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استجابة القطن المصرى للتلقيح بنحل العسل والأسمدة الحيوية

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الملخص العربى

أجريت تجربتان حقليتان بمزرعة خاصة بمركز ديرب نجم – محافظة الشرقية – مصر لدراسة تأثير التلقيح بنحل العسل وتلقيح البذور بالأسمدة الحيوية (كنترول ، الأزوسبيريلليم ، الأزوتوباكتر ، الباسيلس ، الأزوسبيريلليم + الباسيلس ، الأزوتوباكتر + الباسيلس) على صفات التساقط ، المحصول ومكوناته ، التركيب الكيماوى للبذور ، الصفات التكنولوجية لألياف القطن المصرى (صنف جيزة ٨٦) خلال موسمى الزراعة ٢٠١٠ ، ٢٠١١ حيث تم وضع خلايا النحل خلال فترة التزهير بمعدل ٣ طوائف للحقل الملقح وقد لقحت البذور بالأسمدة الحيوية المختبرة قبل الزراعة مباشرة.

ويمكن إيجاز أهم النتائج المتحصل عليها على النحو التالي :-

أدى تلقيح النباتات بنحل العسل إلى زيادة معنوية لصفات عدد اللوز الكلى على النبات ، المحصول ومكوناته (عدد اللوز المتفتح على النبات ، دليل البذرة ، نسبة التبكير، نسبة الشعر ، محصول القطن الزهر للنبات وللفدان) فى حين أدى الى تقليل النسبة المئوية للتساقط الكلى/ النبات مقارنة بالنباتات غير الملقحة بنحل العسل . بينما لم يكن هناك تأثير معنوى لاستخدام نحل العسل فى التلقيح لصفات ارتفاع أول عقدة ثمرية على النبات والتركيب الكيماوى للبذور والصفات التكنولوجية للألياف وذلك فى كلا الموسمين .

أدى تلقيح البذور بالأسمدة الحيوية إلى زيادة معنوية لقيم صفات ارتفاع أول عقدة ثمرية ، عدد اللوزالكلى على النبات ، المحصول ومكوناته ، التركيب الكيماوى للبذور ، الصفات التكنولوجية للألياف (عدا النعومة) فى حين أدى الى تقليل النسبة المئوية للتساقط الكلى / النبات مقارنة بالنباتات غير الملقحة (الكنترول) وذلك فى كلا الموسمين .

تشير نتائج التفاعل بين التلقيح بالنحل و الأسمدة الحيوية إلى تأثر صفات عدد اللوزالكلى على النبات ، النسبة المئوية للتساقط الكلى/ النبات ، عدد اللوز المتفتح على النبات ، نسبة التبكير، محصول القطن الزهر للنبات وللفدان تأثرا معنويا بهذا التفاعل حيث أعطى تلقيح الأزهار بالنحل مع التلقيح المزدوج للبذور ببكتريا الأزوتوباكتر و الباسيلس أقل قيم للتساقط الكلى وأعلى قيم للصفات المحصولية مقارنة بالمعاملة غير الملقحة بأي من نحل العسل والأسمدة الحيوية وذلك خلال موسمى الزراعة .

أوضحت النتائج ان متوسط مساحه الحضنة بالبوصة المربعة ومتوسط مساحة حبوب اللقاح المجموعه بالبوصة المربعة ومتوسط انتاج العسل من الطوائف بالكجم كانت خلال عام ٢٠١٠ هى٩٣٤.٧٧بوصة مربعه و ٩٠٣.٧٣بوصة مربعة و ٣.٩٣ كجم للطائفة الموضوعه بحقل القطن مقارنة بالكنترول والذى اعطى ٧٢٥.٢٣ بوصة مربعة و٤٩٣.٦٣ بوصة مربعة و٢.٥٦ كجم على التوالى ، فى حين كانت النتائج خلال عام ٢٠١١ ٩٣١.٥ بوصة مربعة و ٧٩١.٩ بوصة مربعة و ٣.٦٣ كجم مقارنة بالطوائف الموضوعه بعيدا عن حقل القطن والتى اعطت ٧٥٦.٣٣ بوصة مربعة و ٥٨٦.٣ بوصة مربعة و ٢.٢٦ كجم من الحضنة وحبوب اللقاح والعسل ، على التوالى.

RESPONSE OF EGYPTIAN COTTON (*GOSSYPIUM BARBADENSE*, L.) TO HONEYBEE POLLINATION AND BIOFERTILIZERS INOCULATION

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ABSTRACT: ***Two field experiments were conducted in special farm at Diarb Negm, Sharkia governorate, Egypt, to study the effect of honeybee (Apis mellifera, L.) as a pollinator and biofertilizers inoculation on abscission, productivity, chemical composition of seeds and fiber technological characters of Egyptian cotton (Gossypium barbadense, L.), Giza 86 cultivar as well as bee products (broods, honey and pollen) during 2010 and 2011 seasons. The results indicated that honeybee pollination significantly increased the values of number bolls/plant, yield and its components (number of open bolls/plant, seed index, earliness %, lint % and seed cotton yield per plant and fed), but decreased the total abscission percentage compared to the unpollinated plants. Meanwhile, the height of first fruiting node/plant, chemical composition of seeds and technological characters of fiber were not significantly affected in the two seasons. Inoculation of the tested biofertilizers significantly increased the values of height of first fruiting node, No. of total bolls/plant, yield and its components, chemical composition of seeds and technological characters of fiber (except fiber fineness), but decreased total abscission percentage in favour of dual inoculation with Azotobacter and Bacillus compared to the uninoculated plants in the two growing seasons. The interaction between the honeybee and biofertilizers treatments were found to be significant for number of total bolls/plant, total abscission/plant, number of open bolls /plant, earliness % and seed cotton yield per plant and fed in the two seasons. Honeybee pollinators combined with dual inoculation (Azotobacter and Bacillus) being the most effective interaction treatment for decrease the abscission and increase the yield parameters compared to unpollinated and uninoculated plants in the two seasons. The total amount of extracted honey, mean areas of pollen and broods increased in hives put in cotton field compared with those away from cotton.***

Key words: ***biofertilizers, honeybee, productivity, technological parameters, cotton.***

INTRODUCTION

Cotton is not only the most important fiber crops of the world, but also the second best source for plant proteins after soybean and the oil ranking fifth in the world use among edible oils (Sawan *et al*., 2006). Cotton plays a key role in the economic activity. It is the oldest among the commercial crops and is regarded as white gold. Egyptian cotton is preferred around the world because it is long fiber cotton that makes it softer and stronger at the same time. For many years, it was so valuable that most of the crop was exported to European countries. Besides being a major natural fiber crop, cotton also provides edible oil up to 24%. Cotton seed meal is the product remaining once the oil has been removed from seeds and can be contain up to 41% protein (Smith, 1995). Cotton seed meal is used in food products for animal feed due to its high protein and energetic values. So, it is necessary to increase cotton cultivation area and productivity.

