EFFECT OF TIMES AND METHODS OF POTASSIUM FERTILIZER ON YIELD AND YIELD COMPONENTS OF NEW HYBRID COTTON (GIZA 86 X 10229) UNDER EARLY AND LATE SOWING

Abdel-Aal, S.A. Amal; M.A.A Emara and S.A.F. Hamoda
Department of Agronomy, Cotton Research Institute, Agriculture Research Center, Giza, Egypt

ABSTRACT

Two field experiments were carried out at Sakha Agricultural Research Station at Kafr El-Sheikh Governorate, Egypt, on new hybrid cotton (Giza 86 X 10229) during 2013 and 2014 seasons to study the effect of sowing dates (15 April and 15 May) as main plots and five methods and time of potassium sulphate application as sub plots i.e:

1- Soil application of 24 kg K_2O/fed. as potassium sulphate (48% K_2O) after thinning.
2- Soil application of 24 kg K_2O/fed. as potassium sulphate (48% K_2O) at two weeks after thinning.
3- Foliar application of 5 kg potassium sulphate (48% K_2O)/fed. sprayed two times at the square and start flowering stages.
4- Foliar application of 5 kg potassium sulphate (48% K_2O)/fed. sprayed two times at the start and peak of flowering stages.
5- Foliar application of 5 kg potassium sulphate (48% K_2O)/fed. sprayed three times at square, start and peak of flowering stages. The most important results obtained could be summarized as follows:

1) Results obtained revealed that early sowing (15 April) significantly increased no. of internodes and sympodia on the main stem, no. of open bolls/plant, boll weight, seed cotton yield/plant and /feddan, dry weight of vegetative and fruiting organs of plant, days to first flower, days to first open boll and earliness percentage, while plant height, no. of more monopodial/plant and first sympodium node were decreased.
2) Results indicated the positive effect of potassium when it was applied at the proper time as soil application at two weeks after thinning which resulted in less no. of monopodia and higher no. of sympodia, higher dry weight of vegetative and fruiting organs, heaviest bolls, and higher no. of open bolls as well as seed cotton yield/plant and /feddan. Potassium fertilization showed no effect on no. of main stem internodes/plant, first sympodium node, days to first flower, days to first open boll, seed index, earliness percentage and lint percentage.
3) The interaction of planting date by K treatments was not significant for all traits studied in this investigation.
4) Generally, results obtained revealed that early sowing (15 April) and the soil application of potassium sulphate (24 kg/feddan) fertilizer at two weeks after thinning for obtaining high productivity of new hybrid cotton (Giza 86 x 10229).

KEY WORDS: Cotton, Sowing dates, Potassium sulphate, Fertilizer, Growth, Earliness and Yield.

INTRODUCTION

Cotton is not only the king of fibers and crucial crop used for fiber production all around the world **(Killi and Aloğlu, 2000)** but also it is a vital source of foreign exchange earnings. The suitable sowing date and nutrients play a vital role in cotton production, where the early sowing date is one of the most important management factors involved in producing high yielding and quality (**Dong *et al.*, 2006** and **Bozbek *et al.*, 2006)**. The second one provides the cotton plants with one of the major feeding elements.

Applying different sowing dates expose the cotton plants to different temperature responses, which affecting the optimum requirements of the whole plant, **(Woodward and Sheely, 1983)**. **Young *et al* (1980)** cleared that early sowing fits the cotton plant to full season in order to obtain complete thermal units regime. **McMahon and Low (1972)** mentioned that planting cotton in a suitable time leads to forming the first fruiting branch at a lower node on the stem and only an optimum height, increasing no. of bolls/plant and seed cotton yield, escaping from leaf and boll-worms and aphids at the end of the season and early picking. **Boquet *et al.* (2003)** showed that the excessive plant height at late planting date was partly responsible for lower yield as the crop used a larger portion of its energy budget for vegetative growth and the excess plant height caused lodging. Seed cotton yield/fed. was significantly decreased with delayed planting.

