THE PHYSIOLOGICAL RESPONSE OF COTTON PLANT TO FOLIAR APPLICATION WITH THE GROWTH REGULATOR AMCOTONE

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ABSTRACT

Two field experiments were carried out at Mallawi Agric. Res. Station, Minia Governorate, in 2002 and 2003 seasons to study the response of Giza 83 cotton cultivar to foliar application of the growth regulator Amcotine which contains 1-naphthyl acetic acid (NAA) and 1-naphthyl acetamide (NAAM). Besides the control treatments, Amcotine was used at the rates of 1.0, 1.2 and 1.4 g/l. applied once at the beginning of flowering stage (BF) or twice at BF and 15 days later.

Results of this study reveal that some treatments of Amcotine exhibited significant increases in leaves content of chlorophyll, total chlorophyll, poly phenols, total phenols, number of open bolls/plant and seed cotton yield/fad. However, it exerted a significant reduction in leaves content of reducing sugars, total soluble sugars, number of aborted fruiting sites/plant and bud and boll shedding%. The application of Amcotine had no significant effect on plant growth characters, number of sympodia/plant, total fruiting sites/plant, number of unopen bolls/plant, boll weight, earliness%, lint% or seed index in both seasons.

The application of Amcotine at the rate of 1.2 g/l. either one or two times of application produced the highest seed cotton yield and gave the best results in general during the two studied seasons.

It could be concluded that spraying cotton plants with the growth regulator Amcotine exerted some biochemical and physiological effects which reduced bud and boll shedding and increased boll retention and yield production under the environmental conditions of the present study.

INTRODUCTION

Cotton plant is characterized by high shedding rate of fruiting organs owing to many internal and external factors. Two physiological theories have been put forth to explain fruit shedding: (a) as the plant ages, anti-auxin hormones increases presenting hormonal imbalance between auxin and plant growth retarding which signal the plant to retard or even inhibit boll formation, (b) as boll load increases, carbohydrate shortage can exist and the supply of carbohydrate to bolls could be reduced causing fruit shedding (Abdel-AI, 1998). Bud and boll shedding in cotton is considered a physiological disorder and reducing fruit shedding could increase cotton yield (Prakash and Perumal, 2001). Fruit shedding in cotton could be reduced by ensuring regular supply of photosynthates to the developing bolls, through enhancing leaf photosynthesis and/or leaf longevity during boll development stage (Wallschleger and Oosterhuis, 1990 and Prakash and Perumal, 2001).

Otherwise, the supply of assimilates during boll development stage is restricted by the decline in leaves photosynthetic rate as they ages correlating with decreasing free IAA level (Günn and Brumrett, 1993). Wallschleger and Oosterhuis (1990) reported that photosynthesis declined
throughout the boll-filling period since leaf photosynthesis and carbon production peaked prior to maximum photosynthetic demand by bolls presenting poor synchronization between carbon production and its utilization by developing bolls. They suggest that enhancing leaf photosynthesis and/or leaf longevity during boll filling stage could increase the cotton yield. In this respect, growth regulators auxins have been reported to stimulate photosynthesis and photosynthetic transport to developing fruit (Arteca, 1996 and Ozga and Reinecke, 2003).

Auxins are important growth regulators involved in regulating many aspects of plant growth and development. They represent one of the important classes of signaling molecules transcribed in plants. Auxins action and perception is thought to involve auxin binding to specific receptor(s) and regulating gene expression and protein synthesis with consequent metabolic changes (Leyser, 2001). NAA is an auxinic hormone that is identified with promoting fruit setting. The response of cotton plant to the exogenous application of NAA has been studied by many researchers; Çağatay et al. (1989) reported that NAA increased chlorophyll content and photosynthetic rate and reduced respiration rate in cotton leaves. El-Hamawi et al. (1975) and Abdel-Al et al. (1982) demonstrated that hormonal contents in bolls, especially auxins, have an important role in boll abscission. NAA application reduced the shedding of young bolls through increasing the total and polyphenol contents in bolls. Akhmouf et al. (2000) and Göktürk and Thaker (2002) reported that NAA and IAA promote cotton fiber formation through acting as regulators of the main enzymes activities involved in fiber formation and development i.e. peroxidase, glucan synthetase, and cellulase. It has been shown that the application of NAA on cotton stimulated boll retention and reduced bud and boll shedding (Bhatt, 1991; Swamy, 1991; and Brar et al. 2001), and increased number of open bolls/plant boll weight, seed index and seed cotton yield (Eid and Abdel-Al, 1985; Swamy, 1991; Sawan and Saker, 1998; and Eid-Gabri, 2002).

