# The Response of Vegetative Growth, Chlorophyll Content and Yield of Wheat to Grain Soaking in High Concentration of Cycocel (CCC).

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## ABSTRACT

The response of vegetative growth, leaf chlorophyll content, grain and straw yield of the semi-dwarf spring wheat cultivar "Sidi Misri 1" (*T. aestivum* L.) to grain soaking in a very high concentration (up to 40,000 ppm) of CCC prior to sowing were studied in a field experiment at Tripoli, S.P.L.A.J.

Compared to the control, grain soaking in 20,000 and 40,000 ppm CCC for 24 hours significantly delayed seedling emergence, reduced shoot length and shoot dry weight, increased root length and root dry weight as estimated three weeks after sowing.

Both chlorophyll a and b contents in leaves of plants 35 days after sowing were not affected by CCC treatments when expressed on the basis of fresh and dry weights; whereas a decrease in both chlorophyll pigments, ranging from 22 to 40%, was observed on the basis of leaf area. The same magnitude of reduction was found with leaf specific weight.

When grains were sown dry they produced 3.739 tons/ha grains, 10.500 tons/ha straw, 3.1 head-bearing tillers/plant, and 8.8 cm spike length. The corresponding values for grains soaked in 20,000 and 40,000 ppm CCC prior to sowing, respectively, were 4.461 and 4.822 tons/ha grains, 8.550 and 8.700 tons/ha straw, 5.0 head-bearing tillers/plant, 9.9 and 10.0 cm spike length.

## INTRODUCTION

A series of experiments were conducted in the last few years at the Faculty of Agriculture, Tripoli, Libya, to investigate the response of both tall-and short—straw spring wheat cultivars to CCC application under different levels of nitrogen fertilizer, salinity and water regimes (1,3,4,5,9). A profound response to foliar spray with CCC was reported in respect to reduction in stem height, increase in grain yield and some yield components which confirmed earlier reports by other workers (2,6,7). However, the method of CCC application and equipment required may limit the practical use of this growth retardant in cereal production.

One of the most convenient method of CCC application is through seed treatment prior to sowing. Previous reports on wheat grains treated with CCC, either under greenhouse conditions or in field, utilized rates ranging from 500 to 5000 ppm a.i. of CCC (2,8).

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It appears that higher concentrations of CCC were rarely tested. Therefore, the present study was conducted to investigate the response of the semi-dwarf wheat cultivar 'Sidi Misri 1' to grain soaking in very high concentrations of CCC prior to sowing in the field.

## MATERIALS AND METHODS

A field experiment was carried out in the 1976–1977 growing season at the Faculty of Agriculture farm in Tripoli, the Libyan Jamahiriya. A randomized complete block design was used in four replications. Each plot consisted of seven rows 30 cm apart and 5 m long. Sound grains of the semi-drarf spring wheat cultivar 'Sidi Misri 1' (*Triticum aestivum* L.) were sown on 13 December 1976 at the rate of 80 kg/ha either dry or after 24 hours soaking in water, 0.4% CCC (4000 ppm a.i.), 2% CCC (20,000 ppm a.i.), and 4% CCC (40,000 ppm a.i.). A liquid 40% formulation of cycocel was used to prepare the above mentioned CCC concentrations for grain soaking.

The experimental plots received 400 kg/ha of the 18-48-0 NPK fertilizer before sowing and 60 kgN/ha in the form of ammonium sulfate (20% N) as top dressing 40 days after sowing. Supplementary sprinkler irrigation was applied whenever needed. The number of days required for complete seedling emergence was recorded. Three weeks after sowing, samples of ten seedlings each were carefully dugout to recover the root system as much as possible. The roots were washed and the seedlings were cleaned for the determination of their vegetative growth.

For the estimation of the leaf chlorophyll a and b contents, fresh 35-day old plants were sampled from the field. One gram fresh weight of leaf tissue from each sample was cut into small pieces and the chlorophyll pigments were extracted by grinding the cut tissue with a mortar for about five minutes in 100 ml of 85% (v/v) acetone. Extracts were centrifuged at 3000 rpm for twenty minutes. Six extracted samples from each treatment were used for measuring the optical density at both 663 and 644 mu wavelength by using the 'Unicam Sp 600' spectrophotometer. Both chlorophyll a and b pigments were estimated by using the following equations:

(1) mg chl. a/g tissue = 1.07 (O.D. reading at 663 m u) −0.094(O.D. reading at 644 m u)
(2) mg ch. b/g tissue = 1.77 (O.D. reading at 644 m u) −0.280(O.D. reading at 663 m u)

The quantitative content of chlorophyll was estimated on the basis of fresh and dry weights as well as on a leaf area basis. In May 1977, the five middle rows of each plot were harvested for estimation of yield and its components.