Early sowing appears higher yield potential and alternately, late planting of cotton crop shows very vegetative and difficult to manage resulting in lower seed cotton yield as well (**Ali *et al.*, 2009**). However, several reports have indicated that early sown cotton produces taller plants with higher no. of branches, no. of bolls, seed cotton yield **(Pettigrew, 2006, Arshad *et al.*, 2007** and **Bange *et al.*, 2008**). These findings are also supported by other researchers **Emara *et al.*, (2006), El-Shahawy and Hamoda (2011), Abdul Wahab *et al.*, (2014)** and **Hamoda *et al.*, (2014)** where they found that early planting date significantly increased seed cotton yield/fed. due to the increase of no. of open bolls/plant and boll weight. The planting date treatments did not exhibit significant effect on lint %.

Potassium (K) is a unique plant nutrient for cotton because of its continuous need through all growth stages and its relatively high uptake rate. Yet the cotton plant is a relatively inefficient as a K absorber. Potassium is an important nutrient that has favorable effects on the metabolism of nucleic acids, proteins, vitamins and growth substances. Furthermore, K plays an important role in the translocation of photsynthates from sources to sinks **(Bednarz and Oosterhuis, 1999** and **Morteza *et al.*, 2005)**. However, recently positive response of cotton plants to potassium fertilizer has been documented comparing with unfertilized plants with potassium fertilization **(El-Sayed and El-**

Menshawy 2001, Kassem and Ahmed 2005, El-Sayed *et al.* 2006, Sary *et al.* 2008 and Abou-Zaid *et al.*, 2009). Many studies have shown increased yield and cotton productivity in response to potassium fertilization as reported by **Emara (2012), Sema *et al.*, (2012), Abdel-Aal *et al.*, (2014), Sawan (2014), Gomaa *et al.*, (2014)** and **Emara (2014).**

The aim of this investigation is to evaluate the response of the new hybrid cotton (Giza 86 X 10229) to different application methods and time of potassium sulphate under early and late sowing dates.

MATERIALS AND METHODS

Two field experiments were carried out at Sakha Agricultural Research Station at Kafr El-Sheikh Governorate, Egypt, during 2013 and 2014 seasons using the new hybrid cotton (Giza 86 X 10229) belonging to *Gossypium barbadense,* L. Characterized the new hybrid cotton are showed in Table (1).

Table (1): Characterized the new hybrid cotton (Giza 86 x 10229)

Hybrid name	New promising hybrid cotton (Giza 86 x 10229).
Species	Barbadense.
Category	Long staple and extra fine.
Pedigree	Crossing between G86 x 10229.
Characteristics	Long staple characterized by high yielding, early maturity, resistance to Fuzariam and high lint (%).
Botanical distinguishing characters	The stem has a medium length with polygon shape also has green color mixed by dim red with medium length internodes. The leaves have palmate shape with large size with no deep lobes and leather fell. The node of the first fruiting branch ranged from 8 - 9. A flower petal has tubular shape. The boll size is large and pyramid shape with drawn summit. Seed is big-sized and the fuzz covers about fuzz less to ¼ from the whole size and fuzz color is gray-greenish.
Hybrid bred by	Breeding Res. Section, Cotton Res. Inst., Agric. Res. Center, Giza, Egypt.

Each experiment was laid out in a split plot design with four replications. The main plots were assigned to the two sowing dates i.e.; April 15 (early) and May 15 (late). While, the sub-plots were allocated to four applications of potassium i.e.;

1) Soil application of 24 kg K_2O/fed. as potassium sulphate (48% K_2O) after thinning.
2) Soil application of 24 kg K_2O/fed. as potassium sulphate at two weeks after thinning.
3) Foliar application of 5 kg K_2O/fed. as potassium sulphate sprayed two times at the square and start flowering stages.

4) Foliar application of 5 kg K_2O/fed. as potassium sulphate sprayed two times at the start and peak of flowering stages.

5) Foliar application of 5 kg K_2O/fed. as potassium sulphate sprayed three times at square, start and peak of flowering stages.