Pollination is the transfer of pollen containing the male gamete of a plant

from the anthers to the female part "receptive stigma" of the same or another plant of the same species. This process results in fertilization and sexual reproduction of the plant to produce seeds. Birds can pollinate a limited number of plants, but the vast majority of plants are pollinated by insects such as wasps, butterflies and bees pollinate various flowers, but bees are responsible for the vast majority of pollination. Honeybee performs more than 80% of all pollination of cultivated crops. Cotton plants are visited by bees and sometimes benefit from the supplemental pollination they provide. Many varieties are self-pollinating; however, some varieties respond well to cross-pollination. The pollen is not wind-borne, and insects are good pollinators. With some varieties, bee pollination increases seed set per boll (Pima S-1), cotton yield (Ashmouni and Pima S-1) and earliness of boll set (A-33 and A-44) as reported by McGregor (1976). In practice, few, if any, growers manage bees for pollinating cotton. To improve the yields, it can be accomplished, in part, by introducing the most efficient pollinators for these crops (Batra, 1995). Studies in the developed countries carried out by (Moeller and Koval, 1973) and (Nye and Anderson, 1974) have shown that honeybee pollination increased fruit set by 10 to 25 percent and fruit yield by 18 to 100 percent depending upon the cultivar. Many researchers have described pollination requirements of crops (McGregor 1976; Free 1993; Partap and Verma 1993; Sihag 2000; Mary and Weaver 2001 and Klein *et al* 2006).

Biofertilizers are defined as preparations containing living cells or latent cells of efficient strains of microorganisms that help crop plants uptake of nutrients by their interactions in the rhizosphere when applied through seed or soil. Biofertilizers add nutrients through the natural processes of nitrogen fixation (*Azotobacter chroococcum* and *Azospirillum brasilense*), phosphate dissolving (*Bacillus megaterium*) and stimulating plant growth through the synthesis of growth-promoting substances. Biofertilizers can be expected to reduce the use of chemical fertilizers and pesticides. The microorganisms in biofertilizers restore the soil natural nutrient cycle and build soil organic matter. Through the use of biofertilizers healthy plants can be grown and enhancing the sustainability and the health of the soil. Therefore, they are extremely advantageous in enriching soil fertility and fulfilling plant nutrient requirements by supplying the organic nutrients. Biofertilizers are responsible for produce toxic metabolites inhibitory to many pathogenic fungi (Beshir *et al*., 2000) and improve the growth and yield of cotton (Anjum *et al.,* 2007; Al-Kahal *et al*., 2008 and Akhtar *et al*., 2010).

Therefore, the present study was planned to find out the effect of honeybee pollination and biofertilizers inoculation on the abscission, productivity, seed chemical composition and fiber technological characters of Egyptian cotton (Giza 86 cultivar) as well as bee products (broods, honey and pollen).

MATERIALS AND METHODS

Two field experiments were conducted in special farm at Diarb Negm, Sharkia governorate, Egypt, to study the effect of honeybee pollination and biofertilizers inoculation on total abscission of squares and bolls, yield and its components, chemical composition of seeds and fiber technological characters of the Egyptian cotton (*Gossypium barbadense*) in separated fields as well as bee products during 2010 and 2011 growing seasons. Each experiment included twelve treatments which were the combination of two factors, i.e. honeybee pollination and biofertilizers inoculation. The two tested factors are as follows:

A- Honeybee pollination

1- Without " non bee field "
2- With " bee field "

B- Biofertilizers

1- Control " without inoculation "
2- *Azospirillum brasilense*
3- *Azotobacter chroococcum*
4- *Bacillus megaterium*
5- *Azospirillum + Bacillus*
6- *Azotobacter + Bacillus*

The Treatments were arranged in a split plot design with three replications. The honeybee pollinators were arranged at random in the main plots, while the biofertilizers were assigned at random in the sub-plots.

Three honeybee colonies used in the experimental field "bee field". The colonies put in cotton field during flowering period. However, the control experimental colonies left away from cotton cultivar to open collecting. The data of bee products are analyzed as a randomized blocks design.

The tested N_2-fixing (*Azospirillum brasilense* and *Azotobacter chroococcum*) and P- dissolving bacteria (*Bacillus megaterium var. phosphaticum*) were obtained from microbiological department, Soil, Water, Environ. Research Institute, ARC. For inoculation cotton seeds were coated with Arabic gum solution (20%) as an adhesive agent and rolled into the suspension of bacteria (10^8 cfu / ml). Seeds were left for drying before sowing far from direct sunlight.

The area of each experimental plot was 19.6 m^2, including seven rows, 4 meters along and 0.70 m apart. Seeds of Giza 86 cultivar were sown on 5^{th} and 8^{th} April in the first and second seasons, respectively in hills 25 cm apart on one side of the row. After 30 days from sowing, plants were thinned to two plants /hill, i.e. 48000 plants/fed. The preceding crop was Egyptian clover in both seasons. All experimental plots were soil fertilized with NPK. Calcium superphosphate (15.5% P_2O_5) was added during soil preparation at the rate of 23 kg P_2O_5 /fed. Nitrogen fertilizer at a rate of 60 kg N / fed in the form of ammonium nitrate (33.5 % N) was split into two equal doses; the first dose was added before the first irrigation, while the second dose was applied before the second irrigation. Potassium fertilizer was added in the form of potassium sulphate (48 % K_2O) at the rate of 24 kg K_2O /fed in one dose before the first irrigation. First ginning was done at 150 days after sowing at 60 % of open bolls/plant, while the second one was done at 30 days later from the first one. Normal cultural practices of sowing cotton plants were conducted in the usual manner followed by the farmers of the district. As an average of the two growing seasons, soil mechanical and chemical analyses of the experimental fields were as follows: texture (Silty loam and Silty loam), pH (7.2 and 7.3), Ec (0.93 and 0.91), O.M. % (1.32 and 1.28), available N "ppm" (22.02 and 20.91), available P "ppm" (8.92 and 9.03) and available K "ppm" (231 and 225) in the non bee field and bee field, respectively.

