The Response of Growth and Yield of the Semi-dwarf Wheat Cultivar 'Sidi Misri 1' to Water Regime and Cycocel.

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ABSTRACT

The response of growth and yield of the semi-dwarf wheat cultivar 'Sidi Misri 1', *Triticum aestivum* L., to water regime and Cycocel (CCC) application was investigated during the 1973/1974 and 1974/1975 growing seasons at the Faculty of Agriculture Farm in Tripoli. In general, there were significant increases with supplementary irrigation in plant height, peduncle length, spike length, number of tillers per plant, number of spikes per plant, total yield, grain yield, straw yield, harvest index, grain weight per plant, grain weight per spike, number of grains per plant, number of grains per spike, number of grains per square meter, and the weight of 1,000-grains.

The magnitude of these increases in yield and yield components due to irrigation was greatly enhanced by the addition of stable manure to the soil before planting. In addition to supplementary irrigation and stable manure, the CCC application at the 4-leaf stage produced the highest grain yield of 5.969 tons/ha.

The response of the various traits studied in this investigation to CCC treatments were variable.

INTRODUCTION

Under conditions favorable to lodging, grain yield of spring wheat was increased by treatment with the growth retardant CCC (5,8). Also, treatment with CCC has been reported to increase the tolerance of wheat plants to salinity (2) and water deficit (7). Under dry conditions, Humphries (6) found that treatment with CCC resulted in significant increase in grain yield of wheat. This effect was mainly attributed to more extensive root system in treated plants.

In Libya, where wheat is produced under irrigated as well as rainfed conditions, a series of experiments were initiated to investigate the response of tall- and short-straw cultivars to CCC application under different levels of nitrogen (3,4,10). The grain yield of the short-straw wheat cultivar 'Sidi Misri 1', was found to increase by the application of CCC in the absence of lodging. This was attributed mainly to the increase in number

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of grains per spike (4). Moreover, the same cultivar was reported to tolerate salinized water (up to 6,000 ppm) irrespective of CCC treatments (1).

There is no available information on the response of the semi-dwarf wheat cultivar 'Sidi Misri 1' to CCC treatment under rainfed conditions. Therefore, the present study was initiated to investigate the response of this cultivar to CCC treatments under irrigated as well as rainfed conditions.

MATERIALS AND METHODS

Two field experiments were conducted in the 1973/1974 and 1974/1975 seasons at the Faculty of Agriculture Farm in Tripoli. A split-plot design was laid in a superimposed block arrangement containing two water regimes (rainfed and supplementary irrigation)as the main plots and four CCC treatments as the sub-plots. These treatments were namely: application of CCC at the two-leaf, four-leaf, and boot stages of wheat growth as well as the control (no CCC). Cycocel, in a 40% formulation, was hand-sprayed at the rates of 3 and 5 kg/ha a.i. in the 1973/1974 and 1974/1975 experiments, respectively. The number of replications was five and four and the size of the harvested plots was four and sixteen square meter in the 1973/1974 and 1974/1975 experiments, respectively. The semi-dwarf wheat cultivar 'Sidi Misri 1' (*Triticum aestivum* L.) was hand-drilled in rows 30 cm apart at the rate of 100 kg/ha on 21 November, 1973, and on 6 November, 1974. Both experiments received 750 kg/ha of the 12–24–12 NPK fertilizer in three equal splits at planting, tillering, and boot stage. In the 1974 experiment only, stable manure was mixed with the top soil at the rate of 60 m^3/ha before planting.

After sowing, the experimental plots in both years were sprinkler irrigated until complete seedling emergence. Afterwards, the rainfed plots were left entirely dependent upon the natural rainfall until maturity, whereas the irrigated plots received supplementary surface-irrigation whenever needed.

RESULTS AND DISCUSSION

The amount and distribution of rainfall in the 1973/1974 and 1974/1975 seasons are given in Table 1. The total precipitation during the growing periods were 305.1 mm in 1973/1974 and 425.2 mm in 1974/1975. Also, the pattern of rainfall distribution differed between the two growing seasons. Low rainfall was observed during the period of

Table 1 Recorded rainfall during the 1973/1974 and 1974/1975 seasons at the Faculty of Agriculture Farm, Sidi Misri, Tripoli.

