Effect of potassium fertilization on grain yield and leaf blight disease resistance for some maize lines at nubaria region

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ABSTRACT

Three field experiments were conducted during late summer seasons (nily season) of 2003, 2004 and 2005 at Nubaria Agriculture Research Station, to study the effect of potassium application on grain yield and leaf blight disease severity (*Helminthosporium turcicum*) of six commercial maize (*Zea mays* L.) lines. Four rates of potassium fertilizer (zero, 24, 48 and 72 kg K_2O fad^{-1}) and six commercial lines (Sd.7, Sd.63, Gz.602, Gz.612, Gz.628 and Gm.2) were tested in this study. Data were recorded for grain yield (ard fad^{-1}), leaf blight disease severity (%), plant height (cm) and days to mid-silking (d).

The following results were obtained:

- Highly significant differences in grain yield and leaf blight disease severity were observed due to years, potassium rates and lines.
- Contribution percentages in grain yield were 40.0, 28.3, 13.3 and 18.4% due to year's effect, lines, potassium levels and different interactions, respectively. On the other hand, contribution percentages of the different factors on leaf blight disease severity showed that the genetic structure of the genotype imposed significant effect on disease severity (79%), while potassium contribution was 8.81% only.
- Mean of grain yield, over lines, increased from 7.68 (no potassium) to 10.27 ard fad^{-1} (72 kg K_2O fad^{-1}). Line Gz.602 gave the highest grain yield (11.71) followed by Sd.7 (10.22 ard fad^{-1}), while Gm.2 gave the lowest gain yield (6.89 ard fad^{-1}).
- Under the four levels of potassium, leaf blight disease severity showed general gradual decrease. Line Gm.2 was highly resistant (HR), while Gz.612 was susceptible. Over the lines, disease severity decreased significantly as potassium rates increased. Disease severity was 28.87% at zero level and 17.48% at 72 kg K_2O fad^{-1}.
- Grain yield was, mostly, affected by the genotype rather than potassium application or leaf blight disease severity. Line Gz.602 (MR) gave the highest grain yield, whereas Gm.2 (HR) gave the lowest, over potassium levels. In addition, line Gz.612 (S) gave intermediate grain yield.
- Plant height increased gradually according to potassium levels. Overall means, over lines, were 142.9, 146.2, 154.1 and 153.2 cm, under potassium levels; zero, 24, 48 and 72 kg K_2O fad^{-1}, respectively. Lines Gz.602 and Gz.612 were the tallest, whereas Gm.2 was the shortest. Potassium showed no effect on days to mid-silking.

- It may be concluded that potassium application resulted in increasing grain yield, reducing leaf blight disease severity and increasing plant height, however, the genotype structure could be the main important factor effecting leaf blight disease severity as well as grain yield.

Key words: Maize, Potassium, leaf blight disease, Helminthosporium turcicum.

INTRODUCTION

Maize is one of the most important strategic cereal crops in Egypt. Most of maize area is planted in summer season, but in the last years, large area is planted in late summer (nily season). Generally, the late planting area of maize is more subjected to pests and diseases. Leaf blight disease caused by *Helminthosporium turcicum* is an important foliar disease of maize in temperate areas of the world including Egypt (Khalifa and Zein El-Abedeen, 2000). Many factors control this disease severity, *i.e.* genotype, temperature, humidity and fertilization.

Breeding for varietal resistance is the most effective method to control *H. turcicum* (Hooker, 1975). Resistance is expressed by a reduction in lesion number. Lesion number is quantitative in expression (polygenic in inheritance) controlled by several genes (Jenkins and Robert, 1961). Hooker *et al.* (1965) described another type of resistance according to the form of lesion type. Lesion type is qualitatively expressed (monogenic in inheritance) as chlorotic lesions (Bentolila *et al.*, 1991). Resistance to this type is inherited as a single dominant gene, Ht.1, and first reported by Hooker (1963).

