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EFFECT OF FOLIAR METHANOL APPLICATIONS ON EGYPTIAN COTTON PLANTS

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Abstract

Recent reports indicated that foliar Methanol application enhances vegetative growth and yield of C3 crops and reduces overall crop water use. It has been suggested that methanol may act as a C source for the plant and a photorespiration inhibitor.

Two field experiments were conducted at CIBA GIEGY Experiment station, Qaha region (Kalyubia Governorate) during the 1996 season, to evaluate the effect of foliar methanol application on growth and yield of cotton plants. The first experiment was cultivated after fallow while the second was cultivated after Berseem crop. 10, 20 and 30% Methanol solutions were applied to cotton plants grown under both normal irrigation and under water stress during flowering period.

Methanol application did not show phytotoxic symptoms at any of the given concentrations. The treatments of Methanol increased significantly plant height, leaf area, dry weight of growth parts, shoot/root ratio and number of bolls par plant. There was no significant effect on the number of : leaves on the main stem, internodes, fruiting branches total squares and bolls, and also no significant effect of Methanol on boll weight, lint percentage or earliness of yield.

Methanol increased significantly the seed index and seed Cotton yield per plant and per feddan.

INTRODUCTION

Fruit shedding in cotton plants is inevitable process. due to the plants inherent nature. Two physiological theories have been put forth to explain fruit shedding or slow rate of fruiting: (a) As the plant grows and ages, boll load increases the balance between auxin and growth retarding hormones distribution favours anti-auxin hormones which increase and become more active and signal the plant to retard boll formation or even inhibit it.

(b) As the fruiting mass of the plant exceeds in proportion the vegetative mass, the supply of carbohydrates decreases and the plant ceases to form bolls. The cotton plant, unlike many other field crops and weeds, is unable to utilize all the carbohydrates formed during photosynthesis. There have been attempts to modifay the plant for better utilization of air, water and nutrients.

Plant species which have the potential to utilize almost all the carbohydrates formed during photosynthesis are called C4 plants. These plants like corn, sorghum, sugar cane and weeds, usually have high growth rate.

Some plant species called C_3 plants, including cotton, are unable to utilize all the carbohydrates formed during photosynthesis and tend to either burn or release into the atmosphere a percentage of the carbohydrates in different forms.The process of burning and releasing carbohydrates formed during the process of photoynthesis into the atmosphere is called photorespiration, and plants which do so are C3 plants. C4 plants either do not photorespire or release only a small proportion of photosynthetic carbon into the atmosphere.Cotton, on average, photorespires at about 30% of the photosynthetic rate, which makes cotton grow more slowly than C4 plant species.

Nonomura and Benson (1992) reported that one of the important effects of Methanol as a precursor of CO_2 on the cotton plants is to increase water use efficiency under intense sunlight conditions, due to the increased turgidity which lead to a reduction in the transpiration.They also explained this effect as a response to an increase in sugar content due to the utilization of methanol as source of carbon. The availability of carbon in the vicinity of the leaf enhances the photosynthesis rate. Plants treated with methanal stood erect and vigorous seven days after irrigation at the flowering stage while untreated plants showed water stress dropping symptoms, the treated plants reached that stage two days later. This result showed that under conditions where water supply is a limiting factor for yield improvement, the use of methanol could significantly increase yield.

Nonomura and Benson (1992) also observed a 20% or greater increase in the surface area two or three weeks after application of a 30% methanol solution. The greater increase in leaf area was observed in the upper canopy and the least increase was observed in the lower canopy. A higher leaf area gives a higher photosynthesis rate and determines the harvestable yield of the plant. A 15% increase in plant height was noticed two weeks after the application of 30% methanol: Taller plants coupled with earliness have the potential to give more fruiting points and better yield. Within three weeks after application of methanol the thickness of leaves increased by 25-50% making them more tolerant to adverse climatic conditions. The

growth rate increased in association with reduction in photorespiration rate, enhancing crop maturity. It was also observed that methanol application is not toxic at certain concentrations and in certain environments.