	Rainfall (mm)			
Month	1973/1974		1974/1975	
November	(23 Nov. & up)	50.5	(6 Nov. & up)	45.7
December		35.1		200.0
January		34.2		79.3
February		58.0		56.4
March		127.3		38.3
April		—		5.5
Total		305.1		425.2

vegetative growth (Nov., Dec., Jan.) in 1973/1974, with only 119.8 mm; whereas the rainfall during the same period in 1974/1975 was notably greater (325 mm).

The effects of CCC treatments under rainfed and irrigated conditions on the growth, yield and yield components of the cultivar 'Sidi Misri 1' are shown in Tables 2 to 16.

Plant height was highly significantly reduced by CCC application under both the rainfed and irrigated conditions in the 1973/1974 and 1974/1975 experiments (Table 2). However, the significant interaction between CCC and water regime in 1973/1974 indicated the differential effect of CCC with soil water conditions. It is apparent in this case that the response of plant height to CCC was more pronounced with supplementary irrigation than with rainfed alone except with the application of CCC at the 4-leaf stage. Compared to the control treatment (no Cycocel), the CCC application reduced plant height under supplementary irrigation by 8.5, 7.3 and 22.8% at the 2-leaf, 4-leaf, and the boot stage applications, respectively. On the other hand, the respective percent reduction in plant height was 3.7, 10.4, and 11.7 under the rainfed condition.

As an average of both water regimes in the 1973/1974 experiment, the CCC application at the boot stage resulted in the maximum reduction in plant heigh as compared to the 2-leaf and 4-leaf applications. The mean percent reduction was 6.3, 8.8, and 17.4 at the 2-leaf, 4-leaf and the boot stage applications, respectively. Irrespective of the CCC treatments, the plant height was significantly greater under the supplementary irrigation than with rainfed regimes (68.10 cm as compared to 62.11 cm).

The same response to CCC treatments, more or less, was observed in the 1974/1975 experiment, except that there was no CCC X water regime interaction. The percent reduction in plant height due to CCC treatments, irrespective of the water regimes, was 10.7, 21.5, and 28.2 at the 2-leaf, 4-leaf, and boot stage applications, respectively. Here also, the percent reduction in plant height was the highest with the CCC application at the boot stage. As with the 1973/1974 experiment, the plant height was greater with supplementary irrigation than with the rainfed regime (79.72 cm as compared to 64.51 cm). However, it is apparent that in 1974/1975 experiment, in which the stable manure was added to the soil, the plant height was greater with supplementary irrigation (79.72 cm) as compared to the same water regime in 1973/1974 (68.10 cm). This effect might be attributed, mainly, to the improved soil structure and, consequently, more extensive root system due to the application of stable manure. The soil at the College of Agriculture Farm in Tripoli, as with most of the Libyan arable land, is calcareous and subject to formation of surface crust after rainfall or irrigation. Besides, the high percentage of sand (over 80%) results in frequent compaction within the upper layers of the soil which may impede root penetration. Also, the addition of stable manure might have improved the nutrient balance of essential elements in the soil and, consequently, within the wheat plants (9).

The peduncle length was highly significantly reduced by CCC treatments in both years under supplementary irrigation as well as rainfed regime (Table 3). There was no significant effect on peduncle length due to water treatments in both years. This may indicate that the peduncle was less responsive to water level in the soil than the other internodes of this wheat cultivar. Such differential response (among various internodes) was shown by the significant effect of water regimes on total height (compare data of Tables 2 and 3).

