The Effects of Foliar Applied Atonik and Amino Acid on Yield and Fiber Quality in Cotton (*Gossypium hirsutum* L.)

Güliz AKSONA[1], Aydın ÜNAY[*1]

[1] *Aydın Adnan Menderes Üniversitesi Ziraat Fakültesi Tarla Bikileri Bölümü, Aydın*

Abstract: The study was planned to determine the effects of commonly used Atonik and amino acid foliar applications on cotton yield and quality. Atonik and amino acid-containing chemical combinations were applied in different combinations during the squaring and flowering period. The "Randomized Complete Block Design" was used as trial design. The experiment was conducted at farmer field in Söke/Aydin in 2015. It has been found that both the atonik and amino acid combination treatments at both the squaring and flowering periods significantly increase the seed cotton yield, boll number per plant, boll weight and seed index. It was concluded that the effects of Atonik and amino acid application on seed were more important than fiber characteristics.

Anahtar Kelimeler: foliar spray, nitrophenols, cotton, yield, fiber charactersitics

Atonik ve Amino Asit Yaprak Uygulamalarının Pamukta (*Gossypium hirsutum* L.) Verim ve Lif Kalitesi Üzerine Etkisi

Öz: *Çalışma son yıllarda yaygın kullanım alanı bulan Atonik ve amino asit içerikli yaprak uygulamalarının pamuk verim ve kalite üzerine etkisini saptamak amacıyla planlanmıştır. Atonik ve amino asit içerikli kimyasal, taraklanma ve çiçeklenme döneminde farklı kombinasyonlarda uygulanmıştır. Deneme Tesadüf Blokları Deneme Deseninde 4 tekrarlamalı, 2015 yılında Aydın Söke ilçesinde üretici arazisinde yürütülmüştür. Atonik ve amino asit'in taraklanma ve çiçeklenme dönemindeki birlikte uygulanması kütlü pamuk verimi, bitkide koza sayısı, koza ağırlığı ve yüz tohum ağırlığını önemli düzeyde artırmıştır. Çalışmada, atonik ve amino asit yaprak uygulamalarının lif özelliklerinden daha çok tohum özelliklerini etkilediği sonucuna varılmıştır.*

Keywords: *yaprak uygulaması, nitrofenoller, pamuk, verim, lif özellikleri*

INTRODUCTION

Cotton is a cultivated crop grown between latitudes 45° N and 35°S in tropic and subtropic areas in over 60 countries. The cotton cultivation area of Turkey was approximately 416 thousand hectares. The main regions for the cotton production are Southeast Anatolian (57%), Aegean (23 %) and Çukurova (18 %), respectively. Söke where the research was conducted, is one of the biggest provinces which produce the 40 % of the Aegean Region. Söke valley lies on the coastal area of Aegean Sea, and Mediterrenean climate typically prevails. The summer are dry and extremely hot. The average of seed cotton yield was 4.6 t ha^{-1} for 2015 cotton growing season (Sadık, 2016).

The various chemicals for yield and quality are applied by Söke cotton growers during cotton growing. In addition to fertilization from soil, the percentage of cotton grower's applicated foliar chemicals ranged from 73 % to 87 % at the stages of squaring and flowering. The applications are humic acid, micro elements and amino acid (Albayrak, 2014)

The effects of plant growth regulators, NPK + other macro and micro elements on yield were investigated in many studies. There is lot of conflicting information about the efficiency of foliar applications for maximum growth and yield. It was stated that the effects of gibberellic acid, pix (mepiquat chloride), Atonik and CropPlus (biostimulant) on seed cotton yield and fiber quality were non-significant (Ozdemir, 1991). Similarly, Guo and Oosterhuis (1995) revealed the application of Atonik increased photosynthesis, reduction of nitrate and assimilation of plant nutrients and positively affected the seed cotton yield and maturity, but the differences of lint yield were non-significant. On the other hand, the foliar application of Atonik can reduce the adverse effects of reactive oxygen species (ROS) and increase the seed cotton yield by decreasing boll shedding (Djanaguiraman et al., 2010). Atonik application was found to be highly effective in increasing all the fiber quality characteristics in cotton (Djanaguiraman et al., 2005). Also, it was emphasized that Atonik positively affected yield due to increase in the endogenous auxin level (Datta et al., 1986).

The effects of amino acids on crop physiology intensively examined, and the main approach is that amino acids play the role of promotes internal hormones. It was determined that the foliar applications with amino acids affected the foliar nutrients and parameters of cotton but the increase in yield and fiber quality was not significant (El-Gabiery and Mesbah, 2011). In vegetable crops, foliar applications of amino acid involving alanin, beta-alanin, asparagin, aspartic acid, glutamic acid, glutamine and glisin increased the fresh and dry matter compared to control (Liu and Lee, 2012). It

Sorumlu Yazar: *aunay@adu.edu.tr Bu çalışma yüksek lisans tez ürünüdür.*
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can be thought that the amino acid applications whose efficiency is discussed on yield and quality regulate internal hormone synthesis and facilitate the uptake of micronutrients such as boron and manganese especially under stress conditions (Gomes, 2019).