Moseley *et al.* (1994) reported that using solution containing 30% methanol, 1% urea, 0.01% iron chelate and 1% welting agent spreader, at the rate of 225 L/ha applied between 10.00 am and 2.00 pm beginning before the first flower and continuing at a weekly interval for six to eight weeks, produced no significant differences among the treatments for plant height, squares per meter of row, green bolls per meter of row or dry weight of leaves, stem, all reproductive parts together or total plant weight measured after the third application of methanol and nutrients. Yield also was not affected.

Husman *et al.* (1994) conducted a trial using the same treatments and observed that none of the treatments had a significant effect on the photosynthetic rate, fruit retention and lint yield.

Gerik and Faver (1994) using 0, 10, 20 and 30% aqueous solutions of methanol at square stage or start of flowering, found that methanol increased stomal conductance to CO2 improved transpiration rate and enhanced CO2 assimilation by 10% in biomass accumulation, Leaf area and fruit weight increased by 10% over the control.

Heitholt *et al.* (1994) also conduted trials at three locations and came to the conclusion that methanol is unlikely to benefit cotton.

Cothern (1994) conducted greenhouse and field experiments using methanol in different concentrations. The photosynthesis rate was improved in the greenhouse experiments. In the methanol-treated field experiments, significant increases were noted in the photosynthesis rate (17.7%), total nodes (28.9 versus 26.9), total reproductive nodes (22.1 versus 20.9), first position bolls (5.0 versus 4.1) and total biomass (21.3%) when compared with control. However, the lint yield remained unaffected.

Mauney and Gerik (1994) observed on the average for nine trials, there little effect on gas exchange, water relations, plant growth, lint yield and fiber parameters. In five trials, plant height decreased in methanol treated plots in comparison with the untreated control. In two cases, short-term enhancement of CO_2 uptake was consistent and statistically significant. Only in one trial was a significant increase in yield and biomass. In general, the photorespiration rate does not seem to

be affected by methanol application. They observed that some reasons for nonsignificant results could be well fertilized soils and the absence of water strees and micronutrient deficiency symptoms in the plant.

MATERIALS AND METHODS

This investigation was carried out during the 1996 season, at CIBA GEIGY Experiment station in Qaha (Kalyubia Governorate), to study the effect of spraying methanol, under normal irrigation and under water stress during flowering period, on the growth and yield of cotton plants, Giza 85 Egyptian cotton variety (G.barbadense) was cultivated in plots, each plot containing five rows, five meters long, 70 cm wide with the hills 20cm apart two field experiments were conducted at the same site, the first one was under normal irrigation and the second was under water strees during flowering period. The irrigation period was 25 days under water stress starting from the beginning of flowers. The statistical design in the two experiments was complete randomized block.

The treatments under normal irrigation and under water stress during flowering period were: Control, spraying 10% Methanol Alcohol, at start of flowering, spraying 20% Methanol Alocohol, at start of flowering, and spraying 30% Methanol Alcohol, at start of flowering.

Sowing was on 11th of April, and all the agricultural practices were carried out according to the usual practices of cotton crop. Each experiment was replicated in two sites at the same area. The first was cultivated after fallow and the second was cultivated after a berseem crop.

Random samples of four plants from each plot were taken at 21 and 42 days after spraying to record the following data:

A- Vegetative characters:

Plant height, number of leaves on the main stem, number of internodes, number of fruiting branches, and leaf area per plant.

B- Fruiting characters:

Squares per plant, number of squares and bolls shed/plant, total square and bolls/plant, bolls set/plant, and square and boll shedding percentage.

C- Dry weight (gm):

Table 1. Effect of spraying methanol on cotton plants cultivated after fallow under normal irrigation.