As with plant height, there was a significant CCC X water regime interaction in the 1973/1974 experiment with respect to peduncle length. It is apparent that the greatest reduction in peduncle length was obtained with CCC application at the boot stage under supplementary irrigation (30% less than the control). With the same CCC treat-

Table 2 Effect of Cycocel treatments at different stages of growth and water regime on average plant height (cm) of wheat in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	75.38[c]	68.94	69.86	58.22	68.10	92.50	83.68	74.60	68.10	79.72
Rainfed	66.34	63.90	59.42	58.58	62.11	77.35	68.05	58.80	53.85	64.51
Mean[b]	70.86	66.42	64.64	58.50	—	84.93	75.86	66.70	60.98	—

[a] L.S.D. for water regime treatments: (0.05) = 2.57 & (0.01) = 3.45 cm (in 73/74); and (0.05) = 3.82 & (0.01) = 5.20 cm (in 74/75).
[b] L.S.D. for Cycocel treatments: (0.05) = 3.63 & (0.01) = 4.88 cm (in 73/74); and (0.05) = 5.40 & (0.01) = 7.35 cm (in 74/75).
[c] L.S.D. for interaction: (0.05) = 5.13 cm.

ment under rainfed regime, the percent reduction was less pronounced (21.8%). Also, as with total plant height (compare data of Tables 2 and 3), the percent reduction in peduncle length due to CCC application at 4-leaf stage was greater (7.3%) under rainfed condition than with the supplementary irrigation regime (4.4%).

Irrespective of the water regimes, the percent reduction in peduncle length due to CCC application at the 2-leaf, 4-leaf, and the boot stage were 6.3, 8.8, and 17.4 in the 1973/1974 experiment. However, in the 1974/1975 experiment, the reduction was more pronounced with the respective values of 10.7, 21.5, and 28.12 percent reduction. On the contrary to total plant height, the peduncle length was almost constant in both years, even though stable manure at the rate of 60 m^3/ha, in addition to the same chemical fertilizer treatment, was added to the experimental plots in 1974/1975. Since peduncle length did not change with variations in environmental factors, such as water regimes and soil fertility, it may be suggested that this plant trait was more genetically controlled than the other culm internodes. This can be supported by the observed significant difference in total plant height due to water regime as well as soil fertility (compare data of Tables 2 and 3).

Table 3 Effect of Cycocel treatments at different stages of growth and water regime on average length of peduncle (cm) of wheat in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean	Control	2-leaf	4-leaf	Boot	Mean
Irrigated	30.48[b]	28.42	29.14	21.34	27.34	31.15	29.63	28.23	23.33	28.08
Rainfed	30.84	28.78	28.60	26.60	28.71	30.70	29.18	29.33	24.75	28.49
Mean[a]	30.66	28.60	28.87	23.97	—	30.93	29.40	28.78	24.04	—

[a] L.S.D. for Cycocel treatments: (0.05) = 1.95 & (0.01) = 2.62 cm (in 73/74); and (0.05) = 2.03 & (0.01) = 2.76 cm (in 74/75).
[b] L.S.D. for interaction: (0.05) = 2.75 cm.

Table 4 Effect of Cycocel treatments at different stages of growth and water regime on average spike length (cm) of wheat in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	8.14	8.76	8.14	8.74	8.45	8.70	9.45	9.65	9.80	9.40
Rainfed	7.36	6.84	6.78	6.84	6.96	7.90	8.05	8.45	8.55	8.24
Mean[b]	7.75	7.80	7.46	7.79	—	8.30	8.75	9.05	9.18	—

[a] L.S.D. for water regime treatments: (0.05) = 0.42 & (0.01) = 0.57 cm (in 73/74); and (0.05) = 0.45 & (0.01) = 0.62 cm (in 74/75).
[b] L.S.D. for Cycocel treatments: (0.05) = 0.64 cm (in 74/75).

It is shown in Table 4 that the spikes length was highly significantly affected by the water regimes in both years. As an average of all CCC treatments, the supplementary irrigation increased the spike length, as compared to the rainfed regime, by 21.4% and 14.1% in the 1973/1974 and 1974/1975 experiments, respectively.

Only in the 1974/1975 experiment, there was a significant effect due to CCC application at the 4-leaf and boot stages. The respective percent increase in spikes length due to these treatments, as compared to the control, was 9.0 and 10.6.