## RESULTS AND DISCUSSION

Seedling emergence was significantly delayed by grain soaking in high concentrations of CCC compared with either non-treated or water-soaked grains (Table 1). Treatments with 20,000 and 40,000 ppm CCC retarded the emergence of wheat seedlings under field conditions by three to four days. Soaking grains in water significantly enhanced the seedling emergence by an average of two days in comparison with dry grains.

The delay in seedling emergence due to treatments with high CCC concentrations prior to sowing might be attributed to a slow rate of shoot cell elongation caused by the

Table 1 Effect of soaking wheat grains in high concentrations of CCC on seedling emergence and vegetative growth (3 weeks after sowing).

| Treatment of wheat grains | Number of days to seedling emergence | Vegetative response | | | | | |
|---|---|---|---|---|---|---|---|
| | | Longest root (cm) | Shoot length (cm) | Root dry weight (mg/plant) | Shoot dry weight (mg/plant) | Root/shoot dry weight (%) | Total dry weight (mg/plant) |
| Dry | 10 | 9.7 | 12.8 | 8.2 | 13.8 | 60 | 22.0 |
| Soaked in distilled water | 8 | 10.8 | 13.1 | 11.2 | 16.0 | 69 | 27.2 |
| Soaked in 4,000 ppm CCC a.i. | 11 | 12.2 | 9.6 | 11.2 | 14.6 | 77 | 25.8 |
| Soaked in 20,000 ppm CCC a.i. | 13 | 14.1 | 8.5 | 17.1 | 12.7 | 140 | 29.8 |
| Soaked in 40,000 ppm CCC a.i. | 14 | 13.6 | 8.0 | 10.7 | 12.5 | 87 | 23.2 |
| LSD at 5% | 0.9 | 1.8 | 1.4 | 3.9 | 2.5 | 42 | 4.2 |
| LSD at 1% | 1.4 | 2.6 | 1.9 | 5.5 | 3.4 | 59 | 5.9 |

inhibiting effect of CCC (6). This was demonstrated by the significant reduction of shoot length, as shown in Table 1. Compared with dry grains, soaking wheat grains in 4,000, 20,000, and 40,000 ppm CCC for 24 hours significantly reduced the shoot length (3 weeks after sowing) by 25, 34, and 38%, respectively.

On the other hand, treatments with CCC significantly increased the root length over both dry and water-soaked grains. Soaking wheat grains in 4,000, 20,000, and 40,000 ppm CCC resulted in root length increments of 26, 45, and 40% as compared with dry grains, respectively. These findings might indicate the beneficial effect on root growth due to grain treatments with CCC. Under the semi-arid conditions prevailing in the Jefara area and elsewhere in the Libyan Jamahiriya where most of the wheat acreage is entirely dependent upon an annual rainfall of 150–450 mm and is produced in light sandy soil with low water-holding capacity, the enhancement of root growth due to CCC treatments may improve the efficiency of water use by wheat plants. Humphries (7) had previously reported such beneficial effect of CCC treatment on wheat yield under dry conditions. In view of these results, it might be recommended that a more intensive investigation could be carried out in the future to assess the practical use on a large scale of the wheat grain treatment with CCC under rainfed conditions in the Libyan Jamahiriya.

Root masses, as estimated by the dry weight of recovered rootlets, lend more supporting evidence to the beneficial effect of grain treatments with CCC (Table 1). Soaking grains in 20,000 ppm CCC significantly increased the root dry weight of wheat seedlings by about 108% above the dry grains (control). Moreover, soaking in water and 4,000 and 40,000 ppm CCC resulted in appreciable increments, although not significant, in dry weight of seedling roots by 37, 37, and 30%, respectively, compared to the control.

The response of shoot-seedling dry weight to soaking of grains in very high concentrations of CCC was opposite that of roots. Treatments with 20,000 and 40,000 ppm CCC insignificantly reduced the shoot dry weight by only 8 and 9%, respectively, as compared with dry grains. This slight negative effect of CCC on shoot dry weight was less than the increase in dry weight of roots for the same treatments. This may indicate that the significant shortenting in shoots, due to CCC treatments, does not substract from the total mass of the wheat seedlings. This conclusion was further substantiated by the increase in the total seedling dry weight by CCC treatments, as shown in Table 1. Soaking grains in 4,000, 20,000 and 40,000 ppm CCC increased the total seedling dry weight above dry grains by 17, 35, and 5%, respectively. However, the increment was significant only with the 20,000 ppm CCC treatment. Also, soaking grains in water, prior to sowing, significantly increased the total dry weight of seedlings by 24%, as compared with dry grains. This increase probably was due to the earlier emergence (two days ahead of dry grains) of seedlings. On the other hand, the increments in total dry weight, with CCC treatments, were mainly attributed to the enhancement of root growth, since there was a delay of few days in seedling emergence, as was previously discussed. This observation is further supported by the positive increase in root/shoot dry weight ratio due to CCC treatments. The root/shoot dry weight ratios were only 60 and 69% for dry and water-soaked grains; whereas ratios of 77, 140, and 87% were found with grains soaked in 4,000, 20,000, and 40,000 ppm CCC (see Table 1 and Fig. 1), respectively.

