8	112.8	105.6	114.3	8	7
L_3	89.5	61.7	60.5	66.1	75.6	63.3	12	15
L_4	129.0	127.5	123.1	119.4	128.3	121.3	5	5
Rank Correlation Coefficient							0.862**	

‡ 1 = most susceptible to 18 = most tolerant.

** Significant at $p < 0.01$ probability level, n = 18.

Table (3): Mean percentage and rank of means for grain yield-based susceptibility index (S_y) under post-anthesis stresses of chemical desiccation (Des) and drought (Dry).

Entry	Sy (Des)		Sy (Dry)		Mean		Rank of Mean‡	
	1999/98	2000/99	1999/98	2000/99	S_y (Des)	S_y (Dry)	S_y (Des)	S_y (Dry)
	(%)							
Yecora Rojo	85.2	82.3	78.4	62.3	83.8	70.4	15	15
West Bread	83.9	84.7	68.7	69.1	84.3	68.9	14	16
Giza 155	107.2	106.1	117.8	126.7	106.6	122.2	8	6
Giza 160	133.6	129.5	107.0	102.9	131.6	105.0	1	8
Sakha 69	120.4	116.6	111.5	110.9	118.5	111.2	6	7
Sakha 8	97.8	86.4	87.4	81.5	92.1	84.4	12	12
Waverly	56.6	67.9	62.7	61.0	62.3	61.8	16	18
Blanca	79.6	98.5	92.9	106.7	89.1	99.8	13	10
Sonnora 64	96.4	100.5	86.9	89.8	98.5	88.3	10	11
Inia 66	99.7	94.3	104.6	100.0	97.0	102.3	11	9
Shenap 70	114.8	108.2	129.6	121.8	111.5	125.7	7	4
Namiah	124.6	134.1	142.4	153.4	129.4	147.9	3	1
Norin 28	55.0	66.1	64.9	72.3	60.5	68.6	17	17
Kloka	125.5	136.3	120.5	125.7	130.9	123.1	2	5
L_1	51.7	59.9	76.3	88.5	55.8	82.4	18	13
L_2	124.0	115.9	136.5	127.5	119.9	132.0	5	2
L_3	103.1	106.7	82.3	82.1	104.9	82.2	9	14
L_4	134.6	120.3	129.5	132.4	127.4	130.9	4	3
Rank Correlation Coefficient							0.836**	

‡ 1 = most susceptible to 18 = most tolerant.

** Significant at $p < 0.01$ probability level, n = 18.

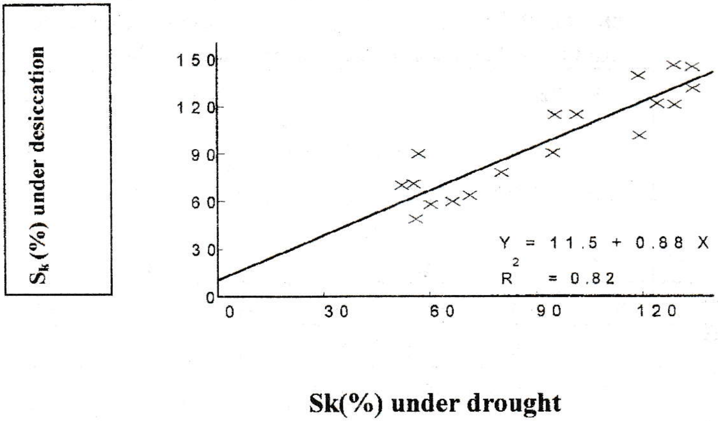

Fig.(1): The relationship between grain weight susceptibility indices (S_k) for 18 spring wheat genotypes under chemical desiccation and soil drought.