Treatments	Plant height (cm)	No.of leaves on main stem	No.of interno-des	No.of fruiting branches	Leaf area (cm^2)	Dry weight/plant (gm.) Stem and bra-nches	Roots	Leav-es	Total plant	Shoot/ Root Ratio	Fruit parts/plant No.of squares	No. of bolls set	No.of squares and bolls shed	No.of total squares and bolls	% of square and boll shed	Weight of fruit parts squares+bolls
After 21 days*																
Control	69.5	10.5	17.5	10.0	1810	21.5	13.9	18.1	73.6	4.30	5.0	8.0	5.0	18.0	27.8	20.1
10 %	88.0	12.0	18.0	10.5	2190	22.1	12.9	21.2	73.8	4.72	11.0	10.0	4.0	15.0	16.0	17.6
20 %	70.0	11.5	17.0	10.0	1880	22.1	16.5	18.9	88.0	4.33	7.0	5.0	6.0	18.0	33.3	30.5
30 %	72.0	11.5	18.0	11.0	1910	24.0	17.0	23.1	86.2	4.07	8.0	9.0	5.0	22.0	22.7	22.1
L.S.D 5%	6.1	N.S	N.S	N.S	190.1	N.S	2.5	2.1	10.9	N.S	2.9	1.2	0.8	2.4	4.1	5.9
After 24 days*																
Control	90.6	10.0	21.5	12.5	2190	23.8	20.4	21.6	111.4	4.50	2.0	12.0	7.5	21.5	34.9	35.6
10 %	106.0	11.0	22.0	13.5	2403	26.7	16.9	23.9	97.4	4.76	2.5	10.0	6.5	19.0	34.2	34.9
20 %	99.5	12.0	22.0	14.0	2302	26.6	22.9	22.9	123.8	4.40	2.0	14.5	5.5	22.0	25.0	51.4
30 %	108.9	13.0	24.5	14.5	2701	26.9	23.8	26.6	131.7	3.99	3.0	15.0	6.0	24.0	25.0	54.4
L.S.D 5%	9.1	N.S	N.S	N.S	150.0	2.1	3.2	3.2	5.9	0.21	N.S	1.1	0.9	2.0	5.1	5.6

* Days from Methanol treatment.

Table 2. Effect of spraying methanol on cotton plants cultivated after Berseem crop under normal irrigation.

Treatments	Plant height (cm)*	No.of leaves on main stem	No.of interno-des	No.of fruiting branches	Leaf area (cm^2)	Dry weight/plant (gm.) Stem and bra-nches	Roots	Leav-es	Total plant	Shoot/ Root Ratio	Fruit parts/plant No.of squares	No. of bolls set	No.of squares and bolls shed	No.of total squares and bolls	% of square and boll shed	Weight of fruit parts squares+bolls)
After 21 days*																
Control	88.5	11.5	18.0	10.0	2274	27.5	15.2	24.1	90.0	4.94	10.0	8.0	7.0	25	28.0	23.2
10 %	89.0	12.5	19.0	11.5	2453	37.5	17.5	32.6	112.0	5.42	13.0	8.0	5.0	26	19.2	24.1
20 %	92.5	12.5	19.5	11.5	2752	37.9	18.6	35.6	116.3	5.25	12.0	8.0	6.0	26	23.1	24.4
30 %	106.0	12.5	20.0	12.5	3181	39.0	19.9	38.7	124.4	5.26	12.0	8.0	6.0	26	23.1	26.3
L.S.D 5%	5.1	N.S	N.S	N.S.	255.1	4.1	2.0	5.1	6.5	0.15	1.5	N.S	0.9	N.S	3.1	1.9
After 24 days*																
Control	106.5	12.5	22.0	14.0	2170	28.0	22.1	26.1	109.3	3.95	5.0	13.0	5.0	23.0	21.7	33.2
10 %	107.5	14.5	23.0	15.0	2400	38.4	25.2	33.1	130.8	4.19	6.0	15.0	4.0	25.0	16.0	34.10
20 %	113.5	13.0	23.0	15.5	2650	38.9	25.1	35.6	134.1	4.34	6.0	14.0	3.0	23.0	13.0	34.4
30 %	114.5	13.0	23.5	15.5	2990	39.1	27.8	38.8	141.9	4.10	6.0	14.0	3.0	23.0	13.0	36.3
L.S.D 5%	4.9	N.S	N.S	N.S	145	3.9	2.2	5.2	10.9	0.25	N.S	0.8	0.9	N.S	4.1	1.5

* Days from Methanol treatment.

Leaves/plant, stem and branches/plant, roots/plant total dry weight/plant fruit parts (squares + bolls), and shoot/root ratio.