This study was conducted to investigate the response of cotton plant to foliar application of Amcotone compound.

MATERIAL AND METHODS

Two field experiments were conducted at Mallawi Agric. Res. Station, Minia Governorate, in 2002 and 2003 seasons, to study the physiological response of Giza 83 cotton cultivar to the foliar application with a synthetic growth regulator compound commercially known as Amcotone which contains 1-naphthyl acetic acid (NAA) and 1-naphthyl acetamide (NAAM). The used rates of Amcotone were 1.0, 1.2 and 1.4 g/ha applied one time at the beginning of flowering stage (BF) or two times at BF and 15 days later. The two experiments were laid out in a randomized block design with four replicates. The experimental unit was 13 m² in area, including 5 ridges; 4 m long and 65 cm apart. Sowing date was during the last week of March in both seasons. All cultural practices were done as recommended for cotton
production. For estimating the effects of Amcotone treatments the following measurement were determined:

1- Chemical constituents of leaves: a random sample of leaves on the top fourth node was collected after 15 days of the application of Amcotone in 2003 season only to determine leaves contents of chlorophyll (Arnon, 1949), reducing sugars (A.O.A.C., 1965), total soluble sugars (Cerning, 1975), polyphenols (A.O.A.C., 1965) and total phenols (Simons and Ross, 1971).

2- Growth parameters: final plant height (cm), number of main stem nodes and internode length (cm).

3- Fruiting characters: number of sympodia/plant, number of aborted fruiting sites/plant, total fruiting sites/plant, and fruit (buds and boles) shedding% (aborted fruiting sites divided by total fruiting sites multiplied by 100).

4- Yield and yield components: number of open bole/plant, unopened boles/plant, boll weight (gm), earliness%, seed cotton yield/fad., lint% and seed index (gm).

All obtained data were statistically analyzed according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1- Chemical constituents of leaves:

Results shown in Table (1) reveal that, in comparison with the control, Amcotone application exhibited significant effects on leaves content of chlorophyll a and total chlorophyll but it had no significant effects on chlorophyll b. Leaves content of chlorophyll a was significantly affected by all used Amcotone treatments except with one spray of 1.0 g/l, and two sprays of 1.2 g/l. At the same time, total chlorophyll level was significantly increased by various Amcotone treatments except with one spray of 1.0 g/l. The highest rate of Amcotone (1.4 g/l) when applied once or twice gave the highest content of chlorophyll in leaves. Exogenously applied NAA have been reported to stimulate photosynthetic rate and chlorophyll content in cotton leaves (Kappgate et. al. 1983). Similar results were obtained by El-Gabry and (2002) who reported that foliar application of NAA increased chlorophyll level in cotton leaves.

Table (1): Effect of foliar application of the growth regulator Amcotone (containing NAA + NAAM) on some chemical constituents of cotton leaves (mg/g dry weight) in 2003 season.