The number of tillers per plant was found to be highly significantly affected by CCC treatments and water regime as well in the 1973/1974 experiment (Table 5). The supplementary irrigation resulted in 18.9% increase over the rainfed regime. Although the application of CCC increased tillering, the differences were significant only at the 4-leaf and boot stage treatments. Compared with the control, there was 25.5% and 17% increase in number of tillers due to these treatments. Data of the 1974/1975 experiment indicated that supplementary irrigation and CCC application also increased tillering, however, the increases were not statistically significant.

As shown in Table 6, the supplementary irrigation significantly increased the number of spikes per plant by 22.1% and 18.7% in the 1973/1974 and 1974/1975 experiments, respectively. Only in the 1974/1975 experiment, the CCC applications at the 2-leaf,

Table 5 Effect of Cycocel treatments at different stages of growth and water regime on average number of tillers per plant of wheat in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean
Irrigated	1.48	1.76	1.98	1.80	1.76	1.50	1.80	1.95	2.10	1.84
Rainfed	1.34	1.52	1.56	1.50	1.48	1.70	1.60	1.85	1.65	1.70
Mean[b]	1.41	1.64	1.77	1.65	—	1.60	1.70	1.90	1.88	—

[a] L.S.D. for water regime treatments: (0.05) = 0.17 & (0.01) = 0.23 tiller/plant.
[b] L.S.D. for Cycocel treatments: (0.05) = 0.24 & (0.01) = 0.32 tillers/plant (in 73/74).

Table 6 Effect of Cycocel treatments at different stages of growth and water regime on average number of spikes per plant of wheat in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	1.28	1.44	1.24	1.56	1.38	1.30	1.65	1.85	1.83	1.65
Rainfed	1.12	1.12	1.18	1.08	1.13	1.15	1.35	1.60	1.45	1.39
Mean[b]	1.20	1.28	1.21	1.32	—	1.23	1.50	1.73	1.64	—

[a] L.S.D. for water regime treatments: (0.05) = 0.17 & (0.01) = 0.23 spike/plant (in 73/74); and (0.05) = 0.14 & (0.01) = 0.19 spike/plant (in 74/75).
[b] L.S.D. for Cycocel treatments: (0.05) = 0.20 & (0.01) = 0.27 spike/plant (in 74/75).

and boot stages significantly increased the number of spikes per plant by 22%, 40.1%, and 33.3%, respectively.

The total yield (grain plus straw) and the grain yield showed the same trend in their response to water regime as well as CCC treatments (Tables 7 and 8). With supplementary irrigation, the total and grain yields of 7.306 and 1.675 tons/ha were significantly higher than those produced under rainfed conditions of the 1973/1974 experiment (4.514 and 1.070 tons/ha, respectively). The same response was found in the 1974/1975 experiment, except that the yields were far greater than those obtained in 1973/1974. The total yields in 1974/1975 were 12.086 and 7.723 tons/ha for supplementary irrigation and rainfed regime, respectively. The respective values for grain yield were 5.568 and 2.691 tons/ha. This high increase in both total and grain yields in the 1974/1975 experiment might be attributed mainly to improved soil condition (fertility as well as structure) due to the application of the stable manure. This trend in yield coincided with the information obtained with plant height (compare data of Tables 2, 7, and 8).

Cycocel application did not significantly affect either total yield or grain yield in both years. However, there was an appreciable increase in grain yield due to CCC application under supplementary irrigation in 1974/1975. The percent increase over the control was 15, 18.6, and 9% for the 2-leaf, 4-leaf, and boot stage applications, respectively.

Table 7 Effect of Cycocel treatments at different stages of growth and water regime on average total yield (grain plus straw) in tons/ha of wheat in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	7.723	7.278	7.278	6.945	7.306	11.953	12.422	12.141	11.828	12.086
Rainfed	4.945	4.723	4.000	4.389	4.514	8.000	7.344	7.969	7.578	7.723
Mean	6.334	6.001	5.639	5.667	—	9.977	9.883	10.055	9.703	—

[a] L.S.D. for water regime treatments: (0.05) = 0.611 & (0.01) = 0.833 ton/ha (in 73/74); and (0.05) = 0.549 & (0.01) = 0.748 ton/ha (in 74/75).