The sub-plot size was 18 m^2 including 6 rows (5 m long and 60 cm width). Nitrogen fertilizer in the form of ammonium nitrate (33.5%N) was added in bands and divided into two equal doses, the first one was applied after thinning just before the first irrigation and the second part before the second irrigation. All other cultural practices were done as recommended in cotton production that is involved as basic dose of 150 kg calcium superphosphate (15.5% P_2O_5) at land preparation. Potassium was added to sub-main plots according to the experimental treatments (type, rate and time of application).

Soil samples were taken in the two seasons before planting cotton to estimate the soil characters using the standard methods as described by **Chapman and Parker, (1981)**. The results are shown in Table (2). In both seasons, the soil texture was clay loam, low content of organic matter, very low calcium carbonate and non-saline. The available amounts of macro- elements were low for nitrogen, phosphorus and potassium.

Table (2): Mechanical and chemical analysis of the experiment soil in 2013 and 2014 seasons.

Seasons	Properties Texture	pH	Organic Matter (%)	TSS (%)	Bicarbonate (%)	Available element (ppm)		
						N	P	K
2013	Clay loam	7.70	1.69	0.64	1.82	12.10	9.21	131.2
2014	Clay loam	8.38	1.74	0.69	1.81	11.95	9.50	126.2

Five representative hills were chosen by random from the four inner rows in order to study the following characters:

A. Growth characters: Final plant height (cm), no. of main stem internodes/plant, no. of monopodia/plant and no. of sympodia/plant.

B. Dry weight: A random sample of five plants were taken at 130 days from sowing. All plants were carefully uprooted, washed hard then floated in water bath for final separation from the muddy medium. All plant parts were dried in an air forced oven at 90^{o}C to a constant weight. The following data were recorded; dry weight of leaves/plant (g), dry weight of stem/plant (g) and dry weight of reproductive organs of plant; squares, flowers and bolls (g).

C. Earliness measurements: First sympodial node, days to first flower, days to first open boll and earliness percentage.

D. Yield components: No. of open bolls/plant, boll weight (g), seed cotton yield/plant, no. of plants at harvest/fed., lint percentage, seed index (g) and

seed cotton yield (kentar/feddan) were estimated from picking all plants of four inner rows of each plot.

The climatic records included minimum and maximum air temperatures (°C) and relative humidity (%) for Sakha Weather Station through the two growing seasons are given in Table (3).

Table (3): Monthly air temperature (^{o}C) and relative humidity (%) during 2013 and 2014 seasons

Month	2013 season				2014 season			
	Air temp. (^{o}C)		RH (%)		Air temp. (^{o}C)		RH (%)	
	Max.	Min	Max.	Min	Max.	Min	Max.	Min
March	26.8	11.8	86.3	49.5	27.0	12.0	85.9	49.0
April	31.5	15.0	85.0	47.7	30.9	14.6	86.0	48.0
May	34.0	18.0	76.7	38.0	33.8	17.9	70.0	39.0
June	37.0	22.2	82.5	46.5	38.1	23.1	82.9	47.1
July	38.0	24.4	79.5	49.2	39.2	24.5	78.7	48.9
August	37.5	24.2	84.0	50.0	38.3	24.7	83.7	51.1
September	38.2	22.7	88.0	49.6	39.2	23.1	87.3	50.0
October	33.0	19.0	82.0	48.0	32.8	20.1	81.3	48.5

The data obtained were subjected to statistical analysis according to procedure outlined by **Snedecor and Cochran (1981)** by using LSD at 5% level.

RESULTS AND DISCUSSION

A. Plant growth characters:

The data presented in Table (4) showed that, final plant height and no. of monopodia/plant were significantly increased in favour of late sowing treatment, while no. of internodes on the main stem and no. of sympodia/plant were significantly decreased. Regarding to potassium fertilizer treatments, the data illustrated in Table (4) showed that, final plant height, no. of monopodia/plant and no. of sympodia/plant were significantly affected by potassium treatments in both seasons. On the other hand, it is apparent that potassium application treatments had insignificant effect on no. of main stem internodes/plant. Adding potassium as soil application at two weeks after thinning produced the tallest plants with high no. of sympodia. The results in the same table indicate that the early application of potassium 24 kg K_2O/feddan at two weeks after thinning relatively prolonged the vegetative growth period. **Halvey (1976)** demonstrated that maximum amount of the K is taken up by cotton plants between the period of 57 to 84 days after emergence (from early squaring to early blooming stage). Similar results were obtained by **Makram *et al.*, (1994)** for plant height and **Ali and El-Sayed (2001), Pettigrew (2006), Arshad *et al.*, (2007)** and **Bange *et al.*, (2008**) for no. of main stem internodes/plant, no. of monopodia/plant, and no. of sympodial/plant.