Table 2 summarizes the data of the quantitative contents of chlorophyll a and b in leaves of 35-day old wheat plants as influenced by CCC treatments. It is apparent from these results that the estimated leaf chlorophyll pigments a and b, as expressed on fresh and dry weight bases, were not affected by CCC treatments. However, there


Fig. 1. Effect of soaking wheat grains in CCC on seedling growth. Treatments from left to right are: dry grains, soaked in water, soaked in 4,000 ppm CCC, soaked in 20,000 ppm CCC, soaked in 40,000 ppm CCC a.i.

were significant reductions in both chlorophyll contents due to CCC treatments when they were estimated on the basis of leaf area. In the case of chlorophyll a pigment, soaking wheat grains in 4,000, 20,000, and 40,000 ppm CCC resulted in 26, 28, and 40% reductions, respectively, as compared to dry grains. Also, the same treatments decreased chlorophyll b pigment by 22, 23, and 35%. These results might be explained by the production of broader and thinner leaves due to CCC treatments. This could be the case since the leaf specific weight was found to be decreased with grain soaking in CCC. The values of leaf specific weight were 7.8, 5.4, 5.2, and 4.5 mg/dm$^2$ for dry grains and grains soaked in 4,000, 20,000, and 40,000 pm CCC, respectively. Compared to the dry grains, these CCC treatments reduced the leaf specific weight by 31, 33, and 42%. This trend coincides with that of chlorophyll a and b contents on the leaf area basis.

Earlier reports (2) suggested that wheat grains soaked in the range of 500 ppm CCC for 14 hours increased chlorophyll content of leaves. The present study, however, showed that soaking wheat grains in much higher CCC concentrations for 24 bours either did not affect chlorophyll content of leaves (on both fresh and dry weight bases) or greatly reduced it when estimated on leaf area basis. These disagreements may be attributed, beside the differences in CCC concentrations, to varietal and environmental factors. El-Damaty *et al.* (2) used a different wheat cultivar grown under greenhouse conditions.

Results of the total yield (grain + straw) did not show significant differences due to CCC treatments (Table 3). However, there were reductions of 5, 9, and 5% due to treatments with 4,000, 20,000, 40,000 ppm CCC, respectively, as compared with dry grains. On the other hand, there were increases in grain yield, although statistically

Table 2 Effect of soaking wheat grains in high concentrations of CCC on seedling chlorophyll content (35 days after sowing).

| | Fresh weight basis (mg/g) | | Dry weight basis (mg/g) | | Leaf area basis mg/dm² | |
|---|---|---|---|---|---|---|
| Treatment of wheat grains | Chl. a[a] | Chl. b | Chl. a | Chl. b | Chl. a | Chl. b |
| Dry | 0.988[b] ±0.007 | 0.408 ±0.008 | 6.027 ±0.043 | 2.489 ±0.049 | 4.709 ±0.034 | 1.945 ±0.038 |
| Soaked in distilled water | 0.945 ±0.004 | 0.390 ±0.005 | 6.426 ±0.027 | 2.652 ±0.034 | 5.060 ±0.021 | 2.088 ±0.027 |
| Soaked in 4,000 ppm CCC a.i. | 1.024 ±0.005 | 0.449 ±0.004 | 6.451 ±0.032 | 2.829 ±0.025 | 3.468 ±0.017 | 1.521 ±0.013 |
| Soaked in 20,000 ppm CCC a.i. | 0.970 ±0.008 | 0.430 ±0.008 | 6.499 ±0.054 | 2.881 ±0.054 | 3.403 ±0.028 | 1.508 ±0.028 |
| Soaked in 40,000 ppm CCC a.i. | 0.977 ±0.004 | 0.438 ±0.003 | 6.351 ±0.026 | 2.847 ±0.020 | 2.835 ±0.012 | 1.271 ±0.009 |

[a]Chl. = Chlorophyll.
[b]Figures represent the mean values ± the standard errors.

not significant, of 19 and 29% due to grain soaking in 20,000 and 40,000 ppm CCC, respectively, as compared with dry grains. Such increases in wheat grain production, due to CCC treatments, could not hardly be overlooked since it occurred in the absence of lodging of the semi-dwarf wheat cultivar 'Sidi Misri 1'. It is apparent from the present study, as well as the previous reports (3,5,9), that CCC treatments, either as a foliar spray or a grain treatment prior to sowing, had a beneficial effect on grain yield of this wheat cultivar.