Characters studied:

1- Abscission.

Ten plants were marked at random at each plot in the field from the second row. The following data was recorded on the main stem and branches per each marked plant.

1- Number of fruiting sites / plant.

2- Number of total bolls at harvest / plant.

3- Total abscission /plant (%) =

[(Number of fruiting sites /plant- Number of total bolls at harvest/plant)/ Number of fruiting sites /plant] x 100

2- Yield and yield components.

At picking, random sample of ten guarded plants was taken from each plot to determine individual plant characters, while seed cotton yield/fed was calculated from the two inner rows of each plot.

1- Number of open bolls / plant.
2- Boll weight (g.).
3- Seed index "100-seed weight" (g.).
4- Earliness (%)
5- Lint %
6- Seed cotton yield / plant (g).
7 - Seed cotton yield / fed (kentar).

3- Chemical composition of seeds.

Seed samples were collected from each treatment at each replicate to determine the oil and protein percentages in the seeds according to the methods described by A.O.A.C (1975).

4- Technological characters of fiber.

Samples of lint were collected from each treatment at each replicate to determine the following characters at the laboratories of Cotton Research Institute , ARC, under standard conditions of test:-

1- **Fiber length (mm): it was determined by the Digital Fibrograph.**

2- **Fiber fineness (micronaire reading): it was determined by Micronaire Instrument as reported by A.S.T.M. (1967).**

3- **Fiber strength (Pressley index): it was determined by Pressley Instrument as reported by A.S.T.M. (1967).**

5- Bee products measurements.

Through the blooming period some production measurements of honeybee colonies were measured, such as a brood area in inch square, pollen area in inch square every 12 days using frame divided into square inches, and collected honey per colony was recorded for every colony during the two seasons.

All obtained data during the two seasons in this study were analyzed according the methods described by Snedecor and Cochran (1967). The differences among the means of different treatments were tested using the Least Significant Differences (LSD) at probability 5%.

RESULTS AND DISCUSSION

1- Abscission:

The data presented in Table (1) showed that honeybee pollination did not significantly affected on number of fruiting sites/plant, but significantly increased the number of total bolls/ plant in the two growing seasons. On the other hand, unpollinated plants with bees recorded the highest values of total abscission percentage in both seasons. Increases in number of bolls and boll set as a result of honeybee pollination may be related to increase numbers of pollen over the entire surface of the stigma, consequently higher fertilization of ovules (Iyengar, 1938 and Arutionova and Gubanov, 1950). Moreover, Badilla and Ramirez (1991) indicated that the fall of non-mature fruits could be explanation to the fact that bees and other pollinators, when bringing pollen of other plants of the same specie, produce a stimulus in the initial growth of the fruit, through a hormonal effect, that remains until the fruit achieves maturity. So, insect pollination increased fruit setting and bolls production (McGregor, 1976 and Dhuyo *et al.*, 1988).

Data given in the same Table indicated that seed inoculation with all tested biofertilizers significantly increased the number of fruiting sites and total bolls per plant compared to uninoculated plants in the two seasons.

Concerning total abscission per plant, it is appeared that biofertilizers inoculation either single or dual significantly decreased abscission percentage compared to the uninoculated plants. These results may be due to that biofertilizers add nutrients through the natural processes of nitrogen fixation (*Azotobacter chroococcum* and *Azospirillum brasilense*), phosphate dissolving (*Bacillus megaterium*) and stimulating plant growth through the synthesis of growth-promoting substances. In this regard, Guinn (1985) reported that fruit abscission and boll retention were primarily related to nutrition management, where the nutritional stress increases boll shedding through an increase in ethylene production. These results may be due to the fact that the hormonal balance of plant probably changed with nutritional intensity.

Table (1): Effect of honeybee pollination and biofertilizers inoculation on abscission during 2010 and 2011 seasons.

Honeybee pollination (A)	Biofertilizers (B)	No. of fruiting sites / plant		No. of bolls /plant		Total abscission /plant (%)	
		2010	2011	2010	2011	2010	2011
without		33.82	32.27	17.38	16.85	48.69	47.92
With		34.17	33.12	18.33	17.95	46.40	45.81
LSD :A		NS	NS	0.41	0.39	0.78	0.89
	Control	30.75	29.35	15.55	14.80	49.47	49.63
	Azospirillum	32.20	30.50	16.55	16.00	48.60	47.53
	Azotobacter	33.70	32.25	17.60	17.40	47.77	46.06
	Bacillus	34.50	34.20	18.15	17.80	47.40	47.91
	Azospirillum+ Bacillus	36.10	34.80	19.40	19.00	46.25	45.39
	Azotobacter + Bacillus	36.70	35.05	19.90	19.40	45.78	44.65
LSD: B		1.07	1.10	0.52	0.35	1.12	1.31
without	Control	30.20	28.80	14.60	13.70	51.66	52.43
	Azospirillum	32.10	30.60	16.30	15.60	49.22	49.02
	Azotobacter	33.80	31.80	17.40	16.50	48.52	48.11
	Bacillus	34.10	33.20	17.60	17.70	48.39	46.69
	Azospirillum+ Bacillus	36.30	34.50	19.10	18.90	47.38	45.22
	Azotobacter + Bacillus	36.40	34.70	19.30	18.70	46.98	46.11
with	Control	31.30	29.90	16.50	15.90	47.28	46.82
	Azospirillum	32.30	30.40	16.80	16.40	47.99	46.05
	Azotobacter	33.60	32.70	17.80	18.30	47.02	44.04
	Bacillus	34.90	35.20	18.70	17.90	46.42	49.15
	Azospirillum+ Bacillus	35.90	35.10	19.70	19.10	45.13	45.58
	Azotobacter + Bacillus	37.00	35.40	20.50	20.10	44.59	43.22
LSD : AB		NS	NS	2.15	2.74	2.08	2.61

With regard to the interaction between honeybee pollination and biofertilizers inoculation, it can be noticed from the same Table that number of bolls/plant and total abscission percentage was significantly affected in the two seasons. The highest values of number of bolls/plant were obtained from the plants treated with honeybee pollination combined with dual inoculation of *Azotobacter* and *Bacillus* in the two seasons. Moreover, it can be noticed that such treatment caused a decrease in abscission percentage /plant amounted to 13.69 and 17.57 % than the untreated plants in the first and second seasons, respectively.