Table (4): Means of some growth characters as affected by sowing dates, time and application methods of potassium and their interaction of 2013 and 2014 seasons.

Treatments Characters	Seasons	Sowing dates (S)			Potassium treatments (K)						Inter S x K
		15 April	15 May	L.S.D	Soil after thinning	Soil 2w after thinning	2 Sprays Sq + F	2 Sprays F + 2F	3 Sprays Sq + F + 2w	L.S.D	
Final plant height (cm)	**2013**	145.8	153.5	**3.20**	148.30	151.80	150.20	149.30	148.30	**1.82**	**NS**
	2014	146.2	153.9	**4.10**	150.00	151.70	148.00	150.50	150.00	**0.87**	**NS**
No. of main stem internodes/plant	**2013**	21.50	18.60	**1.20**	20.70	20.80	19.70	19.80	20.00	**NS**	**NS**
	2014	22.70	17.52	**2.70**	18.90	19.10	20.10	19.90	19.80	**NS**	**NS**
No. of monopodia/plant	**2013**	0.97	1.15	**0.08**	1.08	1.03	1.05	1.08	1.05	**0.01**	**NS**
	2014	1.16	1.25	**0.01**	1.22	1.10	1.20	1.20	1.22	**0.02**	**NS**
No. of sympodia/plant	**2013**	17.90	15.20	**1.21**	17.00	17.10	16.20	16.20	16.30	**0.18**	**NS**
	2014	18.16	14.82	**2.13**	16.55	16.87	16.58	16.13	16.32	**0.19**	**NS**

B. Dry matter weight:

Data presented in Table (5) showed that planting date and potassium treatments had a significant effect on the dry matter plant organs in the two seasons, early fertilized plants with potassium application as soil potassium 24 kg K_2O/feddan at two weeks after thinning increased the dry matter of plant organs. Dry weight production in early and late sowing as well as K absorption was affected in all plant parts. The dry matter accumulation is a good result to the favourable effect of this element on the photosynthesis activity of leaves, promotion of CO_2 assimilation and the translocation of carbohydrates from the leaves to the reproductive organs **(Hart, 1969)**. It is worth to be mentioned here that **Halvey (1976)** reported that the maximum K^+ uptake rate in cotton plants occurred at 57 to 84 days after emergence (early squareing to early blooming stage). Thus, the period of peak K^+ uptake preceded the peak rate of dry matter production. **Basset *et al.*, (1970)** came to same conclusion. This may explain why K application before the second irrigation was found to be the proper time to provide the plant with K for building up the maximum dry matter.

Leaves dry weight/plant was significantly increased due to early sowing in both seasons. Late sowing resulted in rapid vegetative growth as compared to early sown plants which exposed relatively to low air temperatures **(McMahon and Low، 1972)**. The increase in leaves dry weight is mainly due to the increase of leaves number of plant. From other point of view, cotton plants of earlier sowing harvested the highest amount of heat units through the growing season **(Young *et al.*, 1980)**. This situation resulted in much formation of leaf assimilates necessary for increasing the fruiting capacity **(Makram *et al.*, 2001)**.

Table5

C. Earliness

Data given in Table (6) showed the effect of sowing dates, time and application methods of potassium and their interaction on some earliness measurements.