<table>
<thead>
<tr>
<th>Amcotone treatment</th>
<th>Chlorophylls</th>
<th>Carbohydrates</th>
<th>Phenols</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chl. a</td>
<td>Chl. b</td>
<td>Total chl.</td>
</tr>
<tr>
<td>Control</td>
<td>4.050</td>
<td>2.822</td>
<td>7.872</td>
</tr>
<tr>
<td>1.0 g/l at BF</td>
<td>5.170</td>
<td>3.960</td>
<td>9.130</td>
</tr>
<tr>
<td>1.2 g/l at BF</td>
<td>5.355</td>
<td>3.085</td>
<td>8.350</td>
</tr>
<tr>
<td>1.4 g/l at BF</td>
<td>5.380</td>
<td>3.080</td>
<td>8.460</td>
</tr>
<tr>
<td>1.0 g/l at BF + 15 days later</td>
<td>5.307</td>
<td>3.110</td>
<td>8.417</td>
</tr>
<tr>
<td>1.2 g/l at BF + 15 days later</td>
<td>5.240</td>
<td>3.077</td>
<td>8.317</td>
</tr>
<tr>
<td>1.4 g/l at BF + 15 days later</td>
<td>5.440</td>
<td>3.112</td>
<td>8.552</td>
</tr>
<tr>
<td>L.S.D 0.05</td>
<td>0.225</td>
<td>N.S.</td>
<td>0.396</td>
</tr>
</tbody>
</table>

BF: the beginning of flowering stage.
In relation to the effect of Amcotone treatments on leaves content of carbohydrate, it is obvious from Table (1) that reducing sugars content was significantly decreased by one or two sprays of Amcotone with 1.4 g/l and by two sprays of 1.2 g/l. Similarly, total soluble sugars level was significantly reduced by various Amcotone treatments except the lowest rate (1.0 g/l) when applied once at the beginning of flowering stage (BF) only. In general, the reduction in leaves content of carbohydrate was increased with increasing Amcotone rate and times of application. Two sprays of Amcotone with 1.2 or 1.4 g/l caused the highest reduction in carbohydrate level. Such carbohydrate reduction could be a result of the auxin roles in enhancing carbohydrate transport and mobilization and/or inducing incorporation of carbohydrate into the synthesis of other compounds such as phenols, amino acids and other related compounds. Auxins participate in regulating assimilates mobilization via controlling the concentration gradient of photoassimilates between source and sink tissues. Auxins may stimulate phloem transport, modify the strength of sink by stimulating its growth, increase the ability for sucrose unloading from the phloem, or act on metabolism of sucrose (Artica, 1996 and Ozga and Reinecke, 2003).

With regard to leaves content of phenols, results presented in Table (1) indicate that Amcotone application increased leaves content of poly phenols and total phenols as compared with the control. The treatment of 1.0 g/l at BF only did not exert significant increase in phenolic compounds level, while the other Amcotone treatments significantly increased leaves content of poly and total phenols as compared with the control. Phenols level was highest with two sprays of the highest rate of Amcotone (1.4 g/l). El-Hamawi et al. (1975) reported that NAA increased the total and poly phenol contents in leaves. Such results are in agreement with those of Abdel-Al et al. (1982); and Eid and Abdel-Al (1985) who obtained significant increases in cotton leaves content of phenols with NAA application.

2- Plant growth parameters:

Results shown in Table (2) reveal that different treatments of Amcotone had no significant effects on plant growth parameters; plant height, number of main stem nodes and internode length in both seasons. Similar results were obtained by Brar et al. (2001), and Eid and Abdel-Al (1985).

3- Fruiting characters:

It is obvious from Table (2) that the application of Amcotone did not significantly affect number of sympodia/plant and total fruiting sites/plant in both seasons but, it did significantly affected number of aborted fruiting sites/plant and bud and boll shedding % in both seasons. Results reveal that, in comparison with the control, all used Amcotone treatments except one spray of 1.0 g/l caused a significant reduction in the number of aborted fruiting sites/plant in both seasons, consistent with such results, all Amcotone treatments reduced bud and boll shedding % compared with the control but the significance level was not always reached. The lowest values of bud and boll shedding % were produced by two sprays of 1.4 g/l and one or two sprays of 1.2 g/l. the treatments that reduced shedding % in both seasons.
Table (2) : Effect of foliar application of the growth regulator of Amcation (containing NAA + NAAM) on some vegetative and fruiting characters of cotton plant in 2002 and 2003 seasons.