2- Yield and its components:

The data of yield and its components (height of first fruiting node/ plant, number of open bolls/plant, boll weight, seed index, earliness % , lint % and seed cotton yield per plant and fed) as influenced by honeybee pollination, biofertilizers inoculation and their interactions in the two growing seasons are shown in Table (2).

Table 2

Data in the same Table showed the effect of honeybee pollination on cotton yield and its components. The results reveal that honeybee pollination significantly increased number of open bolls/plant, seed index and earliness percentage and lint percentage (in one season), but height of first fruiting node/ plant and boll weight did not significantly affected in the two seasons compared to unpollinated plants. The beneficial role of honeybee in this respect may be related to that most flowers of long stigmas projecting above the stamens do not become completely self- fertilized, as the anthers and stigmas are two widely separated. The flowers of many of the long staple varieties are of this type, the stigmas often exceeding the anthers by 15 mm and the bolls resulting from such flowers have 23% of aborted seeds (Meade, 1918). Thus, it seems unreasonable to leave this abortion to the lack of perfect pollination.

With regard to seed cotton yield per plant and fed. The data showed that significant increases in seed cotton yield per plant and fed were obtained by the honeybee pollination more than the unpollinated plants in the two seasons. These increases in seed cotton yield per plant and fed might be directly attributed to the increase in the number of open bolls /plant. In this concern, numerous authors have cited benefits derived by cotton from insect pollination. Shishikin (1946 and 1952) demonstrated that saturation pollination in areas at the rate of 1-2 colonies of honey bees per acre increased cotton production by 19.5% over areas depending only upon natural pollinators. In cage-grown cotton, which included honeybee but excluded natural pollinators, cotton production was increased 43% over caged cotton without pollinators. Moreover, Mohapatra *et al.* (2010) found that installation of 3-5 bee colonies /acre increased the seed yield of sunflower by 79%, mustard by 55%, sesame by 15%, safflower by 64% and cotton by 18%.

The data in the same Table demonstrated that biofertilizers inoculation either separately or mixed significantly increased the number of open bolls/plant, boll weight, seed index and earliness and lint percentages but decreased the height of first fruiting node/ plant in the two seasons. Inoculation with *Azotobacter chroococcum* appeared to promote blooming of the flowers and boll formation at an earlier period by a few days than uninoculated treatment, both singly and in combination with phosphate dissolving microorganisms (Paul *et al*., 2011). Inoculation seeds with nitrogen fixing bacteria and/or phosphate solubilizing bacteria led to fix more N_2 and release more P (Zayed, 2003), consequently improved absorption of nitrogen, phosphorus and other mineral nutrients which lead to increase dry matter production and yield attributes compared to uninoculated plants (Bashan, 1998). In this concern, several investigators reported that the cotton yield components could be increased by seed inoculation with *Azotobacter* and/or *Azospirillum* (Anjum *et al.,* 2007 and Al-Kahal *et al*., 2008) and *Bacillus* (Akhtar *et al*., 2010) compared to uninoculated plants.

With regard to seed cotton yield, it could be concluded that seed inoculation with biofertilizers significantly increased seed cotton yield per plant and fed in favour of dual inoculants *Azotobacter* and *Bacillus* followed by *Azospirillum* and *Bacillus* in both seasons. This result indicated that plants might be more dependent on N fixing bacteria and P solubilizing bacteria. The superiority of seed cotton yield obtained due to the inoculation of biofertilizers was the logical resultant of the increase in the yield components. The promoting effect of biofertilizers on bolls production and decreasing the abscission was reflected consequently on increasing the number of open bolls / plant and its productivity. Thus, use of dual inoculation in cotton can be recommended for enhancing yield. The combination of *Azotobacter* and *Bacillus* can be exploited for maximizing the benefits derived by the

plant. Many researchers found an increase in the seed cotton yield per plant and unit area due to the inoculation of N_2-fixing (Warnkhade *et al.,* 2001 and Anjum *et al.,* 2007) and P- solubilizing bacteria (Akhtar *et al*., 2010) compared to uninoculated plants.

Significant differences between the two factors, i.e. honeybee pollination and biofertilizers inoculation were obtained for number of open bolls /plant, earliness % and seed cotton yield per plant and fed in the two seasons are shown in Table (2). It is evident from the data that honeybee pollinators combined with dual inoculation produced the highest values of the abovementioned characters in the two seasons. However, the lowest values were obtained by unpollinated and uninoculated plants. The earliness due to honeybee pollination and biofertilizers inoculation might be attributed to that treatment increased number of open bolls per plant and boll retention which reflect on early boll opening and early harvest more than untreated plants. The values of seed cotton yield per plant and fed were significantly and positively responded to honeybee pollination combined with *Azotobacter* and *Bacillus* which were the most effective interaction treatment for producing the highest values in the two seasons. Such treatment caused an increase in seed cotton yield/plant amounted to 31.83 and 36.44 % and in seed cotton yield/fed amounted to 36.27 and 40.16 % more than the unpollinated and uninoculated plants in the first and second seasons, respectively.

3- Chemical composition of seeds:

From the data in Table (3), it is clear that the honeybee pollination had non significant increases in seed oil and protein percentages compared to unpollinated plants in both seasons.

Table (3): Effect of honeybee pollination and biofertilizers inoculation on chemical composition of seeds during 2010 and 2011 seasons.