Table (6) cleared that, node of the first sympodium was significantly lowered in favour of early sowing while number of days from planting to first flower and open boll was significantly decreased by delaying the date of sowing but it still late in the calendar date of appearance for both characters than earlier sowing. This might be due to relatively low temperature of air at the beginning of the season for early sowing which induced the balance between vegetative growth and fruiting capacity, while in late sowing the increase of air temperatures directed the cotton plant development to vegetative growth. At harvest (first pick) most bolls in case of early sowing reached maturity age, in the same time few bolls of late planting reached maturity which was reflected on increasing earliness percentage in early sowing. These results are in line with those obtained by **Emara *et al.*, (2006), Ali *et al.*, (2009), El-Shahawy and Hamoda (2011),** and **Hamoda *et al.*, (2014).**

Table (6) cleared that, application of potassium gave insignificant effect on position of first sympodium, days to first flower and days to first open boll and earliness percentage. These results were in good agreement with those reported by **El-Sayed, (2005)**.

D. Yield and yield components:

Results presented in Table (7) cleared the effect of sowing dates, time and application methods of potassium and their interaction on yield and yield components.

Results presented in Table (7) showed that both no. of open bolls/plant, boll weight and seed cotton yield/plant were significantly increased in favour of earlier sowing. Also, the yield of seed cotton/feddan was significantly increased as a result of increasing no. of open bolls/plant and boll weight, where the plant stand means at harvest remained in narrow range of differences, while lint percentage and seed index were not significantly affected in the two seasons. However, previous results obviously cleared that early sowing fits the cotton plants to full season in suitable climatic window in order to obtain complete thermal units requirements and gave enough time to develop a heavy boll load with large seeds **(Young *et al.*, 1980),** besides the exposure of cotton plant at different stages to suitable air temperature **(Makram *et al.*, 2001).** Similar results were obtained by **Emara *et al.*, (2006), Arshad *et al.*, (2007), Bange *et al.*, 2008), El-Shahawy and Hamoda (2011), Abdul Wahab *et al.*, (2014)** and **Hamoda *et al.*, (2014)**.

Data in Table (7) show that no. of open boll/plant, boll weight and seed cotton yield/plant and /feddan were affected significantly by time and application methods of potassium, while lint percentage and seed index were not significantly affected in the two seasons. Data of seed cotton yield and yield components showed that the fertilization with soil potassium 24 kg K_2O/feddan at two weeks after thinning were highly significant. The increment in the two characters, i.e., seed cotton yield/plant and boll weight may be due to the role of potassium fertilizer in encouraging root hairs to grow early and increasing its elongations well as early appearance of bolls of cotton plants.

Table6

Table7

Regarding the proper time of potassium application, it had been found that soil application with potassium 24 kg K_2O/feddan at two weeks after thinning seemed to be the best timing. This might be due to the fact that most amount of potassium which needed by cotton plant is laying after flowering, while at early stages of growth, the seeding requirements is very low **(Etourneand, 1995)**. **Eatone and Ergle (1957)** proved that total amount of K needed by cotton plants early in its growth is small. Similar results were obtained by **El-Sayed and El-Menshawi (2001), Kassem and Ahmed (2005), Abou-Zaid *et al.*, (2009), Sema *et al.*, (2012), Sawan (2014),** and **Emara (2014)**.

The interaction between sowing dates and potassium treatments had no significant effect on all traits under study in both seasons.

CONCLUSION

Generally, the results obtained in this study could lead us to a package of recommendations, which seemed to be useful for increasing the cotton yield production in quantity and quality. It could be concluded the early sowing (15 April) and the soil application with potassium sulphate (24 kg/feddan) at two weeks after thinning for obtaining high productivity of new hybrid cotton (Giza 86 x 10229) under Sakha location.

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تأثير طرق ومواعيد التسميد البوتاسي على المحصول ومكوناته لهجين القطن الجديد (جيزة ٨٦ × ١٠٢٢٩) تحت مواعيد الزراعة المبكرة والمتأخرة

أمل سامى على عبد العال ، مصطفى عطية أحمد عمارة ، سعيد عبد التواب فرج حمودة
قسم بحوث المعاملات الزراعية - معهد بحوث القطن – مركز البحوث الزراعية – الجيزة – مصر

