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Enhancing production of *Zea mays* genotypes by K application in Peshawar, Pakistan

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ABSTRACT

The food security is a huge problem with the increase in population of the Pakistan. Maiz (*Zea mays)* is one of the major cereal crop and has the capability to compete with the production as well as supporting the controlling applications. As, the modern genotypes has the good potential to resist with the potassium (K) application into the field, an experiment was conducted on K levels with 0, 30, 60 and 90 kg ha^{-1}. Maize genotypes *viz* MM-50, MM-44, ZMS-52, ZMS-51, ZMS-40, ZMS-06, GV-41, Kiramat-2C, 325-PW and Babar-1C were tested into the field. Our results concluded that K levels had a significant effect on grain yield and yield components. Application of K at 60 kg ha^{-1} showed good yield compared to all other levels of K applications. The tested genotypes also had a significant effect on the tested traits. The genotype (MM-50) showed maximum grains yield (3924 kg ha^{-1}) and maximum yield components to all the genotypes. Maximum grains yield (4593 kg ha^{-1}) and 1000 grain weight (260.4 g) were obtained from genotype (MM-50) at K level of 60 kg ha $^{-1}$.

Key words: Enhance, K application, Pakistan, Peshawar, *Z. mays.*

INTRODUCTION

The food security is a major problem due to the growing population in Pakistan. Maize (*Zea mays* L) is one of the important cereal crops of Pakistan and it has the capability to overcome with the production due to better management practices. It is used as food, feed and used in several industries which are benefitting human's health. But it provides rather low yield per unit area in Pakistan which is not advanced country of the world. The important aspects like pest control, seeding rate, irrigation water, balance use of fertilizer application and improved varieties play an important part in growing up the crop productivity (Robert, 2003).

The geographical unit of the region is defined as; Peshawar division was an administrative division of the KP province of Pakistan until the reforms of 2000 of the government of Pakistan. After independence in 1947, the KP split into 2 divisions (D.I. Khan and Peshawar). After 1976, Peshawar division involved the district Hazara and Kohat, when they became divisions separately. In the mid-1990s, the Mardan also get separated and became a separate division.

Still, using the modern genotypes and K application with it is lacking and is not been confirmed. For which, this study was directed to scrutinize the response of advanced maize genotypes to different levels of K application in Khyber Pakhtunkhwa, Pakistan. Rehman (2009) revealed that the countries where the management practices were poor, the yield would be low there. Zhang *et al*., (2000) investigated that when the application of K increased, the yield as well as the net profit also increased, while conducting experiment on three maize cultivars.

Shah *et al*., (2007) reported that the type of soil at the research site was basically composed of quaternary fluvial and lacustrine sediments. It is divided into piedmont soil, floodplain soil and lacustrine soil. The chemical analysis of these soils revealed that the MgO, CaO, Na_2O, K_2O and P_2O_5, other trace and heavy metals, except CO were higher than the limits reported for normal soil.

Rasool *et al*., (1987) conducted a research on the effect of different K levels (0, 30, 60, 90, 120 kg ha^{-1}) tested on yield and yield components of maize. Results showed the increase in grain yield when K was applied at a higher rate, 1000 grain weight while shelling per cent likewise the control treatments. Stauffer *et al*., (1995) studied in field trials on maize that a highest yield response of 66% was revealed from maximum dose of 160 kg K ha^{-1} in D.I. Khan.

The Peshawar sits mainly on the Iranian plateau including the whole KP province. Peshawar is a frontier city of the SC Asia and was the major part of the Silk Road in history. The valley of Peshawar is full of the deposits of silt, sands and gravel of recent geological times. The flood plains of Peshawar are the areas between Kabul River and Budni

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Nala. The meander flood plain leaves from Warsak in the NW towards SE at the top of the district while the Kabul River enters the district from the NW side.

Chaudhary and Malak (2000) investigated K doses (0, 50, 100, 150, 200, 250, 300 and 350 kg K ha $^{-1}$). Results revealed the yield components were not significantly affected but ear yield. Charles (2009) investigated and found that the declining percent of the maize crop may be recovered with the best fertilizer application. As the advanced genotypes and finest fertilizer application are the two major and vital components into the management practices therefore, the study was conducted to define the performance of the naive maize genotypes under different levels of K application in Khyber Pakhtunkhwa, Pakistan.

MATERIALS AND METHODS

Experimental detail and treatments: A field trial was conducted with an objective to examine the performance of maize genotypes to varying level of potassium (K) fertilizer application at new developmental farm, The University of Agriculture Peshawar during *kharif* season in 2015-16. The split plot design was used in arrangements of the experiment followed by three replications. Main plots consisted of potassium levels 0, 30, 60 and 90 kg K ha^{-1}. while sub plots having a size of 4 m × 4.5 m each were allotted to maize genotypes viz. MM-44, GV-41, ZMS-40, MM-50, ZMS-52, ZMS-51, ZMS-06, Babar 1C, 3025-PW and Kiramat 2C. Seeding rate of 30 kg ha^{-1} was used and a normal population of about 60,000 ha^{-1} was maintained approximately. All other agronomic practices were uniformly applied to all experimental units. The data were collected on days to 50 % tasseling and silking, days to physiological maturity (maturity), plant height (cm) number of plants ha^{-1} at harvest, ears plant^{-1}, grains ear^{-1}, shelling percentage, 1000-grain weight (g), grain yield (kg ha^{-1}), stover yield (kg ha^{-1}) and harvest index (H.I). All standard procedures were followed to record the data in chronological order and the data were analyzed using least significant difference (LSD) when F values for treatments were found significant at $P < 0.05$ (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The data on agronomic characteristics were noted as influenced by level of potassium application and maize genotypes. There was no significant interaction between potassium level and maize genotypes for most of the traits studied except 1000-grain weight and grain yield (kg ha^{-1}). Therefore, the main effects of potassium levels and maize genotypes on these traits are given in Table 1 and discussed accordingly.

