# PHYSIOLOGICAL RESPONSE OF SUNFLOWER PLANTS TO FOLIAR APPLICATION OF CCC AND BORON

## Reaktion von Sonnenblumenpflanzen auf CCC und Boron Blattdüngung

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### 1. Introduction

Tawagen (1970), Imbamba (1973), Diaz et al. (1974), Abo Khadrah and El-Morsi (1978) and El-Kady (1981) reported that foliar spray of sunflower with different CCC concentrations decreased plant height and increased stem diameter and seed yield.
Dublijanskaja and Suprunova (1969) and Giordanic and Cuichini (1970) found a negative association between oil and protein contents in sunflower seeds.
The objectives of these experiments were to study the effect of CCC and boron foliar spray, separately and in combination on some plant morphological and leaf as well as seed chemical characteristics.

### 2. Materials and Methods

Two experiments were conducted at Sakha Agricultural Research Station's Farm, Ministry of Agriculture, Egypt during 1980 and 1981 seasons. The seeds were hill planted apart 70 cm ridges and 30 cm between hills on the third of June 1980 and the 30th of June 1981. The seedlings were thinned after about 3 weeks from sowing to one plant per hill. In both experiments sunflower (Helianthus annuus L.) cv. Mayak (introduced Russian cultivar) was used. The growth substance cycocel 40 % (2-chloroethyl trimethyl ammonium chloride) commonly known as growth inhibitor and boric acid were applied as a spray. In the first year, there were 4 concentrations of cycocel, i.e., O, 1000, 2000 and 3000 ppm and 3 concentrations of boric acid i.e., 0, 0.05 % and 0.1 %. In the second year, there were 5 concentrations of CCC, i.e. 0, 500, 1000, 1500 and 2000 ppm and the same treatments of boric acid.

A split plot design with four replicates was used in both experiments. The cycocel concentrations were allocated to the main plots, and the concentrations of Boric acid was designated to the sub-plots. The plants were foliar spray with CCC and Boric acid solutions according to the assigned treatment after 35 and 40 days from planting in the first and second year, respectively. Agricultural practices were carried out as usual. The following characters were studied; plant height, stem and head diameter, dry weight of plants, seed yield per plant. The leaf pigments (Chl. a, Chl. b and carotenoids), were estimated spectrocolorimetrically at 2 and 3 stages from foliar spraying in the first and second years, respectively (as described by Wettstein, 1957).
Protein content: Hulled seeds were used in the estimation of total nitrogen by the standard micro-kjeladhl method. Percentage of crude protein was calculated by mul-

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tiplying the percentage of nitrogen by 6.25. Oil percentage was determined according to A.O.A.C. (1960). Total carbohydrates were determined according to Naguib (1963). All the data were subjected to the statistical analysis as described by Snedecor (1963) and the mean values were compared by Duncan's multiple range test (Duncan, 1955).

## 3. Results and Discussion

### 3.1 Morphological characteristics:

#### 3.1.1 Vegetative characters:

In general, it was found that as CCC concentration was increased, plant height was decreased significantly. The stem diameter was however, increased gradually by raising the CCC concentration. Number of days to 75 % flowering did not change with the different CCC concentrations. The length of internodes was reduced by increased CCC concentration. Plants treated with CCC became chlorotic a few days after the application, but the effect later disappeared. In both seasons, the resulting shorter, sturdier plant under field conditions could be expected to be more easily harvested and to be less prone to lodging (Table 1).

#### 3.1.2 Generative characters:

It is clear from the data that head diameter was increased slightly as CCC concentration increased up to 1500 ppm and then decreased. The seed yield per plant was not affected significantly by the CCC concentration (Table 2).