In Egypt, the disease is mostly occurred in the northern and north western regions of the delta in the late summer maize areas, where favorable wheather conditions are prevailing at this time of the year (El-Assiuty *et al.*, 1987 and Gouda, 1996). High yield losses can occur if lines or hybrids are susceptible for this disease when grown at late season in these areas.

Plant nutrition may influence the resistance or susceptibility to leaf blight disease. Potassium (K), one of the macroelements, is able to decrease severity of many diseases. Also, it is known to increase tolerance to heat and drought stresses (Turner and Hummel, 1992 and Carrow *et al.* 2001). Potassium fertilization has been generally recommended to reduce the severity of maize stalk rot. Stalk rot of maize increases with increasing levels of nitrogen only when potassium levels are low (Warren *et al.*, 1975). A balanced level of potassium induces thicker cell walls, accumulation of amino acids and production of new tissues (Huber, 1981). Potassium increased yields in several soils with optimum or higher available K levels especially when K was banded (Mallarino *et al.*, 1999). Potassium fertilization was associated with higher corn grain yields only in fields that had k soil-test levels higher than 120 mg kg^{-1} (Vyn and Janovicek, 2001). Christians *et al.* (1981) observed that more K was needed as N fertilization rates increased.

The objectives of this study were to: (*i*) study the effect of potassium application on grain yield and leaf blight disease severity of six maize lines, (*ii*) study the response of six maize commercial lines to leaf blight disease severity in Nubaria region, (*iii*) estimate the contribution net value of genotypes and K application and their interaction on grain yield and leaf blight disease resistance. Also, the effects of potassium fertilization and maize lines on plant height and silking date were discussed.

MATERIALS AND METHODS

This study was carried out in the late summer season (nily season) to evaluate six commercial maize lines for grain yield and leaf blight disease resistance under four potassium levels at Nubaria Agric. Res. Station, Northwest of Egyptian Nile Delta, during 2003, 2004 and 2005 seasons. The studied lines were selected according to their previous data (Khalifa and Zein El-Abedeen, 2000) to represent the different groups of resistance to leaf blight disease as follows:

Line	Resistance level
Sids-7 (Sd.7)	Moderately resistant (MR)
Sids-63 (Sd.63)	Highly resistant (HR)
Giza-602 (Gz.602)	Highly resistant (HR)
Giza-612 (Gz.612)	Moderately susceptible (MS)
Giza-628 (Gz.628)	Resistant (R)
Gemmiza-2 (Gm.2)	Highly resistant (HR)

A split-plot design with four replicates was used at each year of this study with potassium rates in main-plot and lines in sub-plot. Plot size was two rows, five meters long with 70 cm apart and 20 cm between hills. Potassium fertilizer was added in the form of potassium sulphate (48% K_2O) at the four studied rates (zero, 24, 48 and 72 kg K_2O fad^{-1}) at two equal doses applied with the doses of nitrogen. All the other recommended practices were followed as common in Nubaria area. Data were recorded for grain yield, leaf blight disease infection (%), plant height (cm) and silking date (d). The total shelled grain weight / plot adjusted to 15.5% grain moisture then converted to ardab / faddan (ard = 140 kg, faddan = 4200 m^2). Disease rating was made 90 days from planting as an average percentage of infected leaf area under natural infection, according to Elliot and Jinkins (1946) with modification as follows:

Rating scale	%leaf area infected	Resistance level
0.0	< 5	Highly resistant (HR)
0.5	6 – 10	Resistant (R)
1.0	11 – 20	Moderately resistant (MR)
2.0	21 – 40	Moderately susceptible (MS)
3.0	41 – 60	Susceptible (S)
4.0	> 61	Highly susceptible (HS)

The scale has been modified to meet the conservation purpose, especially with lines that are usually included in producing commercial hybrids. Lessening ranges within the original scale may help in this concern.