<table>
<thead>
<tr>
<th>Amcation treatments</th>
<th>Plant height (cm)</th>
<th>No. Of main stem nodes</th>
<th>Internode length (cm)</th>
<th>No. Of sympodia plant</th>
<th>Aborted fruiting sites/plant</th>
<th>Total fruiting sites/plant</th>
<th>Buds and bolts shedding %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>105 ± 2.0</td>
<td>26.1 ± 0.8</td>
<td>4.2 ± 0.2</td>
<td>10.2 ± 1.6</td>
<td>13.1 ± 1.0</td>
<td>34.6 ± 2.0</td>
<td>44.4 ± 2.8</td>
</tr>
<tr>
<td>1.0 g/l at BF</td>
<td>104 ± 2.0</td>
<td>26.0 ± 0.8</td>
<td>4.1 ± 0.2</td>
<td>15.2 ± 1.6</td>
<td>14.2 ± 1.0</td>
<td>32.7 ± 2.0</td>
<td>43.3 ± 2.8</td>
</tr>
<tr>
<td>1.2 g/l at BF</td>
<td>105 ± 2.0</td>
<td>25.9 ± 0.8</td>
<td>4.2 ± 0.2</td>
<td>15.3 ± 1.7</td>
<td>13.2 ± 1.0</td>
<td>34.7 ± 2.0</td>
<td>40.1 ± 2.8</td>
</tr>
<tr>
<td>1.4 g/l at BF</td>
<td>103 ± 2.0</td>
<td>25.9 ± 0.8</td>
<td>4.3 ± 0.2</td>
<td>15.3 ± 1.7</td>
<td>13.4 ± 1.0</td>
<td>34.9 ± 2.0</td>
<td>40.5 ± 2.8</td>
</tr>
</tbody>
</table>

BF: the beginning of flowering stage.

Table (3) : Effect of foliar application of the growth regulator of Amcation (containing NAA + NAAM) on cotton yield and yield components in 2002 and 2003 seasons.

<table>
<thead>
<tr>
<th>Amcation treatments</th>
<th>No. of open bolls/plant</th>
<th>No. of unopen bolls/plant</th>
<th>Boll weight (gm)</th>
<th>Earliness %</th>
<th>Seed cotton yield kentoffad.</th>
<th>Lint %</th>
<th>Seed index (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>15.0 ± 2.0</td>
<td>15.2 ± 2.0</td>
<td>2.5 ± 0.2</td>
<td>68.2 ± 2.0</td>
<td>31.0 ± 1.0</td>
<td>45.0 ± 2.0</td>
<td>36.77 ± 2.0</td>
</tr>
<tr>
<td>1.0 g/l at BF</td>
<td>15.2 ± 2.0</td>
<td>15.2 ± 2.0</td>
<td>2.5 ± 0.2</td>
<td>68.3 ± 2.0</td>
<td>31.0 ± 1.0</td>
<td>45.0 ± 2.0</td>
<td>36.77 ± 2.0</td>
</tr>
<tr>
<td>1.2 g/l at BF</td>
<td>17.8 ± 2.0</td>
<td>15.5 ± 2.0</td>
<td>2.5 ± 0.2</td>
<td>69.9 ± 2.0</td>
<td>31.6 ± 1.0</td>
<td>46.4 ± 2.0</td>
<td>38.87 ± 2.0</td>
</tr>
<tr>
<td>1.4 g/l at BF</td>
<td>15.3 ± 2.0</td>
<td>14.1 ± 2.0</td>
<td>2.5 ± 0.2</td>
<td>66.0 ± 2.0</td>
<td>32.0 ± 1.0</td>
<td>40.5 ± 2.0</td>
<td>38.04 ± 2.0</td>
</tr>
<tr>
<td>L.S.D 0.05</td>
<td>1.3 ± 0.2</td>
<td>1.2 ± 0.2</td>
<td>2.5 ± 0.2</td>
<td>68.9 ± 2.0</td>
<td>31.2 ± 1.0</td>
<td>46.0 ± 2.0</td>
<td>38.04 ± 2.0</td>
</tr>
</tbody>
</table>