أجريت تجربتان حقليتان بمحطة البحوث الزراعية بسخا، محافظة كفر الشيخ خلال موسمي ٢٠١٣، ٢٠١٤ وذلك بهدف دراسة تأثير طرق ومواعيد إضافة سماد البوتاسيوم على نمو وإنتاجية القطن تحت ظروف الزراعة المبكرة والمتأخرة (١٥ أبريل، ١٥ مايو) لهجين القطن الجديد جيزة ٨٦ × ١٠٢٢٩ وهذا الهجين انتج من قسم بحوث تربية القطن وفى مرحلة اعداد التوصيات الفنيه له، وكانت معاملات إضافة سماد البوتاسيوم كالآتى:

١- إضافة أرضية بسلفات البوتاسيوم بمعدل ٢٤ وحدة بو٢أ للفدان عند الخف.
٢- إضافة أرضية بسلفات البوتاسيوم بمعدل ٢٤ وحدة بو٢أ للفدان بعد الخف بإسبوعين.
٣- إضافة سلفات البوتاسيوم بمعدل ٥ كجم للفدان رشا مرتين عند ظهور الوسواس وعند بداية التزهير.
٤- إضافة سلفات البوتاسيوم بمعدل ٥ كجم للفدان رشا مرتين عند بداية التزهير وبعد التزهير بإسبوعين.
٥- إضافة سلفات البوتاسيوم بمعدل ٥ كجم للفدان رشا ثلاث مرات عند بداية الوسواس وعند بداية التزهير ثم بعد التزهير بإسبوعين.

وقد صممت التجربة بتصميم القطع المنشقة فى أربع مكررات حيث وضعت مواعيد الزراعة (١٥ أبريل، ١٥ مايو) فى القطع الرئيسية ووضعت طرق ومواعيد إضافة السماد البوتاسى فى القطع الشقية.

وتتلخص أهم النتائج المتحصل عليها فيما يلى:

١- أدت الزراعة فى الميعاد المبكر (١٥ أبريل) إلى زيادة معنوية فى عدد السلاميات علي الساق الرئيسى، عدد الأفرع الثمرية علي النبات، عدد اللوز المتفتح على النبات متوسط وزن اللوزة، ومحصول القطن الزهر بالقنطار للفدان، والوزن الجاف للأعضاء الخضرية والثمرية للنبات وزيادة عدد الأيام لتفتح أول زهرة وأول لوزة وكذلك زيادة نسبة التبكير، بينما أدت إلى نقص الطول النهائى للنبات وعدد الأفرع الخضرية على النبات وإنخفاض موقع أول فرع ثمرى على النبات.
٢- لم تؤثر مواعيد الزراعة علي تصافي الحليج، معامل البذرة وعدد النباتات للفدان عند الجني.
٣- أدى إضافة السماد البوتاسى إلى نتائج إيجابية حينما أضيف فى الميعاد المناسب أرضاً بمعدل ٢٤ وحدة بو٢أ للفدان بعد الخف بإسبوعين، حيث أدت تلك المعاملة إلى نقص عدد الأفرع الخضرية على النبات وإلى زيادة عدد الأفرع الثمرية على النبات وزيادة الوزن الجاف لأجزاء النبات المختلفة وزيادة وزن اللوزة وعدد اللوز على النبات ووزن المحصول للنبات والفدان.
٤- لم يؤثر إضافة البوتاسيوم على عدد السلاميات للساق الرئيسى وعلى موقع أول فرع ثمرى وعدد الأيام لتفتح أول زهرة وأول لوزة ووزن ١٠٠ بذرة وتصافى الحليج وعدد النباتات للفدان عند الجني.
٥- لم يكن للتفاعل بين مواعيد الزراعة ومواعيد وطرق إضافة السماد البوتاسى أى تأثير معنوى على الصفات تحت الدراسة.

من النتائج المتحصل عليها في هذه الدراسة فأنه يمكننا التوصية بزراعة هجين القطن الجديد (جيزة ٨٦×١٠٢٢٩) مبكراً فى (١٥ أبريل) مع إضافة ارضية لسلفات البوتاسيوم بمعدل ٢٤ كجم K_2O/فدان مرة واحدة بعد الخف بإسبوعين وذلك لزيادة إنتاجية محصول القطن تحت ظروف منطقة سخا.