The chemical and physical analysis of the experimental soil showed that Nubaria soil has a light texture of sandy loam to sandy clay loam, with high content of total $CaCO_3$ (more than 25%). The soil PH lies around alkalinity (8.2), soluble calcium and sodium ions are the dominant cations, while soluble chloride is the dominant anion. Soil organic matter content, available phosphorus, total nitrogen percent and available potassium are below the critical limit (0.4%, 2.0 mg kg^{-1}, 0.11% and 116 mg kg^{-1} respectively).

Data were statistically analyzed as a split plot design according to Steel and Torrei (1980), using proc ANOVA at SAS software (SAS software Rel. 6.12, 1997). Year effects were considered random, while potassium levels and lines were fixed effects in the analysis of variance. Tests for homogenity of error variances were carried out according to Snedecor and Cochran (1981). Homogenity differences between the error variances of the three years were detected. Therefore, combined analysis over years was done, as a split-split plot design, according to the expected mean square which presented in Table (1).

Table (1): Expected mean square of four potassium rates and six lines at Nubaria during 2003, 2004 and 2005 seasons.

S.O.V.	df	Expected mean square
Year (Yr)	2	$\sigma^2_a + 96\,\sigma^2_Y$
Error (a)	9	σ^2_a
Potassium rate (K)	3	$\sigma^2_b + 24\,\sigma^2_{YP} + 72\,K^2_p$
Yr x K	6	$\sigma^2_b + 24\,\sigma^2_{YP}$
Error (b)	27	σ^2_b
Lines (Lin)	5	$\sigma^2_c + 16\,\sigma^2_{YL} + 48\,K^2_L$
Yr x Lin	10	$\sigma^2_c + 16\,\sigma^2_{YL}$
K x Lin	15	$\sigma^2_c + 4\,\sigma^2_{YPL} + 12\,K^2_{pL}$
Yr x K x Lin	30	$\sigma^2_c + 4\,\sigma^2_{YPL}$
Error (c)	180	σ^2_c

RESULTS AND DISCUSSION

Highly significant differences in grain yield and leaf blight disease severity were observed for years, potassium rates and lines (Table 2). Also, all interactions were significant or highly significant for the studied traits except k x line for grain yield.

The different studied factors differently affected grain yield, where 40.0% of total contribution was due to years effect, 28.3% due to lines, 13.3% due to potassium fertilization and about 18.4% due to the different interactions (Table 2). The high contribution of the years could be interpreted due to soil fertility and environmental conditions prevailed each year so that means of grain yield were 10.93, 6.91 and 9.44 ard/fad (unshown data) in 2003, 2004 and 2005 seasons, respectively.

Contribution percent of the different studied factors on leaf blight disease severity showed that the genetic composition of the genotype imposed highly significant effect on percentage of disease severity (79%), whereas, potassium fertilization contribution in disease severity was 8.81% only (Table 2). All the other factors shared about 12.19% of contribution. This confirms the fact that breeding resistant genotype is the best and most effective method to control plant disease. These results reflected that the genotype is considered the important factor affecting grain yield and leaf blight disease resistance.

Table (2): Mean square and net value of contribution % for grain yield and leaf blight disease infection of four potassium levels and six maize lines at Nubaria during 2003, 2004 and 2005 seasons.

S.O.V.	df	Grain yield		Leaf blight disease †	
		Mean square	Contribution %	Mean square	Contribution %
Year (Yr)	2	397.44**	40.0	9.98**	1.86
Error (a)	9	1.20	---	0.76	---
Pot. rate (K)	3	99.33**	13.3	34.24**	8.81
Yr x K	6	1.09*	0.1	1.58**	1.09
Error (b)	27	0.35	---	0.23	---
Lines (Lin)	5	163.13**	28.3	199.15**	79.0
Yr x Lin	10	20.28**	11.7	3.74**	4.25
Pot x Lin	15	1.11	1.00	2.65**	3.34
Yr x K x Lin	30	2.40**	5.0	0.59**	1.71
Error (c)	180	0.36	---	0.24	---
C.V.		6.6		12.2	

† Data was converted by angular transformation

*, ** Significant and highly significant differences at 0.05 and 0.01 level of probability, respectively.