Honeybee pollination (A)	Biofertilizers (B)	Oil (%)		Protein (%)	
		2010	2011	2010	2011
without		23.11	23.06	21.87	21.80
With		23.19	2309	21.98	21.89
LSD :A		NS	NS	NS	NS
	Control	22.05	22.19	21.12	21.09
	Azospirillum	22.25	22.26	21.65	21.47
	Azotobacter	23.27	22.66	22.09	22.13
	Bacillus	23.70	23.62	21.27	21.26
	Azospirillum+ Bacillus	23.71	23.76	22.45	22.15
	Azotobacter + Bacillus	23.96	23.99	22.99	22.97
LSD: B		0.35	0.31	0.64	0.52
without	Control	22.02	22.11	21.14	21.08
	Azospirillum	22.31	22.23	21.59	21.40
	Azotobacter	23.21	22.74	22.13	22.06
	Bacillus	23.60	23.82	21.36	21.21
	Azospirillum+ Bacillus	23.74	23.51	22.18	22.10
	Azotobacter + Bacillus	23.83	23.95	22.80	22.94
with	Control	22.08	22.27	21.10	21.11
	Azospirillum	22.19	22.29	21.71	21.53
	Azotobacter	23.32	22.57	22.04	22.19
	Bacillus	23.80	23.69	21.17	21.30
	Azospirillum+ Bacillus	23.67	23.72	22.71	22.20
	Azotobacter + Bacillus	24.08	24.02	23.18	23.00
LSD : AB		NS	NS	NS	NS

The results in same Table showed that there are significant differences in seed oil and protein % due to different biofertilizers inoculation. It is clear that inoculation of *Bacillus* recorded the highest value of oil % especially when mixed with *Azotobacter* or *Azospirillum* in the two seasons. The increment in oil % could be attributed to the role of phosphate dissolving bacteria which lead to release of mineral nutrients from the soil especially phosphorus (Ghanem *et al*., 2006), which is a main constituent of phospholipids and phosphoprotein (Ewais, 2006). However, inoculation of *Azotobacter* either separately or mixed with *Bacillus* produced the highest significant values of protein % compared to other biofertilizers and uninoculated treatment in both seasons. This result may be attributed to that *Azotobacter* produce IAA and fixation of atmospheric nitrogen (Barea and Brown, 1974 and Anjum *et al.,* 2007) and consequently increased accumulated nitrogen content in seeds. This finding seems to be confirmed with that obtained by Al-Kahal *et al*. (2008) who found that seed oil and protein percentages were increased with inoculation of *Azotobacter* and/or *Azospirillum* compared to uninoculated cotton plants. Moreover, Ali (2010) concluded that inoculation soybean seeds with N_2-fixing and/or P- dissolving bacteria increased oil and protein percentages compared to uninoculated plants.

With regard to the interactions between the two factors, i.e. honeybee pollination and biofertilizers inoculation were not significant for seed chemical composition.

4- Technological characters of fiber:

It is clear from the data in Table (4) that the honeybee pollination had non significant increases in all technological characters compared to unpollinated plants in both seasons.

Table (4): Effect of honeybee pollination and biofertilizers inoculation on technological characters of fiber during 2010 and 2011 seasons.

Honeybee pollination (A)	Biofertilizers (B)	Fiber length (mm)		Fiber fineness (micronaire reading)		Fiber strength (Pressley index)	
		2010	2011	2010	2011	2010	2011
without		30.67	31.09	4.54	4.60	10.02	10.03
With		31.37	31.55	4.50	4.57	10.06	10.14
LSD :A		NS	NS	NS	NS	NS	NS
	Control	29.58	29.87	4.65	4.73	9.480	9.560
	Azospirillum	30.96	31.29	4.55	4.61	9.980	9.700
	Azotobacter	31.52	31.73	4.46	4.56	10.27	10.42
	Bacillus	30.62	30.78	4.58	4.64	9.630	9.770
	Azospirillum + Bacillus	31.10	31.62	4.49	4.53	10.39	10.46
	Azotobacter + Bacillus	32.34	32.65	4.42	4.47	10.50	10.58
LSD: B		0.97	0.84	NS	NS	0.430	0.600
without	Control	29.11	29.59	4.69	4.75	9.450	9.570
	Azospirillum	30.84	31.21	4.57	4.63	9.940	9.830
	Azotobacter	31.26	31.73	4.47	4.58	10.24	10.38
	Bacillus	30.27	30.49	4.60	4.66	9.650	9.720
	Azospirillum + Bacillus	30.64	31.14	4.48	4.50	10.36	10.42
	Azotobacter + Bacillus	31.89	32.39	4.43	4.48	10.47	10.56
with	Control	30.05	30.14	4.61	4.70	9.510	9.540
	Azospirillum	31.08	31.37	4.52	4.59	10.02	9.910
	Azotobacter	31.77	31.72	4.44	4.54	10.30	10.45
	Bacillus	30.96	31.06	4.56	4.61	9.610	9.810
	Azospirillum+ Bacillus	31.55	32.09	4.49	4.55	10.41	10.50
	Azotobacter + Bacillus	32.78	32.91	4.40	4.45	10.52	10.60
LSD : AB		NS	NS	NS	NS	NS	NS

With regard to the effect of biofertilizers, it can be noticed from same Table that fiber length and fiber strength were significantly increased when the seeds were inoculated especially with *Azotobacter* and *Bacillus* in the two seasons. Meanwhile, seed inoculation of biofertilizers failed to score any significant increase for fiber fineness in the two seasons. Thus, it could be concluded that there is a positive relationship between biofertilizers and fiber length and strength which are useful for improving fiber quality. In this respect, Akhtar *et al*. (2010) found that staple length was significantly increased with seed inoculation of *Bacillus megaterium* compared to uninoculated plants. However, inoculation of *Azospirillum* and/or *Azotobacter* failed to score any significant increase for fiber fineness and fiber strength compared to uninoculated plants (Al-Kahal *et al*., 2008).

The data in the same Table show that the interaction between honeybee pollination and biofertilizers inoculation had non significant effect on technological characters of fiber in the two seasons, indicating that each factor affected each trait independently.

5- Bee products measurements:

Data in Table (5) showed the mean areas of brood in inch^2, pollen collected in inch^2 and the total amount of collected honey per colony in kg/ colony during the two years (2010 and 2011) compared to the control colonies. The total amount of extracted honey, mean areas of pollen and broods significantly increased in hives put in cotton field compared with those away from cotton. The mean areas of brood /inch^2, pollen collected /inch^2 and the total amount of collected honey per colony in kg /colony during 2010 were 934.77, 903.73 and 3.93, respectively compared with colonies in non cotton fields, which gave 725.23, 493.63 and 2.56 for brood areas/inch^2, collected pollen / inch^2 and the total amount of collected honey per colony in kg. Meanwhile, the mean areas of brood /inch^2, collected pollen / inch^2 and the total amount of collected honey per colony in kg/ colony during 2011 were 931.5, 791.9 and 3.63, compared to non cotton field, which gave 756.33, 586.3 and 2.26 for the same measurements, respectively.