Table (1): Some morphological characteristics of CCC treatments in sunflower (average of 10 plants) during 1980 and 1981 seasons.

| Treatments ppm of CCC | Plant height (cm) | Diameter of stem (cm) | No. of internodes | Leaf area ($dm^2$/plant) |
|---|---|---|---|---|
| | | 1980 | | |
| Control | 154.1 | 2.01 | 30 | 39.20 |
| 1000 | 131.0 | 2.33 | 30 | 58.41 |
| 2000 | 112.1 | 2.76 | 29 | 75.60 |
| 3000 | 96.0 | 3.10 | 29 | 43.20 |
| L.S.D. 5% | 5 | 0.07 | N.S | 11.91 |
| L.S.D. 1% | 7 | 0.10 | | 16.41 |
| | | 1981 | | |
| Control | 188.5 | 2.40 | 31 | 80.04 |
| 500 | 156.0 | 2.60 | 30 | 110.88 |
| 1000 | 138.5 | 2.70 | 30 | 132.36 |
| 1500 | 126.5 | 3.10 | 27 | 153.84 |
| 2000 | 124.5 | 3.40 | 24 | 78.84 |
| L.S.D. 5% | 18.8 | 0.30 | 0.9 | 26.66 |
| L.S.D. 1% | 21.0 | 0.40 | 1.3 | 36.36 |

Table (2): Characteristics of inflorescences and seeds after CCC spray during 1980 and 1981 seasons.

CCC spray during 1980 and 1981 seasons.

| Variables | Treatments ppm of CCC | | | | L.S.D. | |
|---|---|---|---|---|---|---|
| | Control | 1000 | 2000 | 3000 | 5% | 1% |
| | | 1980 | | | | |
| Head diameter | 9.1 | 11.2 | 12.1 | 10.5 | N.S | |
| Seed yield/plant | 24.2 | 33.1 | 32.4 | 30.5 | N.S | |
| | | 1981 | | | | |
| | Treatments ppm of CCC | | | | L.S.D. | |
| | Control | 500 | 1000 | 1500 2000 | 5% | 1% |
| Head diameter | 9.9 | 12.4 | 12.8 | 13.3 13.0 | N.S. | |
| Seed yield/plant | 26.1 | 38.4 | 37.0 | 37.9 35.0 | N.S | |

### 3.1.3 Dry weight:

The data from table (3) showed that CCC had a significant effect on the dry weight of the different organs of plant. A clear trend increased dry weight increasing CCC concentrations up to 1500 and 2000 ppm were obtained. The leaf area per plant was of the same trend.
Boric acid spray had no effect on the morphological characteristics.

**Table (3): Dry weight of plant parts (gm) after CCC treatments in sunflower during 1980 and 1981 seasons (Average of 10 plants).**

| Treatments ppm of CCC | Leaves | Stems | Roots | Inflore-scences | Total dry weight (gm) |
|---|---|---|---|---|---|
| | | | 1980 | | |
| Control | 7.21 | 18.20 | 4.70 | 24.20 | 54.31 |
| 1000 | 10.40 | 21.49 | 5.10 | 33.09 | 70.08 |
| 2000 | 12.61 | 22.48 | 4.15 | 32.40 | 71.64 |
| 3000 | 7.21 | 15.78 | 4.09 | 30.49 | 57.57 |
| L.S.D. 5% | 1.51 | 2.06 | N.S | N.S | |
| L.S.D. 1% | 2.07 | 2.83 | | | |
| | | | 1981 | | |
| Control | 13.34 | 24.98 | 5.92 | 13.08 | 57.42 |
| 500 | 18.48 | 26.20 | 6.62 | 14.12 | 65.42 |
| 1000 | 22.06 | 27.50 | 8.46 | 13.38 | 71.40 |
| 1500 | 25.64 | 27.14 | 8.34 | 17.50 | 78.62 |
| 2000 | 13.14 | 17.42 | 7.48 | 16.28 | 54.32 |
| L.S.D. 5% | 4.44 | 6.29 | 1.89 | 2.05 | |
| L.S.D. 1% | 6.06 | - | - | 2.79 | |

## 3.2 Chemical characteristics:

### 3.2.1 Pigment content:

The data showed that chlorophylls and carotenoids, separately or in combination (Tables 4 and 5) varied with age. Thus, in the first year the pigments decreased with the increase of CCC concentration in the first collection. However, in the 2nd collection, the pigments alternated increase and decrease at the CCC concentrations. In the second year, pigments increased up to 1000 ppm then decreased even to below the

control level at 2000 ppm in the first collection. In the second collection, however, pigments were raised up to 1500 ppm then declined. Finally, in the third collection the pigments were increased all through out. The results of treatments in the field were not consistent from one year to the other due to the fluctuation of environmental factors.