C- Yield and yield components:

Total number of bolls/plant. Average boll weight, seed index, lint percentage, earliness of yield %, and seed cotton yield in kentar/fed.

RESULTS AND DISCUSSION

1. Under Normal Irrigation :

A. Growth:

Results in tables 1,2 indicate that cotton plants under normal irrigation which were cultivated after fallow or berseem crop, and sprayed with Methanol at three concentrations (10%, 20% and 30%) showed significantly increased plant height, leaf area, dry weight/plant (stem and branches, roots, leaves) and shoot/root ratio. These increases included fruit parts afterwards. Methanol treatments led to significant increases in number of set bolls and a significant decrease in the number of squares and young boll shedding. On the other hand, Methanol treatments did not significantly affect the number of leaves on main stem, number of internodes, number of fruiting branches or number of total squares and boll (setting & shedding). However, methanol clearly increased number of square setting because it decreased the drop of squares or small bolls.

These results agree with Nonumura and Benson (1992) who observed a 20% or greater increase in the surface area two or three weeks after application of a 30% Methanol solution. They also found increases in the growth rate of the methanol treated plants over non-treated.

The association of the increase in growth with reduction in the photorespiration rate, enhances crop maturity. The same trend of Methanol effects were obtained by Gerik and Faver (1994) and Cothern (1994). On the other hand Cothran (1994) and Mauney and Gerik (1994) observed a significant increase in yield and biomass only in one out of nine trials.

B. Yield and Yield Components :

Table 3. Effect of spraying methanol on yield and yield components of Giza 85 cotton cultivated under normal irrigation.

Treatments	After Berseem crop						After Fallow					
	Boll weight (gm)	Seed index	Lint (%)	Earliness	Seed cotton yield (kentar/f)	Seed cotton yield/ plant (gm)	Boll weight (gm)	Seed index	Lint (%)	Earliness	Seed cotton yield (kentar/f)	Seed cotton yield/ plant (gm)
Control	2.32	10.35	33.33	62.9	7.86	29.44	2.30	10.19	34.9	51.9	7.49	27.95
10 %	2.37	10.76	33.8	52.4	10.44	39.77	2.27	10.55	35.0	53.0	7.65	28.59
20 %	2.37	10.76	34.6	55.0	9.85	37.40	2.33	10.57	36.2	52.6	9.07	34.27
30 %	2.38	10.92	34.8	52.0	9.31	35.22	2.39	10.61	35.1	52.6	10.55	40.19
L.S.D 5%	N.S	0.21	N.S	N.S	0.41	2.1	N.S	0.40	N.S	N.S	0.91	5.21

Table 4. Effect of spraying methanol on cotton plants cultivated after fallow under normal irrigation.

Treatments	Plant height (cm)*	No.of leaves on main stem	No.of internodes	No.of fruiting branches	Dry weight/plant (gm.) Leaf area (cm^2)	Stem and branches	Roots	Leaves	Total plant	Shoot/ Root Ratio	Fruit parts/plant No.of squares	No. of bolls set	No.of squares and bolls shed	No.of total squares and bolls	% of square and boll shed	Weight of fruit parts (squares+bolls)
After 21 days*																
Control	73.0	12.0	17.5	10.0	1750	17.2	11.1	14.9	63.4	4.70	4.0	5.0	8.0	17.0	47.0	19.1
10 %	78.0	12.0	18.5	11.0	1990	22.1	15.2	19.2	81.5	4.36	5.0	7.0	7.0	19.0	36.8	45.0
20 %	73.0	11.5	17.5	9.5	1750	29.1	20.0	22.1	88.1	3.41	8.0	5.0	7.0	20.0	35.0	17.1
30 %	7.9	12.0	18.5	11.0	1820	30.0	20.9	24.9	92.0	3.40	12.0	12.0	10.0	27.0	18.5	16.2
L.S.D 5%	N.S	N.S	N.S	N.S.	199.0	5.2	3.5	3.1	15.9	0.40	3.6	2.2	2.1	4.1	9.5	8.9
After 42 days*																
Control	90.5	10.0	19.0	11.0	1680	22.0	14.7	16.6	84.6	4.48	4.5	8.5	11.0	24.0	54.8	31.3
10 %	111.0	12.5	21.5	15.0	2750	28.8	20.4	26.9	106.2	4.22	7.0	14.0	7.0	28.0	25.0	40.1
20 %	120.5	12.0	23.0	14.5	2803	40.1	22.1	27.7	111.7	4.50	7.5	9.5	11.0	28.0	39.3	41.8
30 %	117.0	10.0	22.0	13.0	2600	41.1	24.9	30.0	120.2	3.83	2.0	12.5	9.0	23.5	38.3	45.4
L.S.D 5%	10.1	N.S	N.S	N.S	220	8.2	4.8	5.1	5.8	0.21	2.1	2.2	3.0	3.0	9.0	9.9