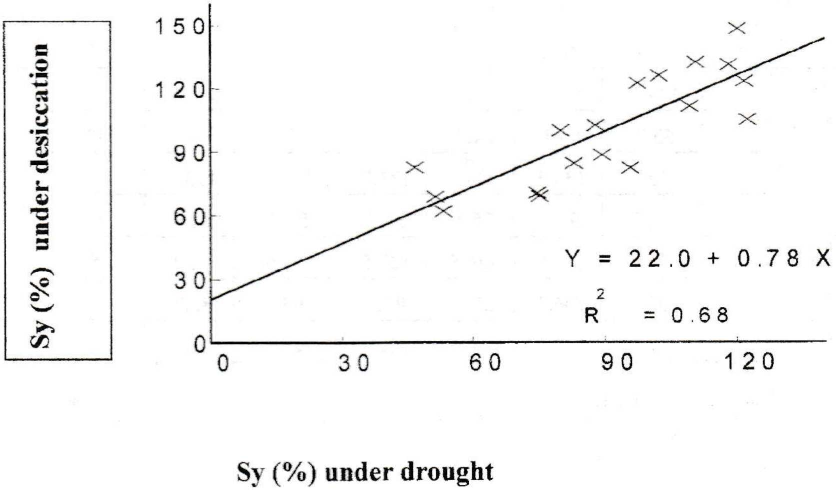

Fig.(2): The relationship between grain yield susceptibility indices (Sy) for 18 spring wheat genotypes under chemical desiccation and drought.

Therefore, a possible antagonism between improving potential grain weight, as a component of high potential yield, and the selection for drought adaptive traits is expected and was previously reported by Blum *et al.*, (1983b) and Blum *et al.*, (1991). However, the drought-adaptive trait of lower grain weight was relatively compensated by the high number of grains per spike, where the correlation study (Table 4) showed negative association between genotypic S_k values and non-stressed (potential) grain number per spike. Therefore, a non-significant association between S_k and the non-stressed (potential) total grain weight per spike was revealed, as expected, due to the contrasting relationships between S_k and each of potential grain weight and potential grain number. Furthermore, the negative association revealed between the non-stressed grain weight and the non-stressed grain number per spike (Table 4) emphasized that a reduction in potential grain size and associated expected improvement in tolerance to stress is not necessarily antagonistic to increased total sink size where small grains are mostly compensated by high potential grain number. Similar relationships among grain weight, grain number, and grain yield under stressful environments were reported in the literature (Blum *et al.*, 1983b; Blum *et al.*, 1991). However, the advantage of smaller grains is to be considered only for cultivars grown in environments where severe post-anthesis stress is highly expected. Previous research (Gusta and Chen, 1987 and Boyer, 1996) indicated that large size of grains might offer an advantage as a factor involved in plant compensation for the suppression of earlier yield components where earlier intermitted stresses occur during pre-anthesis growth stages.

Additionally, grain filling under stress appears to be affected by the duration of plant growth. A significant positive association is revealed between S_k and days from sowing to physiological maturity (DM), Table 4. The late maturing cultivars, *i.e.* Namiah and Kloka, were more grain-filling susceptible (high mean S_k value) to both post-anthesis desiccation and drought stresses. Additionally, in spite of non-significant positive correlation between S_k and days from sowing to anthesis (DA), a longer duration of pre-anthesis growth was associated with more days required for maturity (Table 4). These results are in agreement with the context of the well-known advantage of early maturing cultivars in hot and dry environments of arid and semiarid regions (Gusta and Chen, 1987).

Table (4): Correlation coefficients among the studied traits across 18 spring wheat entries.

Trait	Sk-Dry	GY-C	PH	DA	DM	TGW-C	GN-C	GW-C
S_k-Des	0.907**	-0.022	0.558*	0.370	0.542*	0.120	-0.486*	0.692**
GW-C	0.605**	0.337	0.590*	0.098	0.046	0.671**	-0.067	
GN-C	-0.547*	0.498*	-0.106	-0.463	-0.650**	0.631**		
TGW-C	0.074	0.608**	0.261	-0.402	-0.477*			
DM	0.641**	-0.546*	0.418	0.698**				
DA	0.312	-0.356	0.448					
PH	0.416	0.036						
GY-C	-0.163							

S_k-Des = % injury to grain weight by desiccation, S_k-Dry = % injury to grain weight by drought, GW-C = Non-stress grain weight, GN-C = Non-stress grain number per spike, TGW-C = Non-stress total grain weight per spike, GY-C = Non-stress grain yield, DA = Days to anthesis, DM = Days to physiological maturity, and PH = Plant height.

*, ** Significant at *P* = 0.05 and 0.01, respectively, df = 16.

Grain filling of tall cultivars in our study tended to be more susceptible to post-anthesis desiccation (r between S_k-Des and PH = 0.558, $p < 0.05$, $n = 18$), while the positive association of S_k due to drought with plant height was non-significant. Blum *et al.*, (1983a) working with spring wheat and Austin *et al.*, (1980) working with barley did not report any association between plant height and the rate of assimilate remobilization from the stem to the grains. The conflicting results could be due to different genotypic response and/or different timing of desiccation under different environments. However, Blum *et al.*, (1997) reported highly significant association between plant height and the ability of sorghum genotypes to mobilize assimilate reserves to sustain high grain weight under stress.