**Table (4): Differences in pigments content after foliar spraying of CCC concentrations at 1 and 3 weeks by sunflower during 1980 season.**

| Pigments | No. of weeks after foliar spraying | CCC concentration ppm | | | |
|---|---|---|---|---|---|
| | | 0 | 1000 | 2000 | 3000 |
| Chl.a(mg/g fresh wt.) | 1 | 0.38a | 0.30b | 0.23a | 0.14b |
| | 3 | 0.55b | 0.64a | 0.46c | 0.52b |
| Chl.b(mg/g fres wt.) | 1 | 0.29a | 0.19ab | 0.10bc | 0.06c |
| | 3 | 0.42b | 0.56a | 0.38b | 0.42b |
| Chl.a/b ratio | 1 | 1.31 | 1.58 | 2.30 | 2.33 |
| | 3 | 1.31 | 1.08 | 1.21 | 1.24 |
| Chl.(a+b) | 1 | 0.67a | 0.51b | 0.33c | 0.20d |
| | 3 | 0.97ab | 1.20a | 0.84b | 0.95ab |
| Carotenoids (mg/g fresh wt.) | 1 | 0.34a | 0.32ab | 0.24b | 0.11c |
| | 3 | 0.56b | 0.64a | 0.43d | 0.49c |
| Chl.(a+b)/carotenoids ratio | 1 | 1.97 | 1.59 | 1.38 | 1.81 |
| | 3 | 1.73 | 1.88 | 1.95 | 1.94 |
| Chl.(a+b)+ carotenoids | 1 | 1.01a | 0.83b | 0.57c | 0.31b |
| | 3 | 1.53b | 1.84a | 1.27c | 1.44b |

Means designated by the same letter, are not significantly different at the 1 % level according to Duncan's multiple range test.

**Table (5): Differences in pigments content after foliar spraying of CCC concentrations at 1, 3 and 5 weeks by sunflower during 1981 season.**

| Pigments | No. of weeks after foliar spraying | CCC concentration ppm | | | | |
|---|---|---|---|---|---|---|
| | | 0 | 500 | 1000 | 1500 | 2000 |
| Chl.a (mg/g | 1 | 0.51b | 0.54a | 0.50b | 0.35c | 0.27d |
| fresh wt.) | 3 | 0.29c | 0.48ab | 0.51a | 0.51a | 0.46b |
| | 5 | 0.24e | 0.31c | 0.29d | 0.38b | 0.43a |
| Chl.b(mg/g | 1 | 0.41a | 0.42a | 0.45a | 0.34a | 0.16b |
| fresh wt.) | 3 | 0.22c | 0.27c | 0.39ab | 0.44a | 0.36b |
| | 5 | 0.16d | 0.23b | 0.19c | 0.33a | 0.34a |
| Chl. a/b | 1 | 1.24 | 1.29 | 1.11 | 1.03 | 1.68 |
| ratio | 3 | 1.32 | 1.78 | 1.31 | 1.16 | 1.28 |
| | 5 | 1.50 | 1.35 | 1.53 | 1.15 | 1.26 |
| Chl. (a+b) | 1 | 0.91ab | 0.88ab | 0.96a | 0.69b | 0.43c |
| | 3 | 0.51b | 0.75c | 0.90a | 0.95a | 0.82bc |
| | 5 | 0.40e | 0.54c | 0.48d | 0.71b | 0.77a |
| Carotenoids | 1 | 0.52a | 0.55a | 0.55a | 0.36b | 0.26c |
| (mg/g fresh wt.) | 3 | 0.40d | 0.44c | 0.51a | 0.48b | 0.43c |
| | 5 | 0.22c | 0.30b | 0.31b | 0.43a | 0.43a |
| Chl.(a+b)/ | 1 | 1.75 | 1.60 | 1.75 | 1.92 | 1.66 |
| carotenoids | 3 | 1.28 | 1.70 | 1.76 | 1.98 | 1.91 |
| ratio | 5 | 1.82 | 1.80 | 1.55 | 1.65 | 1.79 |
| Chl.(a+b)+ | 1 | 1.44a | 1.52a | 1.51a | 1.05b | 0.69c |
| carotenoids | 3 | 0.91c | 1.19b | 1.41a | 1.43a | 1.25b |
| | 5 | 0.62e | 0.84c | 0.79d | 1.14b | 1.20a |