* Days from Methanol treatment.

Table 5. Effect of spraying methanol on cotton plants cultivated after Berseem crop under water stress.

Treatments	Plant height (cm)*	No.of leaves on main stem	No.of interno-des	No.of fruiting branches	Leaf area (cm^2)	Dry weight/plant (gm.) Stem and bra-nches	Roots	Leav-es	Total plant	Shoot/ Root Ratio	Fruit parts/plant No.of squares	No. of bolls set	No.of squares and bolls shed	No.of total squares and bolls	% of square and boll shed	weight of fruit parts squares+bolls
After 21 days*																
Control	82.5	12.0	18.0	11.5	2146	25.8	16.0	21.2	75.0	3.69	10.0	5.0	9.0	24.0	37.5	12.8
10 %	87.0	12.0	19.5	11.5	2151	33.8	18.2	29.3	97.5	4.37	9.0	7.0	9.0	25.0	36.0	16.2
20 %	89.0	12.0	18.0	10.5	2240	35.3	18.9	29.4	100.7	4.34	10.0	8.0	6.0	24.0	25.0	17.7
30 %	89.5	12.5	19.0	11.5	2344	36.7	19.1	30.9	113.6	4.96	9.0	7.0	7.0	26.0	26.9	19.8
L.S.D 5%	4.5	N.S	N.S	N.S.	240.0	1.2	2.1	3.2	3.5	0.15	N.S	0.9	1.1	N.S	3.1	3.2
After 42 days*																
Control	96.0	12.5	21.0	12.5	2040	26.0	23.0	21.2	89.9	2.90	5.0	10.0	5.0	20.0	25.0	19.7
10 %	100.0	13.0	22.0	14.0	2100	33.8	25.2	30.2	112.2	3.5	4.0	12.0	5.0	21.0	23.8	23.0
20 %	105.5	13.0	23.0	14.5	2120	35.9	25.9	30.5	117.1	3.5	4.0	13.0	5.0	22.0	22.7	24.8
30 %	105.9	13.0	23.0	14.0	2200	37.1	26.1	31.9	121.8	3.7	3.0	13.0	5.0	21.0	23.8	26.8
L.S.D 5%	8.1	N.S	N.S	N.S	135	4.1	2.2	3.5	5.9	0.25	0.8	0.9	N.S	N.S	N.S	4.8

* Days from Methanol treatment.

Table 3 shows the effect of spraying Methanol on yield and yield components of Giza 85 cotton variety which was cultivated under normal irrigation after Berseem crop or after fallow. There was no significant effect of Methanol on boll weight, lint percentage, or earliness of yield. The methanol treatments significantly increased seed index, seed cotton yield/plant and seed cotton yield/feddan.

These results are in agreement with those obtained by Nonumura and Benson (1992) and Gerik and Faver (1994).

II. Under water stress during flowering period:

A. Growth

Nonumura and Benson (1992) reported that the use of Methanol reduced the frequency of irrigation which was applied to the treated field as a result of a reduction in the transpiration rate, this resulted in greater water use efficiency. The data in tables 4 and 5 agree with Nonumura and Benson (1994) under water stress.

The results given in tables 4 and 5 indicate that Methanol significantly increased plant height, leaf area, dry weight of stem and branches, roots, leaves and shoots/root ratio as measured 21 and 42 days after treatment with Methanol at different doses.