Effect of potassium fertilization on grain yield:

Significant response of grain yield to potassium application was observed on the studied lines (Table 3). Overall mean of grain yield, over lines, was increased from 7.68 (no potassium applied) to 10.27 ard fad^{-1} (72 kg K_2O fad^{-1}). Significant gradual increase of grain yield was detected with different potassium levels. The highest grain yield was observed in line Gz.602 (11.71) followed by Sd.7 (10.22 ard fad^{-1}), while the lowest line was Gm.2 (6.89 ard fad^{-1}). Other studied lines yielded 9.93, 8.4 and 7.41 ard fad^{-1} for Gz.628, Gz.612 and Sd.63, respectively.

Table (3): Interaction means of four potassium rates and six maize lines for grain yield and leaf blight disease severity % during 2003, 2004 and 2005 seasons.

Potassium rate / Lines	Grain yield (ard fad^{-1})				
	Zero	24 kg	48 kg	72 kg	Mean
Sids-7	8.90	9.60	11.06	11.30	10.22
Sids-63	6.25	7.07	7.54	8.78	7.41
Giza-602	10.12	11.25	12.34	13.13	11.71
Giza-612	7.07	7.48	9.52	9.52	8.40
Giza-628	8.10	9.73	10.81	11.10	9.93
Gemmiza-2	5.65	6.50	7.65	7.76	6.89
Mean	7.68	8.51	9.82	10.27	
$LSD_{0.05}$ (K)	0.43				
$LSD_{0.05}$ (lines)	2.05				
Potassium rate / Lines	Leaf blight disease infection (%)				
	Zero	24 kg	48 kg	72 kg	Mean
Sids-7	39.17	35.01	30.48	30.53	33.80
Sids-63	26.77	22.47	19.77	15.65	21.16
Giza-602	19.36	13.57	8.28	7.21	12.10
Giza-612	56.65	47.92	36.55	30.45	42.89
Giza-628	30.18	28.12	22.87	19.97	25.28
Gemmiza-2	1.08	1.53	1.08	1.07	1.19
Mean	28.87	24.77	19.84	17.48	22.71
$LSD_{0.05}$ (K)	3.54				
$LSD_{0.05}$ (lines)	6.65				

Out of six, four lines didn't differ significantly when potassium level passed over 48 kg K_2O fad^{-1}, while the other two lines (Sd.63 and Gz.602) were significantly responded to 72 kg K_2O fad^{-1} (Table 3 and Fig. 1). Therefore, potassium fertilization (at least 48 kg K_2O fad^{-1}) would be necessary for maize production at Nubaria region. Response of grain yield to potassium application may be due to the low level of potassium at Nubaria soil, in addition, the N x K interaction, where more nitrogen could be efficient when more potassium is applied. These results agree with those reported by Christians *et al.* (1981), Bordoli and Mallarino (1998), Mallarino *et al.* (1999) and Vyn and Janovick (2001).