Means designated by the same letter are not significantly different at the 1 % level according to Duncan's multiple range test.

### 3.2.2 Protein, oil and carbohydrates contents:

Oil percentage increased gradually by increasing boron concentrations in both seasons. The data showed that, CCC had no significant effect on the percentage of oil up to 1000 ppm (Tables 6 and 7). There was a small visible effect of CCC on protein or carbohydrate in sunflower seeds. It was noticed, that the highest oil content treat-

ments had the lowest protein percentage. These results agreed with those reported by Dublijanskaja and Supranova (1969), and Giordanic and Cuichini (1970). Neither CCC nor Boron affected a significant change in carbohydrate.

**Table (6): Effect of CCC on some chemical characteristics in 1980 and 1981 seasons in sunflower.**

| Treatments ppm of CCC | Protein % | Oil % | Carbohydrate % |
|---|---|---|---|
| | | 1980 | |
| 0 | 25.22 | 27.59 | 15.85 |
| 1000 | 24.19 | 29.05 | 16.22 |
| 2000 | 24.91 | 27.32 | 16.22 |
| 3000 | 22.16 | 18.57 | 14.08 |
| L.S.D. 5% | N.S | 2.05 | N.S |
| L.S.D. 1% | | 3.10 | |
| | | 1981 | |
| 0 | 24.97 | 30.12 | 16.33 |
| 500 | 24.25 | 30.56 | 16.10 |
| 1000 | 23.28 | 31.30 | 16.23 |
| 1500 | 24.26 | 30.26 | 16.06 |
| 2000 | 24.73 | 28.82 | 15.81 |
| L.S.D. 5% | 0.86 | 1.36 | N.S |
| L.S.D. 1% | 1.25 | 1.98 | |

**Table (7): Effect of Boron on some chemical characteristics in 1980 and 1981 seasons in sunflower.**

| Treatments of Boron (%) | Protein % | Oil % | Carbohydrate % |
|---|---|---|---|
| | | 1980 | |
| 0 | 26.03 | 19.99 | 15.21 |
| 0.05 | 25.03 | 24.08 | 15.62 |
| 0.10 | 21.29 | 32.82 | 15.94 |
| L.S.D. 5% | N.S | 1.76 | N.S |
| L.S.D. 1% | | 2.42 | |
| | | 1981 | |
| 0 | 28.86 | 23.28 | 15.94 |
| 0.05 | 24.47 | 30.59 | 16.30 |
| 0.10 | 19.57 | 36.75 | 16.10 |
| L.S.D. 5% | 1.16 | 1.07 | N.S |
| L.S.D. 1% | 1.38 | 1.28 | |


## 4. Summary

Foliar spraying of sunflower with Cycocel (1000, 1500, 2000 and 3000 ppm) increased the dry weight, stem thickness and head diameter but decreased the plant height and leaf area. Boron had no effect on morphological characteristics.