No significant effect of Methanol treatments was observed on the number of leaves on the main stem, number of internodes, or number of fruiting branches. Spraying with Methanol significantly increased the number of bolls set, number of total squares and bolls/plant and weight of fruit parts (squares & bolls). On the other hand, methanol reduced the percentage of square and boll shedding. These results were more clearer after fallow than after Berseem crop.

B. Yield and yield components:

Under water stress condition Methanol treatments (Table 6) significantly increased seed index and cotton yield after both Berseem and fallow.

Spraying with Methanol increased boll weight but it was significant only after Berseem. Lint percentage and earliness were not affected by Methanol treatments.

These results agree with those mentioned by Nonumura and Benson (1992) and Gerik and Faver (1994).

Table 6. Effect of spraying methanol on yield and yield components of Giza 85 cotton cultivated under water stress.

Treatments	After Berseem crop						After Fallow					
	Boll weight (gm)	Seed index	Lint (%)	Earliness	Seed cotton yield (kentar/f)	Seed cotton yield/ plant	Boll weight (gm)	Seed index	Lint (%)	Earliness	Seed cotton yield (kentar/f)	Seed cotton yield/ plant (gm)
Control	2.15	9.94	33.4	56.3	6.60	24.40	2.13	8.95	35.4	60.1	5.92	17.69
10 %	2.30	10.62	34.5	51.2	7.20	26.80	2.18	9.34	36.1	64.2	6.63	20.52
20 %	2.37	10.78	35.4	50.6	10.4	39.80	2.16	9.30	36.2	56.0	7.10	22.40
30 %	2.34	10.61	34.9	25.9	7.95	29.78	2.28	9.39	36.3	56.6	6.98	21.92
L.S.D 5%	0.12	0.32	N.S	N.S	8.05	3.80	N.S	0.41	N.S	N.S	0.84	3.10

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تأثير المعاملة بالميثانول على نباتات القطن المصرى

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معهد بحوث القطن – مركز البحوث الزراعية – الجيزة – مصر

توضح التقارير البحثية الحديثة أن النمو الخضرى وكمية المحصول للنباتات ثلاثية الكربون تستجيب للمعاملة بكحول الميثانول رشا وعلاوة على ذلك يقل احتياج النباتات للماء عند رشها بالميثانول. وعلى هذا فانه يمكن اعتبار أن الميثانول يلعب دورا كمصدر للكربون للنباتات ثلاثية الكربون على أساس أنه يثبط التنفس الضوئى لها.

أجريت تجربتان فى محطة بحوث سيبا جايجى بمنطقة قها (محافظة القليوبية) فى موسم ١٩٩٦ وذلك لتقييم ما اذا كانت المعاملة بالميثانول رشا تعمل على زيادة النمو لمحصول القطن فى صنف القطن جيزة ٨٥ وذلك فى مساحتين متجاورتين، احداهما بعد بور والأخرى بعد برسيم.

وقد أستخدم محلول الميثانول بتركيزات ١٠٪ ، ٢٠٪ ، ٣٠٪ بجانب المقارنة وذلك تحت ظروف الرى العادى وأيضا تحت ظروف اطالة فترات الرى خلال مرحلة التزهير.

أوضحت النتائج أن المعاملة بالميثانول بمختلف التركيزات لم تظهر أى أعراض سامة على نباتات القطن، وأدت معاملات الرش بالميثانول الى زيادة معنوية فى أطوال النباتات ومساحة الأوراق والأوزان الجافة لأجزاء النمو المختلفة (ساق ، أفرع ، جذور ، أوراق ، أجزاء ثمرية)، كما أدت الى زيادة النسبة بين الأفرع/ الجذور وكذلك على زيادة نسبة اللوز العاقد الكلى. بينما لم يكن له تأثير معنوى على عدد الأوراق على الساق الرئيسى ، عدد السلاميات، الأفرع الثمرية وكذلك عدد الوسواس واللوز الكلى (الساقط والعاقد) وأيضا لم يكن له تأثير معنوى على صفة وزن اللوزة والنسبة المئوية للشعر والتبكير فى المحصول بينما كان له أثر ايجابى معنوى على معامل البذرة والمحصول سواء بالقنطار فدان أو محصول النبات بالجرام.