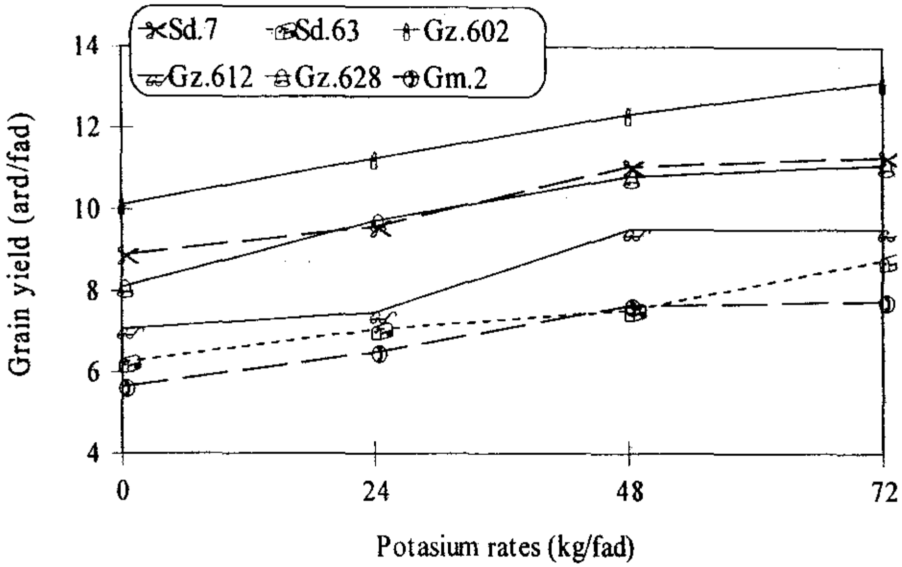

Fig.1 : Effect of four potassium rates on grain yield for six maize lines at Nubaria region.

Effect of potassium fertilization on leaf blight disease severity:

General gradual differences in leaf blight disease severity were detected among all the tested lines under the four levels of potassium applied in this study (Table 3 and Fig.2). Line Gm.2 was considered to be highly resistant genotype to leaf blight disease (1.19%) as average of the different levels of potassium fertilization, while line Gz.612 was susceptible (42.89%). The other lines were either moderately resistant i.e. Gz.602 (12.1%) or moderately susceptible, *i.e.* Sd.7 (33.81%), Sd.63 (21.16%) and Gz.628 (25.28%). These findings are on line with those found by Diab *et al.* (1993) and Khalifa and Zein El-Abedeen (2000) for Gz.612 and Sd.7 only.

It was noticed that lines Gm.2 and Gz.602 exhibited chlorotic lesion type of resistance in which the lesions are expressed in the form of limited elongated necrotic areas always surrounded by a chlorotic or yellowish halo. This type of resistance was first identified by Hooker (1961) and the presence of this type of infection in Egyptian genetic material was reported by El-Shafey *et al.* (1978), El-Assiuty *et al.* (1987) and Diab *et al.* (1980 and 1993) and also reported by Khalifa and Zein El-Abedeen (2000).

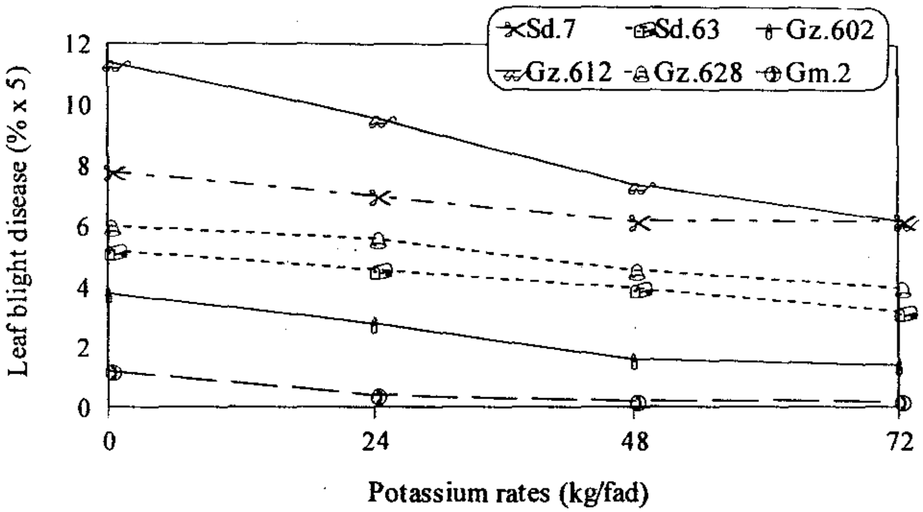

Fig.2 : Effect of four potasium rates on leaf blight disease severityfor six maize lines at Nubaria region.