Table 8 Effect of Cycocel treatments at different stages of growth and water regime on average grain yield (tons/ha) of wheat in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	1.750	1.667	1.611	1.667	1.675	5.031	5.789	5.969	5.484	5.568
Rainfed	1.111	1.139	0.945	1.083	1.070	2.969	2.391	2.719	2.688	2.691
Mean	1.431	1.403	1.278	1.372	—	4.000	4.090	4.344	4.086	—

[a] L.S.D. for water regime treatments: (0.05) = 0.222 & (0.01) = 0.278 ton/ha (in 73/74); and (0.05) = 0.377 & (0.01) = 0.513 ton/ha (in 74/75).

The reduction in straw yield with CCC application was more pronounced and significant only at the 4-leaf and boot stage treatments in 1973/1974 (Table 9). As with the total and grain yields, there was significant increase in straw production due to supplementary irrigation in both years. However, the percent increase was 63.7 and 29.6 for the 1973/1974 and 1974/1975 experiments, respectively. This response was opposite to that of grain yield. As shown in Table 8, the supplementary irrigation has resulted in 56.5 and 106.9% increase in grain yield for the 1973/1974 and 1974/1975 experiments, respectively. Therefore, it may be concluded that the beneficial effects of supplementary irrigation with improved soil condition due to addition of stable manure in (1974/1975) was greatly reflected upon grain production rather than on straw. This conclusion was further substantiated by the data on harvest index (percent grain to total yield) summarized in Table 10.

The harvest index of 45.97% under supplementary irrigation was significantly higher than that obtained under the rainfed condition (34.7%) in the 1974/1975 experiment. On the other hand, the two harvest indices, were essentially the same in 1973/1974. Moreover, the CCC × water regime interaction was significant in 1974/1975 even though no significant response was found due to CCC treatments, irrespective of water regime, in both years. This significant interaction between water regime and CCC application in 1974/1975 indicated that, only under supplementary irrigation,

Table 9 Effect of Cycocel treatments at different stages of growth and water regime on average straw yield (tons/ha) of wheat in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	5.973	5.612	5.667	5.278	5.639	6.922	6.633	6.172	6.344	6.518
Rainfed	3.833	3.584	3.056	3.306	3.445	5.031	4.953	5.250	4.891	5.031
Mean[b]	4.917	4.612	4.362	4.306	—	5.977	5.793	5.711	5.618	—

[a] L.S.D. for water regime treatments: (0.05) = 0.278 & (0.01) = 0.361 ton/ha (in 73/74); and (0.05) = 0.388 & (0.01) = 0.531 ton/ha (in 74/75).
[b] L.S.D. for Cycocel treatments: (0.05) = 0.389 & (0.01) = 0.500 ton/ha (in 73/74).

Table 10 Effect of Cycocel treatments at different stages of growth and water regime on average harvest index (grain/total yield %) of wheat in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	22.56	23.04	22.06	23.92	22.90	41.78[b]	46.60	49.10	46.40	45.97
Rainfed	22.30	23.48	20.84	24.66	22.82	36.90	32.53	34.08	35.33	34.71
Mean	22.43	23.26	21.45	24.29	—	39.34	39.56	41.59	40.86	—

[a] L.S.D. for water regime treatments: (0.05) = 2.46 & (0.01) = 3.35%.
[b] L.S.D. for interaction: (0.05) = 4.92%.

there were significant increases in harvest index due to CCC application. The highest harvest index of 49.10% was obtained with CCC application at the 4-leaf stage under irrigated condition. This coincided with the highest grain yield of 5.969 tons/ha obtained under the same mentioned treatments of water and CCC (Table 8). Also, it should be noticed that, in the 1973/1974 experiment, the harvest index values were considerably low (ranging from 20.84 to 24.66%) compared with those of 1974/1975 experiment.