In cotton, the foliar applications such as plant growth regulator, biostimulant, bioactivator and fertilizer with NPK + trace elements were investigated in many studies (El-Gabiery and Mesbah, 2011; Liu and Lee, 2012). There is a little information about foliar application with amino acid or atonik + amino acid combinations. However, the interest of cotton growers in foliar application has increased, and these applications are considered as guarantee of high yield and quality. Thus, we aimed to determine the influence of amino acid, Atonik and their combinations at different stages on seed cotton yield, yield components and fiber quality parameters under the grower's condition.

MATERIALS and METHODS

The study was conducted in a grower's field ($37^0$71'N, $27^0$38'E), Söke-Aydın, during cotton growing season of 2015. The cotton variety, Gloria (*Gossypium hirsutum* L.), was used as plant material. The mean temperatures between May and October were 21.33, 24.47, 28.17, 28.38, 24.95 and 24.95 ^{0}C, respectively. These values were non-significant compared with long period. The precipitation of 2015 (440 mm) was found higher than that of long period (113 mm).The analyzed soil parameters were; pH 8.38; EC 0.01 ds m-1; Organic Matter 0.79; $CaCO_3$ 11.01; insufficient nitrogen, phosphorus and potassium; textural class: loamy of the experimental area.

The main ingredients of Atonik are sodium o-nitrophenolate (2 g lt^{-1}), sodium para-nitrophenolate (3 g lt^{-1}), and sodium 5-nitroguaiacolate. STYM 25 used for amino acid application contains all amino acids in L form. The experiment was arranged in Randomized Complete Design with four replications. Treatments are;

1. Control
2. Atonik (beginning of squaring)
3. Atonik (beginning of squaring + beginning of flowering)
4. STYM 25 (beginning of squaring)
5. STYM 25 (beginning of squaring + beginning of flowering)
6. Atonik + STYM 25 (beginning of squaring)
7. Atonik + STYM 25 (beginning of squaring + beginning of flowering)

Plots consisted of seven 12 m rows, planted 0.73 m apart and 0.1 m space, that were end trimmed to final length 10 m to harvest of the center 5 rows. Parcel area was 21 m^2. The basal fertilizer was applied at a rate of 52-96-48 kg ha^{-1} NPK, and 150 kg ha^{-1} N (urea) was applied prior to first irrigation. The leafhopper (Empoasca spp.) and bollworm (*Heliothis armigera*) were controlled with chemicals. The application doses were 500 ml ha^{-1} for Atonik; 2000 ml ha^{-1} for STYM 25 based on recommendation. The backpack sprayer was used for all foliar applications. All other agricultural managements followed recommended practices for cotton growing of Aegean Region. The plant height (cm), the number of monopodial and sympodial branches per plant, boll number per plant, boll weight (g), first picking percentage (%) were determined by randomly chosen 15 plants at harvest. Seed cotton yield (kg ha^{-1}) was obtained in 21 $m^2$of parcel area at harvest. Ginning percentage (%) and seed index (g) were calculated after ginning. Fiber fineness (mic), fiber length (mm) and fiber strength (g tex^{-1}) were determined by HVI.

Data were analyzed using TOTEM-STAT statistics Packet Program according to Randomized Complete Block Design. Differences between means were compared using the LSD (Least Significant Difference).

RESULTS and DISCUSSION

The differences among foliar applications were found to be significant for the number of bolls (BN), boll weight (BW), seed cotton yield (SCY) and seed index (SI) (Table 1 and 2). The number of boll per plant varied from 9.10 to 10.60. Atonik combined with STYM 25 at the stage of first squaring significantly produced higher boll/plant followed by Atonik + STYM 25 at the stages of first squaring and first flowering combination (10.60 and 10.35, respectively). It was remarkable that the least boll number significantly recorded at control and Atonik (FS+FF). In our study, boll weight ranged from 4.29 g to 4.72 g. The application, Atonik + STYM 25 combination applied in both stages, performed significantly in terms of boll weight followed by Atonik + STYM 25 (FS) and STYM 25 (FS+FF). Among the foliar application, the minimum boll weights were recorded in Atonik (FS) control and Atonik (FS + FF).

It was seen that foliar applications gradually increased seed cotton yield compared with control (Table 2). The application, Atonik + STYM 25 combination applied in both stages, showed supremacy over all applications and control for seed cotton yield, and the difference between control and Atonik + STYM 25 (FS+FF) was approximately 1000 kg ha^{-1}. The effect of foliar application on seed index was found to be significant. The highest values of seed index obtained from Atonik + STYM 25 (FS+FF) and Atonik + STYM 25 (FS), respectively.