Table (5): Mean areas of brood in inch^2, pollen collected in inch^2 and the total amount collected per colony in kg/ colony during 2010 and 2011 seasons.

Honey bee colonies	Replicates	Season 2010			Season 2011		
		Brood areas/ inch^2	Pollen areas/ inch^2	Honey (Kg)	Brood areas/ inch^2	Pollen areas/ inch^2	Honey (Kg)
Cotton field	1st	960.4	889.6	4.2	980.4	759.4	3.6
	2nd	942.6	830.4	3.5	899.6	799.6	3.2
	3rd	901.3	991.2	4.1	914.5	816.7	4.1
	Total	2804.3	2711.2	11.8	2794.5	2375.7	10.9
	Mean	934.77	903.73	3.93	931.5	791.9	3.63
Non cotton field	1st	754.3	425.2	2.95	801.2	513.2	2.1
	2nd	721.9	488.3	2.25	744.6	556.4	1.98
	3rd	699.5	567.4	2.50	723.2	689.3	2.7
	Total	2175.7	1480.9	7.70	2269	1758.9	6.78
	Mean	725.23	493.63	2.56	756.33	586.3	2.26
LSD		24.61	154.74	0.50	45.91	168.27	0.35

REFERENCES

Akhtar, N., A. Iqbal, M. A. Qureshi and Khizer Hayat Khan (2010). Effect of phosphate solubilizing bacteria on the phosphorus availability and yield of cotton (*Gossypium hirsutum*). Journal of Scientific Research, XXXX (1): 15-24.

Ali, O.A.M. (2010). Effect of mineral and biofertilization on the growth, yield and chemical composition of soybean (*Glycine max*, L.). Ph.D. Thesis, Fac. of Agric., Minufiya Univ., Egypt.

Al-Kahal, A. A., Alia A.M. Namich and A.A. Abo El-Soud (2008). The individual and combined effect of bioinoculants on cotton growth and yield under different levels of N-fertilizer. Minufiya J. Agric. Res., 33 (2): 557-574.

Anjum M. A., M. R. Sajjad, N. Akhtar, M. A. Qureshi, A. Iqbal, A. R. Jami and M. Ul-Hasan (2007). Response of cotton to plant growth promoting rhizobacteria (PGPR) inoculation under different levels of nitrogen. J. Agricultural Research, 45: 135–43.

A.O.A.C. (1975). Association of Official Analytical Chemists. Official Methods of analysis 12th Ed. Washington, D.C., USA.

Arutionova, L. G. and G. I. A. Gubanov (1950). In regard to the biology of cotton fertilization. Agrobiologiya 6: 94-99.

A.S.T.M. (1967). American Society for Testing and Materials. Part 25, D. 1448 and D. 1578, USA.

Badilla, F. and W. Ramirez (1991). Polinización del café por *Apis mellifera* y otros insectos en Costa Rica. *Turrialba 41*: 284-288.

Barea J. M. and M. E. Brown (1974). Effect on plant growth produced by *Azotobacter paspali* related to synthesis of plant growth regulating substance. J. Applied Bacteriology 37: 583-593.

Bashan, Y. (1998). Inoculants of plant growth-promoting bacteria for use in agriculture. Biotechnology Advances. 16 (4): 729-770.

Batra, S.(1995). Bees and pollination in our changing environment. Apidologie, 26: 361-370.

Beshir, M.A., K.I. Zaki and Bouthina F. Abd-El Ghany (2000). Effect of rhizobia and *Pseudomonas* in the control of *Macrophonina* damping-off and root-rot of soybean and sunflower plants. Egypt J. Appl. Sci., 15 (2): 33-40.

Dhuyo, A.R., G.H. Munshi, S.M.S.H. Naqvi, S.N.H., Rizvi, M. A. Rustamani (1988). Insect pollinator complex of cotton crop *Gossypium hirsutum* L. at Tandojam, Pak. Cottons 30:45-47.

Ewais, Magda A. (2006). Response of vegetative growth, seed yield and quality of peanut grown on a sandy soil to application of organic manure, inoculation with *Rhizobium* and phosphate dissolving bacteria. Egypt J. Appl. Sci, 21(10B): 794-816.

Free, J.B. (1993). Insect pollination of crops. 2nd edition. Academic Press, London, pp.414-417.

Ghanem, Kh. M., N.N. El- Hefnawy, M.M.F. Abd Allah and A.A. El- Sheshtawy (2006). Effect of solarization, organic and bio-fertilizer on faba bean growth and yield. Egypt. J. Appl. Sci 21(10B): 481-494.

Guinn, G. (1985). Fruiting of cotton, nutritional stress and cut out. Crop Sci., 25: 981–985.

Iyengar, N. K. (1938). Pollen tube studies in *Gossypium*. J. Genetics 37: 69-106.

Klein, A., B.Vaissiere, J.Cane, I. Steffan-Dewenter, S. Cunningham, C. Kremen and T. Tscharntke (2006). Importance of pollinators in changing landscapes for world crops.Proceedings of the royal Society of London.

Mary and B. Weaver (2001). Understand pollination and you can more easily sell your pollination services. American Bee J. 141(3):179-189.

McGregor, S. E. (1976). Insect pollination of cultivated crop plants. Agriculture Handbook, No. 496. U.S. Department of Agriculture, Agriculture Research Service. GPO, Washington, D.C. pp: 411.

Meade, R. M. (1918). Beekeeping may increase the cotton crop. J Heredity, 9 (6): 282-285.

Moeller, F. E. and C. F. Koval (1973). Honeybee pollination of strawberries in Wisconsin. Resource report, Co-operative Extension, University of Wisconsin No.A2549.

Mohapatra, L. N., B. K. Sontakke and N. Ranasingh (2010). Enhancement of crop production through bee pollination. Orissa Review, September: 44-47.

Nye, W.P. and J.L. Anderson (1974). Insect pollinators frequenting strawberry blossoms and the effect of honeybees on yield and fruit quality. J. American Society of Horticultural Science 99:40-44.

Partap, U. and L.R. Verma (1993). Pollination of vegetable crops using the Asian hive bee Apis cerena in the Kathmandu valley, Nepal. In: Proc. Int. Symp. Pollination in Tropics, India. (eds.) Veeresh, G.K., R. Uma Shanker and K.N. Ganeshaich. pp. 184-186.