In general, it appears from the present data that there was a beneficial combined effect of supplementary irrigation, CCC application at 4-leaf stage, and improved soil conditions through the addition of stable manure.

Results shown in Table 11 revealed the highly significant effect of water regime on the average grain yield per plant in both years. Supplementary irrigation significantly increased the grain yield per plant by 91.7 and 125% in 1973/1974 and 1974/1975, respectively. It is apparent that the magnitude of increase, over the rainfed regime, was greater in 1974/1975 than in 1973/1974. This differential effect of supplementary irrigation regime over the two growing seasons might be attributed, at least in part, to a greater efficiency of irrigation with the presumably improved physical and chemical soil properties due to the addition of stable manure in 1974/1975.

Table 11 Effect of Cycocel treatments at different stages of growth and water regime on average grain yield per wheat plant (g) in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	2.90	3.34	3.04	3.66	3.24	3.94	4.80	4.87	5.55	4.79
Rainfed	1.60	1.66	1.82	1.68	1.69	1.62	1.90	2.60	2.44	2.13
Mean[b]	2.25	2.50	2.43	2.67	—	2.78	3.35	3.73	3.99	—

[a] L.S.D. for water regime treatments: (0.05) = 0.62 & (0.01) = 0.83 g/plant (in 73/74); and (0.05) = 0.56 & (0.01) = 0.76 g/plant (in 74/75).
[b] L.S.D. for Cycocel treatments: (0.05) = 0.78 g/plant (in 74/75).

Table 12 Effect of Cycocel treatments at different stages of growth and water regime on average grain weight per spike (g) of wheat in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	2.22	2.34	2.38	2.36	2.33	3.13	2.93	2.63	3.08	2.94
Rainfed	1.44	1.42	1.58	1.46	1.48	1.39	1.41	1.67	1.70	1.54
Mean	1.83	1.88	1.98	1.91	—	2.26	2.17	2.15	2.39	—

[a] L.S.D. for water regime treatments: (0.05) = 0.25 & (0.01) = 0.33 g/spike (in 73/74); and (0.05) = 0.42 & (0.01) = 0.57 g/spike (in 74/75).

As an overall average of water regimes, the CCC applications tended to increase grain yield per plant in both years. However, the differences were significant only in the 1974/1975 data with the 4-leaf and boot stage applications as compared to the control. These treatments resulted in 34.2 and 43.5% increase in grain weight per plant.

The average grain weight per spike was highly significantly increased due to supplementary irrigation in both years (Table 12). Irrespective of CCC treatments, supplementary irrigation increased the grain weight per spike over the rainfed condition, by 57.4% in 1973/1974 and 90.1% in 1974/1975. This response was parallel to that observed with the total grain yield, harvest index, and the grain weight per plant (compare data of Tables 8, 10, 11, and 12). In both years, the CCC treatments did not significantly affect the average grain weight per spike as indicated by the data of Table 12. Similarly, the average number of grains per plant and per spike showed no significant response to CCC treatments except with the number of grains per plant in 1974/1975 (Tables 13 and 14). The 4-leaf and boot stage CCC applications resulted in significant increase, over the control, of 36 and 48.4%, respectively. On the other hand, water regimes significantly affected the number of grains per plant and per spike in both years. With regard to the number of grains per plant, there was a significant increase

Table 13 Effect of Cycocel treatments at different stages of growth and water regime on average number of grains per wheat plant in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	67.20	84.00	67.08	91.04	77.33	71.68	91.80	95.30	105.45	91.06
Rainfed	42.16	42.96	42.52	43.32	42.74	38.50	40.85	54.50	58.00	47.96
Mean[b]	54.68	63.48	54.80	67.18	—	55.09	66.33	74.90	81.73	—

[a] L.S.D. for water regime treatments: (0.05) = 15.09 & (0.01) = 20.31 grains/plants in (73/74), and (0.05) = 12.71 & (0.01) = 17.29 grains/plant (in 74/75).

[b] L.S.D. for Cycocel treatments: (0.05) = 17.97 grains/plant (in 74/75).