Over the studied lines, leaf blight disease severity significantly decreased when potassium rate was increased from zero up to 72 kg K_2O fad^{-1}. The highest significant percentage of disease severity (28.87%) was observed at zero level, whereas the lowest percentage (17.48%) was observed at 72 kg K_2O fad^{-1} level. Significant differences in leaf blight disease severity were distinct only at 48 kg K_2O fad^{-1} or more (Table 3). This observation, in general, was also true for each line. Fair and true evaluation of lines for leaf blight disease should be performed under 48 kg K_2O fad^{-1} as a recommended dose at Nubaria region. Based on the previous note, Sd.63 and Gz.628 lines could be MR instead of MS. Also, Gz.602 could be considered R instead of MR and Gz.612 could be MS rather than S.

Relationship between grain yield and leaf blight disease severity:

Grain yield was mostly, also, affected by the genotype rather than potassium application or leaf blight disease severity (Fig. 3). Line Gz.602 (MR) gave the highest significant grain yield, whereas Gm.2 (HR) gave the lowest grain yield, over potassium levels, in addition, line Gz.612 (S) gave intermediate grain yield. This, again, confirms that grain yield is mostly related to the genetic structure of each genotype which can compensate the reduction of growth or development due to leaf blight disease or low nutrition levels. On the other side, it was apparent that, at line level, there was gradual increase in grain yield and reduction in leaf blight disease severity coincides with increase in potassium fertilization rate.

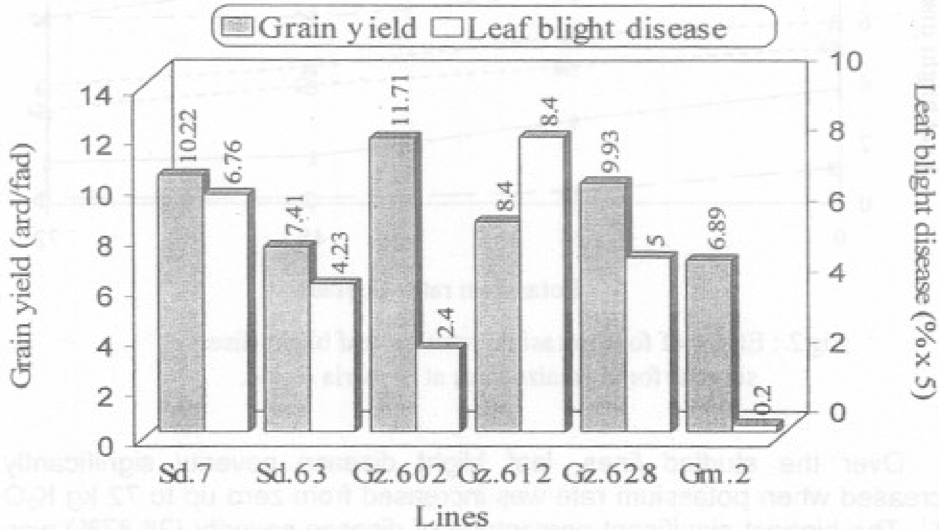

Fig.3 : Response of six maize lines to potassium application on grain yield and leaf blight disease severiy at Nubaria region.

Effect of potassium fertilization and maize lines on some other agronomic traits:

It was important to study the effect of potassium application on some other agronomic traits such as plant height and days to mid-silking (silking date). Results showed highly significant differences due to years, potassium fertilization, lines and year x line interaction for plant height (Table 4). Also, highly significant differences were observed for years, year x K, year x line and K x line interactions for silking date. These results showed that more variability of plant height and silking date is due to year's effect, reflected variation in environmental conditions across years of this study.