Paul, S., M. S. Rathi and S. P. Tyagi (2011). Interactive effect with AM fungi and Azotobacter inoculated seed on germination, plant growth and yield in cotton (*Gossypium hirsutum*). Indian J. Agricultural Sciences 81 (11): 1041–1045.

Sawan, Z. M., S. A. Hafez, A. E. Basyony and A. R. Alkassas (2006). Cottonseed, protein, oil yields and oil properties as affected by nitrogen fertilization and foliar application of potassium and a plant growth retardant. World J. Agricultural Sciences, 2(1): 56-65.

Shishikin, E. A. (1946). Honey bees in the service of cotton pollination. Pchelovodstvo 23: 31-32.

Shishikin, E. A. (1952). Effect of pollination by honeybees on increasing the productivity of cotton. *In* Krishchunas, I.V. and A. F. Gubin (eds.) pollination of agricultural plants. Moska, Gos. Izd-vo Selkhoz Lit-ry, pp. 95-103.

Sihag, R.C. (2000). Management of bees for pollination. In: Asian Bees and Beekeeping, Progress of Research and Development. (eds.) Matsuka, M., L.R. Verma, S. Wongsiri, K.K. Shrestha and U. Partap. ICIMOD, Kathmandu, pp. 163-165.

Smith, C. W. (1995). Cotton (*Gossypium hirsutum*, L.). Chapter 6, *In*: Crop production, evolution, history and technology. John Wiley and Sons, Inc. New York: 287- 349.

Snedecor, G.W and W.G. Cochran (1967). Statistical Methods, 6th Ed. The Iowa State Univ. Press, Ames. Iowa, USA.

Warnkhade, S. T., V. M. Solanke, A. B. Turkhede, S. D. Malvi and R. N. Katkar (2001). Effect of biofertilizer on growth and yield of Arboreum cotton (AKA-8401). Crop Res., 21(1): 38-40.

Zayed, A. (2003). Growth promotion of some soybean cultivars by *Rhizobium* and phosphate - solubilizing bacteria. J. Agric. Sci. Mansoura Univ., 28 (10): 7481-7490.

استجابة القطن المصرى للتلقيح بنحل العسل والأسمدة الحيوية

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الملخص العربى

أجريت تجربتان حقليتان بمزرعة خاصة بمركز ديرب نجم – محافظة الشرقية – مصر لدراسة تأثير التلقيح بنحل العسل وتلقيح البذور بالأسمدة الحيوية (كنترول ، الأزوسبيريلليم ، الأزوتوباكتر ، الباسيلس ، الأزوسبيريلليم + الباسيلس ، الأزوتوباكتر + الباسيلس) على صفات التساقط ، المحصول ومكوناته ، التركيب الكيماوى للبذور ، الصفات التكنولوجية لألياف القطن المصرى (صنف جيزة ٨٦) خلال موسمى الزراعة ٢٠١٠ ، ٢٠١١ حيث تم وضع خلايا النحل خلال فترة التزهير بمعدل ٣ طوائف للحقل الملقح وقد لقحت البذور بالأسمدة الحيوية المختبرة قبل الزراعة مباشرة.

ويمكن إيجاز أهم النتائج المتحصل عليها على النحو التالي :-

أدى تلقيح النباتات بنحل العسل إلى زيادة معنوية لصفات عدد اللوز الكلى على النبات ، المحصول ومكوناته (عدد اللوز المتفتح على النبات ، دليل البذرة ، نسبة التبكير، نسبة الشعر ، محصول القطن الزهر للنبات وللفدان) فى حين أدى الى تقليل النسبة المئوية للتساقط الكلى/ النبات مقارنة بالنباتات غير الملقحة بنحل العسل . بينما لم يكن هناك تأثير معنوى لاستخدام نحل العسل فى التلقيح لصفات ارتفاع أول عقدة ثمرية على النبات والتركيب الكيماوى للبذور والصفات التكنولوجية للألياف وذلك فى كلا الموسمين .

أدى تلقيح البذور بالأسمدة الحيوية إلى زيادة معنوية لقيم صفات ارتفاع أول عقدة ثمرية ، عدد اللوزالكلى على النبات ، المحصول ومكوناته ، التركيب الكيماوى للبذور ، الصفات التكنولوجية للألياف (عدا النعومة) فى حين أدى الى تقليل النسبة المئوية للتساقط الكلى / النبات مقارنة بالنباتات غير الملقحة (الكنترول) وذلك فى كلا الموسمين .

تشير نتائج التفاعل بين التلقيح بالنحل و الأسمدة الحيوية إلى تأثر صفات عدد اللوزالكلى على النبات ، النسبة المئوية للتساقط الكلى/ النبات ، عدد اللوز المتفتح على النبات ، نسبة التبكير، محصول القطن الزهر للنبات وللفدان تأثرا معنويا بهذا التفاعل حيث أعطى تلقيح الأزهار بالنحل مع التلقيح المزدوج للبذور ببكتريا الأزوتوباكتر و الباسيلس أقل قيم للتساقط الكلى وأعلى قيم للصفات المحصولية مقارنة بالمعاملة غير الملقحة بأي من نحل العسل والأسمدة الحيوية وذلك خلال موسمى الزراعة .

أوضحت النتائج ان متوسط مساحه الحضنة بالبوصة المربعة ومتوسط مساحة حبوب اللقاح المجموعه بالبوصة المربعة ومتوسط انتاج العسل من الطوائف بالكجم كانت خلال عام ٢٠١٠ هى٩٣٤.٧٧بوصة مربعه و ٩٠٣.٧٣بوصة مربعة و ٣.٩٣ كجم للطائفة الموضوعه بحقل القطن مقارنة بالكنترول والذى اعطى ٧٢٥.٢٣ بوصة مربعة و٤٩٣.٦٣ بوصة مربعة و٢.٥٦ كجم على التوالى ، فى حين كانت النتائج خلال عام ٢٠١١ ٩٣١.٥ بوصة مربعة و ٧٩١.٩ بوصة مربعة و ٣.٦٣ كجم مقارنة بالطوائف الموضوعه بعيدا عن حقل القطن والتى اعطت ٧٥٦.٣٣ بوصة مربعة و ٥٨٦.٣ بوصة مربعة و ٢.٢٦ كجم من الحضنة وحبوب اللقاح والعسل ، على التوالى.