Table 14 Effect of Cycocel treatments at different stages of growth and water regime on average number of grains per wheat spike in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	52.00	57.64	52.56	57.72	54.98	56.43	55.90	51.25	58.33	55.48
Rainfed	37.20	36.56	36.54	38.90	37.30	33.05	30.23	34.88	40.48	34.66
Mean	44.60	47.10	44.55	48.31	—	44.74	43.06	43.06	49.40	—

[a] L.S.D. for water regime treatments: (0.05) = 6.35 & (0.01) = 8.55 grains/spike (in 73/74); and (0.05 = 9.01 & (0.01) = 12.26 grains/spike (in 74/75).

with supplementary irrigation up to 80.9% in 1973/1974 and 89.9% in 1974/1975. The increases in number of grains per spike were 47.4 and 60.1% in 1973/1974 and 1974/1975, respectively, due to supplementary irrigation. This strongly positive influence of irrigation on these two yield components might, partially, explain the striking increase with irrigation in total grain yield, as indicated by Table 8, and the significant increase in total number of grains per square of ground area (Table 15). Irrespective of CCC treatments, increases in total number of grains per m^2 due to irrigation reached 43.9% in 1973/1974 and 81.8% in 1974/1975. Generally, the total number of grains/m^2 was not responsive to CCC treatments in both years.

Grain size (1,000-grain weight) was significantly improved by supplementary irrigation (Table 16). Compared with rainfed regime, the increases in grain size due to irrigation were 7.6 and 14.3% in 1973/1974 and 1974/1975, respectively. This positive effect, might also be attributed to the improvement in total grain yield due to irrigation. Cycocel did not significantly affect the grain size in 1974/1975 experiment. However, there were significant variations among various CCC treatments in the 1973/1974 data.

In conclusion, the results of the present investigation have shown that supplementary irrigation improved grain production of the semi-dwarf wheat cultivar "Sidi Misri 1". Moreover, the magnitude of this improvement due to irrigation was greatly enhanced by the addition of stable manure as well as CCC application at the 4-leaf

Table 15 Effect of Cycocel treatments at different stages of growth and water regime on average number of grains/m^2 of wheat in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	4049.3	4120.7	3573.5	4092.0	3958.9	9853.7	11052.0	12029.4	10414.1	10837.3
Rainfed	2908.3	2990.3	2208.1	2901.2	2752.0	6763.4	5401.1	5754.1	5923.8	5960.6
Mean	3478.8	3555.5	2890.8	3496.6	—	8308.6	8226.5	8891.7	8168.9	—

[a] L.S.D. for water regime treatments: (0.05) = 439.6 & (0.01) = 591.9 grains/m^2 (in 73/74); and (0.05) = 1230.9 & (0.01) = 1674.7 grains/m^2 (in 74/75).

Table 16 Effect of Cycocel treatments at different stages of growth and water regime on average grain size (1000-grain weight) in grams of wheat in 1973/1974 and 1974/1975 seasons.

Water regime treatments	Cycocel treatments									
	1973/1974					1974/1975				
	Control	2-leaf	4-leaf	Boot	Mean[a]	Control	2-leaf	4-leaf	Boot	Mean[a]
Irrigated	43.36	40.64	45.02	40.94	42.49	51.45	52.55	51.23	52.75	51.99
Rainfed	38.78	38.48	42.60	38.10	39.49	44.10	44.53	47.85	45.48	45.49
Mean[b]	41.07	39.56	43.81	39.52	—	47.78	48.54	49.54	49.11	—

[a] L.S.D. for water regime treatments: (0.05) = 2.40 g (in 73/74); and (0.05) = 2.30 & (0.01) = 3.12 g (in 74/75).
[b] L.S.D. for Cycocel treatments: (0.05) = 3.39 g (in 73/74).

stage. It is, therefore, recommended that stable manure or any similar substitute should be frequently added to the Libyan soils to improve their physical and chemical properties and, consequently, increases the grain yield of wheat. The value of CCC application should be further investigated in view of this recommendation.

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