Plant height gradually increased according to potassium levels (Table 5). Overall means of plant height, over lines, under potassium levels (zero, 24, 48 and 72 kg K_2O fad^{-1}) were 142.9, 146.2, 154.1 and 153.2 cm, respectively. The studied lines significantly varied in plant height, where

Gz.602 and Gz.612 were the tallest lines (180.8 and 175.3 cm, respectively), while Gm.2 was the shortest line (94.3 cm). These results indicated that when more potassium amounts were applied (up to 48 kg K_2O fad^{-1}), more vegetative growth occurred, taller plants and increased grain yield. High significant correlation was detected between grain yield and plant height (0.7).

Potassium levels showed no effect on days to mid-silking (Table 5). Also, little variation was detected among the studied lines for silking date. Mean of silking date for the lines ranged from 68.5 (Gm.2) to 70.9 d (Sd.63 and Gz.602).

Table (4): Mean square for plant height and silking date of four potassium levels and six maize lines at Nubaria during 2003, 2004 and 2005 seasons.

S.O.V.	df	Plant height	Silking date
Year (Yr)	2	17642.4 **	2194.06 **
Error (a)	9	51.8	1.74
Pot. rate (K)	3	520.6 *	7.59
Yr x K	6	107.1 *	3.59 **
Error (b)	27	32.8	0.44
Lines (Lin)	5	6691.1 **	48.87 *
Yr x Lin	10	144.9 **	12.59 **
Pot x Lin	15	64.1	2.92 **
Yr x K x Lin	30	37.2	0.81 *
Error (c)	180	31.3	0.48
C.V.		8.6	1.0

*, ** Significant and highly significant differences at 0.05 and 0.01 level of probability, respectively.

Table (5): Interaction means of four potassium rates and six maize lines for plant height and days to mid-silking during 2003, 2004 and 2005 seasons.

Potassium rate / Lines	Plant height (cm)				
	Zero	24 kg	48 kg	72 kg	Mean
Sids-7	156.8	159.2	171.2	168.3	163.8
Sids-63	135.4	128.2	138.6	138.4	135.1
Giza-602	169.5	181.8	186.8	185.1	180.8
Giza-612	165.3	173.9	180.3	181.7	175.3
Giza-628	139.5	143.8	150.0	147.3	145.1
Gemmiza-2	90.8	90.4	97.6	98.5	94.3
Mean	142.9	146.2	154.1	153.2	149.4
LSD $_{0.05}$ (K)	3.5				
LSD $_{0.05}$ (lines)	13.6				

Potassium rate / Lines	Days to mid-silking (d)				
	Zero	24 kg	48 kg	72 kg	Mean
Sids-7	69.9	69.8	70.8	71.8	70.6
Sids-63	70.5	70.8	70.8	71.8	70.9
Giza-602	70.9	71.3	70.4	71.3	70.9
Giza-612	69.4	69.5	69.3	68.9	69.3
Giza-628	69.4	69.6	69.6	70.6	69.8
Gemmiza-2	67.9	68.7	68.9	68.4	68.5
Mean	69.7	69.9	69.9	70.5	70.0
LSD $_{0.05}$ (K)	3.5				
LSD $_{0.05}$ (lines)	1.6				

It may be concluded that potassium application resulted in increasing grain yield, reducing leaf blight disease severity and increasing plant height, however, the genotype structure could be the main important factor effecting leaf blight disease severity as well as grain yield.

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الملخص العربى

تأثير إضافة البوتاسيوم على محصول الحبوب والمقاومة لمرض لفحة الأوراق فى بعض سلالات الذره الشاميه المزروعة فى منطقة النوباريه

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(٢) قسم بحوث أمراض الذره والمحاصيل السكريه – معهد أمراض النبات– مركز البحوث الزراعيه – مصر.

(٣) قسم بحوث خصوبة الأراضى وتغذية النبات – معهد بحوث الأراضى والمياه والبيئه – مركز البحوث الزراعيه – مصر.