Straw yield, on the other hand, was significantly reduced by the treatment with high concentrations of CCC. Compared with dry grains, grain soaking in both 20,000 and 40,000 ppm CCC decreased straw yield by 19 and 17%, respectively (Table 3). It is apparent, therefore, that CCC treatments of 'Sidi Misri 1' grains favored grain production over straw.

Table 3 Effect of soaking wheat grains in high concentrations of CCC on yield and its components.

| Treatment of wheat grains | Total yield (tons/ha) | Grain yield (tons/ha) | Straw yield (tons/ha) | Spike number/ plant | Spike length (cm) |
|---|---|---|---|---|---|
| Dry | 14.239 | 3.739 | 10.500 | 3.1 | 8.8 |
| Soaked in distilled water | 15.030 | 3.780 | 11.250 | 3.6 | 8.9 |
| Soaked in 4,000 ppm CCC a.i. | 13.502 | 3.752 | 9.750 | 4.1 | 9.7 |
| Soaked in 20,000 ppm CCC a.i. | 13.011 | 4.461 | 8.550 | 5.0 | 9.9 |
| Soaked in 40,000 ppm CCC a.i. | 13.522 | 4.822 | 8.700 | 5.0 | 10.0 |
| LSD at 5% | N.S.[a] | N.S. | 1.790 | 1.6 | N.S. |

[a]N.S. = Not significant.

Also, the number of spikes per plant was significantly increased by grain soaking in both 20,000 and 40,000 ppm CCC. This apparent significant increase of about 61% was positively reflected upon the increase in grain yield. The same trend, although nonsignificant, was observed with respect to spike length.

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## استجابة النمو الخضرى ومحتوى الكلورفيل ومحصول القمح لمعاملات نقع الحبوب فى تركيزات مرتفعة من السيكوسيل

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### الملخـــــص

أقيمت تجربة حقلية لدراسة تأثير نقع حبوب القمح للصنف قصير الساق « سيدى المصرى ١ » قبل الزراعة على النمو الخضرى ومحتوى الكلورفيل بالأوراق ومحصول الحبوب والقش تحت الظروف المحليـــة بطرابلس بالجماهيرية الليبية ٠

وبالمقارنة الى زراعة الحبوب جافة ، وجد ان نقع الحبوب لمدة ٢٤ ساعة قبل الزراعة فى محلـــول السيكوسيل بتركيز ٠٠٠ و ٢٠ ، ٠٠٠ و ٤٠ جزء فى المليون قد تسبب فى تأخير معنوى لظهور البادرات ، وتخفيض فى الطول والوزن الجاف لسيقان البادرات فى عمر ٣ أسابيع بعد الزراعة ، كما انتج عن هـذه المعاملات زيادة معنوية فى الأطوال والوزن الجاف لجذور البادرات ٠

وعندما تم تقدير محتوى صبغتى الكلوروفيل « ا » ، « ب » فى أوراق البادرات بعد ٣٥ يوما مـــن الزراعة ، لوحظ عدم وجود أى تأثير معنوى لمعاملات السيكوسيل على محتوى الكلوروفيل على أساس الوزن الأخضر والوزن الجاف ، بينما وجد ان معاملات السيكوسيل تسببت فى نقصان قدره ٢٢ الى ٤٠ ٪ فى محتوى الكلوروفيل عندما قدرت على أساس مساحة المسطح الورقى ، ولوحظ أيضا أن نفس المعامـــــلات تسببت فى خفض الوزن النوعى للأوراق بذات النسبة فى محتوى الكلوروفيل ٠

أما المحصول ومكوناته ، فقد وجد ان معاملات السيكوسيل أدت الى زيادة ملموسة فى محصول الحبوب ومكوناته ، والى نقص فى محصول القش وذلك بالمقارنة الى زراعة الحبوب بدون معاملة ٠
وكانت قيم مكونات المحصول هى : ـ

١ ـ عند الحبوب جافة ٠

٣و٧٣٩ طن حبوب / هكتار ، ٥و١٠ طن قش / هكتار ٠
١و٣ سنابل / نبات ، ٨و٨ سم طول السنبلة ٠

٢ ـ عند زراعة الحبوب بعد نقعها فى محلول ٠٠٠و٢٠ جزء فى المليون سيكوسيل لمدة ٢٤ ساعة ٠
٤و٤٦١ طن حبوب هكتار ، ٥٥و٨ طن قش / هكتار ٠

٥ سنابل / نبـــات ، ٩و٩ سم طول السنبله ٠

٣ ـ عند زراعة الحبوب بعد نقعها فى محلول ٠٠٠و٤٠ جزء فى المليون سيكوسيل لمدة ٢٤ ساعة ٠
٤و٨٢٢ طن حبوب / هكتار ، ٧٠و٨ طن قش / هكتار ٠

٥ سنابل / نبـــات ، ١٠ سم طول السنبله ٠