Leaf content of chlorophylls and carotenoids of treated plants with low concentration of CCC (500 and 1000 ppm) were similar to the control, and lower than those treated with higher levels (2000 and 3000 ppm) at the early stages (1 and 3 weeks) while the response was reversed at the later stages. Boron had no effect on pigment contents.

Seed oil % was increased, while seed protein was decreased by the application of Boron (0.05 and 0.1 %). CCC had an insignificant effect on both oil and protein. Neither CCC nor boron affected a significant change in carbohydrates.

## Zusammenfassung

Cycocel (CCC) in Konzentration von 1000, 1500, 2000 und 3000 ppm auf das Blatt von Sonnenblumen (Helianthus annuus L.) appliziert, vergrößerte das Trockengewicht, den Stamm- und Kopfdurchmesser, aber verringerte die Pflanzenlänge und die Blattfläche. Boron hatte keinen Einfluß auf morphologische Merkmale.

Der Chlorophyll- und Carotinoidgehalt der Blätter mit niedriger CCC-Applikation (500 und 1000 ppm) war im frühen Entwicklungsstadium (1. - 3. Woche) ähnlich dem der Kontrolle, dagegen niedriger bei 2000 und 3000 ppm. In späteren Stadien kehrte sich diese Wirkung um. Boron zeigte keinen Einfluß auf den Pigmentgehalt.

Der Ölgehalt derSamen wurde nach Boron-Applikation (0,05 und 0,1 %) erhöht, während sich der Proteingehalt verringerte. CCC zeigte keinen signifikanten Einfluß auf den Öl- und Proteingehalt. Der Kohlenhydratgehalt wurde durch keines der Mittel beeinflußt.

**References**


Abou Khadrah, S. and El-Morsi, A. (1978). A preliminary study on the effect of Cycocel on the growth, photosynthetic pigments content and yield of sunflower. Proc. of the 4th Conf. of Pest. Control. NRC, Cairo, Egypt.

A.O.A.C. (1960). „Official Methods of Analysis", pp. 161.

Diaz de la Guardia, Gorica Torres, M.L. and Berengena, J. (1974). Effects of growth regulators on sunflower in the greenhouse and in field plots. Proc. of the 6th Inter. Sunflower Conf., Bucharest, Romania.

Dublijanskaja, N.F. and Suprunova, L.V. (1969). Protein content in the seeds of sunflower varieties with high oil content. Vestn. Seliskohoz. Nauk (New Agric.Sci.) No. 9: 34-37 (Russian).

Duncan, B.D. (1955). Multiple range and multiple F tests. Biometrics, 11: 1 - 42.

El-Kady, F. (1981). Effect of growth regulators on sunflower varieties. M. Sc. Thesis, Fac. of Agric. Tanta Univ., Egypt.

Giordanic, C. and Cuichini, M. (1970). Comparative analysis of the seed sunflower cultivars in three years of trials in the Tuscan Fenland and a comparsion with the original seed from Kramodor, Crimea and from Rumania. Rev. Agric. Subtrop. 98 - 110. (C.F. Plant Breed. Abstr., 41(1): 1529, 1971).

Imbamba, S.K. (1973). Response of cow peas to salinity and (2-chloroethyl trimethyl ammoium chloride) CCC. Physiologia Plantarum 28 (2): 346 - 349.

Naguib, M.I. (1963). Colorimetric estimation of plant polysaccharides. Zucher 16: 15 - 18.

Snedecor, G.W. (1963). Statistical methods (Applied experiments in Agriculture and Biology). Iowa State College Press. Ames, Iowa, U.S.A.

Tawagen, A.M.M. (1970). Effect of Cycocel on the growth and anatomy of Helianthus annuus L. growth with a complete nutrient supply and without adequate nitrogen. Diss. Abast. Int. 30, 9: 3931 B.

Wettstein, D. (1957). Chlorophyll, letal und der submicroskopische Formmech Sell-der-plastiden. Exptl. Cell. Res. 12: 427.