The non-significant effects of foliar application on plant height (PH), the number of monopodial branches (MB), the number of sympodial branches (SB) showed that Atonik and amino acid not altered plant architecture of cotton. Similarly, first picking percentage as earliness parameter not affected by foliar applications. The non-significant differences among foliar applications for ginning

Table 1. Mean values of plant height (PH), the number of monopodial branches (MB), the number of sympodial branches (SB), the number of bolls (BN), boll weight (BW) and first picking percentage (FPP).

	PH (cm)	MB ($plant^{-1}$)	SB ($plant^{-1}$)	BN ($plant^{-1}$)	BW (g)	FPP (%)
Control	101.60	0.85	11.53	9.22 b	4.33 bc	60.17
Atonik (FS)	106.83	0.80	12.10	9.40 ab	4.29 c	61.30
Atonik (FS+FF)	100.86	0.85	12.38	9.10 b	4.37 bc	60.11
STYM 25 (FS)	100.35	0.78	11.63	9.50 ab	4.42 bc	57.88
STYM 25 (FS+FF)	100.63	0.85	12.80	9.93 ab	4.54 ab	59.01
Atonik + STYM 25 (FS)	105.25	0.73	12.63	10.60 a	4.54 ab	56.78
Atonik + STYM 25 (FS+FF)	106.93	0.73	12.72	10.35 ab	4.72 a	59.94
$LSD_{(0.05)}$				1.27	0.22	

Table 2. Mean values of seed cotton yield (SCY), seed index (SI), ginning percentage (GP), fiber fineness (Mic), fiber length (FL), fiber strength (FS).

	SCY ($kg\ ha^{-1}$)	SI (g)	GP (%)	Mic.	FL (mm)	FS ($g\ tex^{-1}$)
Control	4495.9 b	10.31 ab	41.83	4.31	30.43	33.28
Atonik (FS)	4528.8 ab	9.88 b	42.38	4.14	30.10	33.75
Atonik (FS+FF)	4712.5 ab	9.81 b	41.83	4.10	29.65	35.93
STYM 25 (FS)	4752.2 ab	9.94 b	42.33	4.23	30.15	34.73
STYM 25 (FS+FF)	5062.3 ab	10.19 ab	42.03	4.06	31.09	35.53
Atonik + STYM 25 (FS)	5376.7 ab	10.67 a	41.65	4.21	31.26	33.53
Atonik + STYM 25 (FS+FF)	5494.1 a	10.75 a	41.25	4.18	30.40	34.03
$LSD_{(0.05)}$	977.8	0.69				

percentage and all fiber parameters such as length, fineness and strength were recorded.

It was seen that foliar applications gradually increased seed cotton yield compared with control (Table 2). The application, Atonik + STYM 25 combination applied in both stages, showed supremacy over all applications and control for seed cotton yield, and the difference between control and Atonik + STYM 25 (FS+FF) was approximately 1000 kg ha^{-1}. The effect of foliar application on seed index was found to be significant. The highest values of seed index obtained from Atonik + STYM 25 (FS+FF) and Atonik + STYM 25 (FS), respectively.

The non-significant effects of foliar application on plant height (PH), the number of monopodial branches (MB), the number of sympodial branches (SB) showed that Atonik and amino acid not altered plant architecture of cotton. Similarly, first picking percentage as earliness parameter not affected by foliar applications. The non-significant differences among foliar applications for ginning percentage and all fiber parameters such as length, fineness and strength were recorded.

Although Ozdemir (1991) and El-Gabiery and Mesbah (2011) emphasized that the effects of foliar application such as Atonik, amino acid and micro nutrient were non-sigficant for yield and fiber quality parameters, Datta et al. (1986) and Djanaguiraman et al. (2004) stated that foliar applications can increase the yield and quality. Guo and Oosterhuis (1995) described Atonik as a yield and growth enhancer. In present study, boll number, boll weight, seed index and seed cotton yield were significantly affected by Atonik and amino acid combination. There were non-significant differences in terms of the plant canopy characteristics such as plant height and branching and fiber quality characteristics such as ginning percentage and fiber fineness, length and strength.

CONCLUSION

In cotton growth physiology, fiber and seed are competing sinks and partioning of assimilates between fiber and seed has been altered by genetic and environmental factors. The results showed that the effects of Atonik and amino acid application on seed were higher than that of fiber because of significant differences in terms of seed index, boll weight and seed cotton yield. The increase in yield and yield components in the plots where Atonik and STYM 25 are applied together shows that the two applications increase the effect of each other. It should be recommended that the use of Atonik and amino acid combination could be suitable for adverse climatic and soil conditions.

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