In conclusion, the genotypic post-anthesis tolerance to water deficit, in terms of assimilate remobilization for grain filling, can be indirectly screened for by post-anthesis chemical desiccation of plants in a non-stressful environment where the desiccant might mimic the effects of post-anthesis drought. The association between tolerance and most plant attributes appears to be mediated mostly through grain weight and total plant sink size.

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التجفيف الكيماوى كوسيلة لتقييم تحمل جفاف ما بعد الإزهار فى القمح

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ملخص

يعد التعرف على تراكيب وراثية من القمح متحملة للجفاف فى مرحلة ما بعد الإزهار ذو أهمية للمربين المنشغلين بتربية أصناف للمناطق الجافة وشبه الجافة ، ولقد أجريت هذه الدراسة لتقييم التجفيف الكيماوى كطريقة للتعرف على قدرة تحمل القمح لجفاف ما بعد الإزهار ، واستخدم للدراسة ١٨ مدخلا من القمح الربيعي (*Triticum aestivum* L.) تم اختبارها لموسمين متتاليين فى تجارب حقلية وذلك بالرش بمجفف (٠,٤% وزن/حجم ، أيوديد البوتاسيوم) بعد ١٠ أيام من الإزهار ، وتم مقارنة تأثير التجفيف الكيماوى مع تأثير إجهاد الجفاف فى مرحلة ما بعد الإزهار وأيضا مع معاملة الرى المعتاد (بدون إجهاد) ، وفى كلا الموسمين كان هناك اتجاه تلازم للضرر الناتج فى التراكيب الوراثية المختلفة عن كل من التجفيف الكيماوي ونقص ماء التربة فى مرحلة ما بعد الإزهار من حيث شدة الإصابة فى

وزن الحبة (S_k) وفى محصول الحبوب (S_y) ، وكان ترتيب التراكيب الوراثية بعد معاملة التجفيف من حيث الإصابة لوزن الحبة والإصابة لمحصول الحبوب مشابها إلى حد كبير لترتيبها فى حالة جفاف ما بعد الإزهار (تلازم مرتب ٠,٨٦ للـ S_k ، ٠,٨٣ للـ S_y ، باحتمال أقل من ٠,٠١) ، وكانت هناك علاقة انحدار قوية بين S_k المتسببة عن التجفيف الكيماوي وتلك المتسببة عن الجفاف ($R = 0.82$) وأيضا علاقة انحدار مشابهة بين قيم S_y المناظرة ($R = 0.69$) ، وكان لمدى تحمل إجهاد ما بعد الإزهار صلته بمعظم صفات النبات المدروسة أساسا من خلال وزن الحبة حيث أن عدد الحبوب بالسنبلة لم يتأثر بإجهاد ما بعد الإزهار ، وحيث وجد أن صفة صغر الحبوب كانت من أكثر الصفات تلازما مع تحمل إجهادات ما بعد الإزهار (التجفيف الكيماوي والجفاف) ، وأوضحت علاقة التضاد بين S_k وأقصى وزن للحبة (تحت البيئة الأمثل) من جهة وبين S_k وعدد الحبوب بالسنبلة من جهة أخرى أن الانتخاب لوزن حبة أقل (كصفة موائمة مع جفاف ما بعد الإزهار) لا يعنى بالضرورة نقص للمحصول ، حيث كانت هناك الدلالة على أنه يمكن الحفاظ على محصول عالي تحت ظروف إجهاد ما بعد الإزهار من خلال التعديل فى أبعاد المصب (Sink Geometry) بالاتجاه نحو وزن أقل للحبوب مصحوبا بعدد أكبر للحبوب فى السنبلة ، ومما سبق أمكن الاستنتاج بأن استخدام المجفف الكيماوي على الغطاء النباتي يماثل بكفاءة نقص الماء فى فترة ما بعد الإزهار ، وبناءا عليه يمكن قياس مدى تحمل التراكيب الوراثية لجفاف ما بعد الإزهار (وفيما يتعلق بقدرتها على إعادة توزيع نواتج التمثيل لغرض ملء الحبة) عن طريق غير مباشر بالاستدلال بالتجفيف الكيماوي للنباتات فى مرحلة ما بعد الإزهار وفى بيئة غير مجهدة.

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