- زرعت ثلاثة تجارب حقليه خلال الموسم الصيفى المتـأخر (النيلـى) مواسـم ٢٠٠٣ ، ٢٠٠٤ و٢٠٠٥ بمحطة البحوث الزراعيه بالنوباريه بهدف دراسة تأثير إضافة السماد البوتاسـى علـى محصول الحبوب وشدة الاصابه بمرض لفحة الأوراق على ستـة سلالات ذره الشاميه.
- وقد استخدم فى هذه الدراسه أربعة مستويات من التسميد البوتاسى شملت صفر ، ٢٤ ، ٤٨ و٧٢ كجم بو٢أ / فدان وستة سلالات ذره شاميه هى: سدس-٧ ، سدس-٦٣ ، جيزه-٦٠٢ ، جيـزه-٦١٢ ، جيزه-٦٢٨ وجميزه-٢. تم تسجيل البيانات لصفات محصول الحبوب (أردب/فدان) ، شدة الاصابه بمرض لفحة الأوراق (%) ، متوسط ارتفاع النبات (سم) وموعد ظهور ٥٠% حرائـر (يوم).
- أوضحت النتائج وجود فروق عالية المعنويه لصفات محصول الحبوب وشدة الاصـابة بمـرض لفحة الأوراق راجعة الى السنوات ، مستويات البوتاسيم والسلالات تحت الدراسه.
- بلغت نسبة المشاركه لصفة محصول الحبوب حوالى ٤٠ ، ٢٨,٣ ، ١٣,٣ و١٨,٤% للـسنوات ، السلالات ، مستويات البوتاسيوم والتفاعل بين هذه العوامل مجتمعه على الترتيب – بينمـا بلغـت هذه النسب لشدة الاصابه بالمرض حوالى ٧٩% للسلالات و٨,٨١% لمستويات البوتاسيوم.
- زاد محصول الحبوب كمتوسط للسلالات مجتمعـه مـن ٧,٦٨ (بـدون تـسميد) حتـى ١٠,٢٧ أردب/فدان (٧٢ كجم بو٢أ / فدان). أعطت السلاله جيزه-٦٠٢ أعلى محصول للحبوب (١١,٧١) تليها السلاله سدس-٧ (١٠,٢٢ أردب/فدان) ، بينما أعطت السلاله جميـزه-٢ أقـل محـصول للحبوب (٦,٨٩ أردب/فدان).
- انخفضت شدة الاصابه بمرض لفحة الأوراق تدريجيا بزيادة التسميد البوتاسى وأعطـت الـسلاله جميزه-٢ درجة مقاومه عاليه (HR) بينما كانت السلاله جيزه-٦١٢ حساسه للاصابه بـالمرض (S). تراوحت شدة الاصابه بالمرض من ٢٨,٨٧% (بدون تسميد بوتاسى) كمتوسـط للـسلالات مجتمعه بينما انخفضت الاصابه الى ١٧,٤٨% عند مستوى ٧٢ كجم بو٢أ / فدان.
- أعطت السلاله جيزه-٦٠٢ درجة مقاومه متوسطه (MR) لمرض لفحة الأوراق كما أعطت أكثر محصول للحبوب ، بينما كانت السلاله جميزه-٢ عالية المقاومه (HR) لكنها الأقـل محـصولا. أيضا كانت السلاله جيزه-٦١٢ حساسه للاصابه بالمرض (S) لكن أعطت محصولا متوسطا.
- زادت متوسطات ارتفاع النبات تدريجيا بزيادة التسميد البوتاسى وقدرت هـذه المتوسـطات بـــ ١٤٢,٩ ، ١٤٦,٢ ، ١٥٤,١ ، ١٥٣,٢ سم لمستويات التسميد المستخدمه على الترتيب. أعطـت السلالات جيزه-٦٠٢ وجيزه-٦١٢ أكثر المتوسطات لارتفاع النبات بينما كانت السلاله جميزه-٢ أقصر السلالات.