BF: the beginning of flowering stage.
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Such reduction in bud and boll shedding associated with Amcotone application could be due to its effect in increasing phenols level. El-Hamawi et. al. (1975) and Abdel-Al et. al. (1982) reported that the reduction in young boll shedding, due to NAA application, was connected with an increase in the total and poly phenols content in young bolls. Poly phenols play an indirect role in inhibiting the action of IAA oxidase. Hormonal content of bolls, especially auxin, have an important role in the abscission of young bolls. Results of many previous studies indicate that NAA is identified as a fruit setting promoter and the exogenous application of NAA reduced bud and young boll shedding in cotton (Bhatt, 1991; Swamy, 1991; and El-Gabery, 2002).

4- Yield and Yield component:

Results presented in Table (3) reveal that the application of Amcotone significantly increased number of open bolls/plant and seed cotton yield/fad. as compared with the control in both seasons. However, number of unopened bolls/plant, boll weight, earliness %, lint% and seed index were not significantly affected by the application of Amcotone in the two studied seasons. In general, all used treatments of Amcotone exhibit an increase in number of open bolls/plant and seed cotton yield/fad. in both studied seasons. However, the consistent significant increases in both traits were obtained by one or two sprays of 1.2 g/l. and two sprays of 1.4 g/l. Such results indicate that cotton plants treated with Amcotone produced more open bolls and higher seed cotton yield than the untreated ones. This could be attributed to reducing shedding of fruiting organs concomitant with increasing the supply of photoassimilates to the developing bolls during boll-filling stage. Exogenously applied auxins have been reported to stimulate photosynthetic rate through increasing chlorophyll content and promoting stomatal opening (Kapgate et. al., 1989; and Arceca, 1996). Auxins also, induce assimilate mobilization to the developing fruit and promote sucrose incorporation into cellulose in cotton fiber (Baara et. al., 1992; and Ozga and Reaincke, 2003). Additionally, auxins promote fiber formation and growth (Akhunov et. al., 2000; and Gokani and Thaker, 2002).

It could be thought that the positive effects for Amcotone application on boll retention and yield production were through enhancing metabolite supply to bolls during boll development stage. Boll shedding could be decreased through ensuring regular supply of metabolites to the developing bolls (Prakash and Perumal, 2001). Wallischleger and Oosterhuis, (1999) demonstrated that cotton yield could increased by enhancing photosynthetic activity of leaves and/or leaf longevity during the reproductive development. Several investigators reported that the application of NAA significantly increased number of open bolls/plant and seed cotton yield/fad. (Eid and Abdel-Al, 1985; Swamy, 1991; Sawan and Saker, 1998; Brar et. al., 2001; Katkar et. al., 2002; and El-Gabery, 2002).
It could be concluded from this study results that treating cotton plants with the growth regulator Amcotone at 1.2 g/l, as one or two sprays at the beginning of flowering only or + 15 days later could enhance leaf photosynthetic rate during boll-filling stage and promote the supply of photosynthates to the developing bolls, thereby it could reduce fruit shedding and increase boll retention and cotton yield production.

REFERENCES


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الاستجابة الفسيولوجية لنبات القطن للعاملة بمنظم النمو أمكوتون

محمد محمد أحمد قاديوس

 المصدر:
 أحمد محمد أحمد قاديوس

A new technique to study the growth of cotton plants treated with different concentrations of the growth hormone “Amkotron”. The effect of the application of the hormone on the growth parameters such as the number of leaves, the number of flowers, the number of bolls, and the total yield was studied.

The results showed that the application of the hormone at a concentration of 100 ppm had the most significant effect on the growth parameters of the cotton plant. The number of leaves, flowers, and bolls increased significantly compared to the control group. The total yield also increased significantly, indicating the effectiveness of the hormone in promoting the growth and yield of cotton plants.

It can be concluded that the hormone “Amkotron” has a positive effect on the growth and yield of cotton plants.