Table (2): Effect of honeybee pollination and biofertilizers inoculation on yield and its components during 2010 and 2011 seasons.

Honeybee pollination (A)	Biofertilizers(B)	Height of first fruiting node/ plant (cm)		No. of open bolls /plant		Boll weight (g.)		Seed index (g.)		Earliness (%)		Lint (%)		Seed cotton yield/plant (g.)		Seed cotton yield/fed (kentar)	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
without		**23.11**	**23.43**	**16.62**	**15.98**	**2.16**	**2.14**	**9.67**	**9.83**	**59.91**	**57.73**	**37.24**	**38.07**	**35.21**	**33.71**	**10.44**	**10.19**
With		**22.88**	**23.12**	**17.80**	**17.22**	**2.19**	**2.16**	**9.77**	**10.17**	**62.11**	**60.89**	**37.91**	**38.32**	**37.74**	**36.07**	**11.20**	**11.24**
LSD :A		NS	NS	1.01	1.12	NS	NS	0.05	0.13	0.24	0.41	NS	0.20	0.71	1.72	0.62	0.41
	Control	**24.07**	**25.21**	**15.25**	**14.40**	**2.02**	**1.98**	**8.79**	**9.02**	**57.88**	**57.27**	**36.01**	**36.23**	**33.13**	**30.88**	**9.70**	**9.47**
	Azospirillum	**23.42**	**24.07**	**16.20**	**15.65**	**2.09**	**2.04**	**9.46**	**9.90**	**59.05**	**58.28**	**37.09**	**37.55**	**34.61**	**32.97**	**10.07**	**9.90**
	Azotobacter	**23.23**	**23.88**	**17.15**	**17.10**	**2.24**	**2.23**	**9.34**	**10.05**	**60.99**	**58.56**	**38.20**	**38.90**	**35.57**	**34.87**	**10.58**	**10.44**
	Bacillus	**23.06**	**22.60**	**17.75**	**17.20**	**2.15**	**2.05**	**9.56**	**9.63**	**61.89**	**59.43**	**36.54**	**36.92**	**36.94**	**34.66**	**10.64**	**11.02**
	Azospirillum+ Bacillus	**22.35**	**22.19**	**18.20**	**17.40**	**2.24**	**2.19**	**10.54**	**10.70**	**62.34**	**60.55**	**38.15**	**39.57**	**38.25**	**37.58**	**11.67**	**11.53**
	Azotobacter + Bacillus	**21.83**	**21.68**	**18.70**	**17.85**	**2.33**	**2.42**	**10.63**	**10.71**	**63.90**	**61.79**	**39.48**	**40.03**	**40.39**	**38.40**	**12.24**	**11.94**
LSD: B		1.20	1.33	1.34	1.63	0.11	0.18	1.05	0.98	1.03	0.52	1.32	1.20	1.60	2.42	0.44	0.35
without	**Control**	**24.12**	**25.27**	**14.30**	**13.20**	**1.97**	**1.94**	**8.78**	**8.94**	**57.12**	**55.70**	**35.81**	**36.12**	**32.11**	**29.23**	**9.32**	**8.79**
	Azospirillum	**23.56**	**24.06**	**15.80**	**15.10**	**2.04**	**1.98**	**9.44**	**9.96**	**58.23**	**56.83**	**36.94**	**37.25**	**33.54**	**31.67**	**9.76**	**9.58**
	Azotobacter	**23.19**	**23.81**	**16.60**	**16.20**	**2.28**	**2.24**	**9.57**	**10.13**	**60.34**	**57.10**	**37.55**	**38.64**	**34.87**	**33.29**	**10.02**	**10.19**
	Bacillus	**23.01**	**23.01**	**17.10**	**17.10**	**2.11**	**2.06**	**9.33**	**9.59**	**61.24**	**57.18**	**35.97**	**37.36**	**35.54**	**34.10**	**10.24**	**10.10**
	Azospirillum+ Bacillus	**22.64**	**22.37**	**17.80**	**17.00**	**2.25**	**2.2**	**10.42**	**10.29**	**60.11**	**58.77**	**38.11**	**39.24**	**36.77**	**37.06**	**11.50**	**10.89**
	Azotobacter + Bacillus	**22.11**	**22.03**	**18.10**	**17.30**	**2.31**	**2.41**	**10.45**	**10.07**	**62.42**	**60.82**	**39.07**	**39.82**	**38.45**	**36.91**	**11.78**	**11.56**
With	**Control**	**24.01**	**25.14**	**16.20**	**15.60**	**2.07**	**2.01**	**8.80**	**9.09**	**58.64**	**58.83**	**36.21**	**36.34**	**34.16**	**32.52**	**10.08**	**10.14**
	Azospirillum	**23.28**	**24.08**	**16.60**	**16.20**	**2.14**	**2.09**	**9.47**	**9.83**	**59.87**	**59.72**	**37.24**	**37.85**	**35.67**	**34.27**	**10.38**	**10.22**
	Azotobacter	**23.27**	**23.94**	**17.70**	**18.00**	**2.20**	**2.22**	**9.10**	**9.96**	**61.63**	**60.01**	**38.85**	**39.15**	**36.27**	**36.44**	**11.14**	**10.68**
	Bacillus	**23.10**	**22.19**	**18.40**	**17.30**	**2.18**	**2.04**	**9.78**	**9.66**	**62.54**	**61.67**	**37.11**	**36.47**	**38.34**	**35.22**	**11.03**	**11.94**
	Azospirillum+ Bacillus	**22.05**	**22.01**	**18.60**	**17.80**	**2.22**	**2.18**	**10.65**	**11.12**	**64.57**	**62.33**	**38.18**	**39.89**	**39.72**	**38.09**	**11.84**	**12.16**
	Azotobacter + Bacillus	**21.54**	**21.33**	**19.30**	**18.40**	**2.35**	**2.43**	**10.80**	**11.36**	**65.22**	**62.75**	**39.88**	**40.24**	**42.33**	**39.88**	**12.70**	**12.32**
LSD : AB		NS	NS	2.05	2.41	NS	NS	NS	NS	2.15	3.18	NS	NS	2.63	3.14	1.87	2.13