Mean values of the data revealed that days to 50% tasseling were significantly ($P<0.05$) affected by application of potassium levels and genotypes (Table 1). Maximum numbers of days 56.8 were taken by control plots whereas, minimum numbers of 52 days were taken by the plot applied with 60 kg K ha^{-1}. These results are in line with those of Asif *et al*., (2007) who reported that tasselling were delayed when potassium levels were increased up to 60 kg ha^{-1}. Genotypes effects on tasseling were significantly different from each other. Minimum numbers of 51.5 days were taken by ZMS-40 and MM-50. All other genotypes took maximum number of days but not significantly different from each other (Table 1). Varietal differences in tasseling have also been observed by Shafi *et al*., (2011) in their study.

Table 1: Agronomic trait as influenced by varying levels of potassium applications and maize genotypes at Newly Developmental Farm, The University of Agriculture Peshawar during 2015-16.

K level kg ha^{-1}	Days to 50% Tasseling	Silking	Days to maturity	plant ht (cm)	plant ha^{-1} at harvest	Grains ear^{-1}	Shelling %age	Stover yield (kg ha^{-1})	H.I (%)
0	56.8a	61.4a	110.0a	213.3c	51870c	415.5c	71.12a	6556b	44.99b
30	52.5b	60.2ab	109.6ab	215.4bc	53080b	460.6b	72.36a	6749b	46.48b
60	52.0b	56.3c	105.8c	220.7a	55540a	494.3a	76.41a	7274a	50.16a
90	52.9b	59.3b	108.5b	216.6b	53610b	456.6b	73.79a	6873 b	47.76 ab
LSD 0.05	1.15	1.45	1.25	2.91	9.48	11.78	NS	385.1	3.24
Genotypes									
MM-44	54.00 a	60 bc	110.0 ab	213.4 b	51030 d	450.3 bcd	72.75 bc	6303 b	43.55 c
GV-41	54.00 a	59 cd	110.8 a	215.3 fg	51750 cd	472.3 abc	69.92 de	6758 de	44.14 de
ZMS-40	51.50 b	58 de	107.0 de	209.4 i	52280 cd	424.4 e	68.00 e	6159 f	44.14 de
MM-50	51.50 b	57 e	106.0 e	221.1 a	58030 a	481.6 b	80.07 a	7505 a	51.48 a
ZMS-52	54.00 a	59 cd	107.0 de	217.3 de	54330 b	464.9 abcd	76.23 abc	7200 bc	49.57 ab
ZMS-51	54.00 a	60 bc	110.0 ab	216.1 ef	53010 bc	449.8 cd	71.24 cde	6730 e	46.71 bcd
ZMS-06	54.25 a	62 a	108.9 bc	218.3 cd	53160 bc	451.3 bcd	73.51 bcd	6800 de	46.53 cd
Babar-06	54.00 a	59 cd	108.0 cd	214.5 gh	52390 cd	446.7 de	69.08 de	6900 de	48.78 abc
3025-PW	54.25 a	58 dc	106.1 e	22.3 ab	57210 a	472.5 ab	77.29 ab	7275 ab	50.06 a
Kiramat-2C	54.00 a	61 ab	111.0 a	219.3 bc	52080 cd	453.5 bcd	76.09 abc	7000 cd	48.52 abc
LSD 0.05	1.7	1.47	1.47	1.61	1529	22.58	5.37	249.3	2.97

* Mean followed by same letters (row wise) is non-significantly different = * significance at $p < 0.05$

N. S. = Not significant

Days to 50% silking were significantly affected by application of potassium levels and genotypes. Maximum days (61.4) to silking were taken by control plots and minimum days of 56.3 were taken by plots with 60 kg K ha^{-1} applied. Asif *et al*., (2007) also found that days to silking were delayed when potassium application was increased up to 60 kg ha^{-1}. Maize genotypes MM-50 took minimum days of 58 to 50% silking. Whereas, ZMS06 took more days (62) to 50% silking. Muhammad *et al*., (2002) also observed that days to 50% silking were affected by varieties and fertilizer applications. Physiological maturity was affected by potassium application and took 105.8 days by the plots fertilized with 60 kg k ha^{-1} and matured earlier as compared to control plots which took 110 days to maturity. Maize genotypes also affected maturity and genotype MM-50 took minimum days (106.0) whereas Kiramat 2C took maximum days (111.0) to reach maturity. Maize genotypes maturing earlier are more adopted by the growers to fit in their cropping system. As is evident the data in table 1 plant height was significantly affected by potassium levels and genotypes. Plant height was higher (220.7cm) in plots 60 kg K ha^{-1} applied as compared to control plots with 213.3 cm plant height. Genotypes MM-50 gave higher plant height of 221.0 cm and a minimum plant height of 213 cm was obtained by ZMS 40 genotype. This may be due to the difference in the genetic makeup of the genotypes from each other.

The effect of K was not significant on shelling percentage although there was a general trend of increased shelling percentage with increased in the level of potassium application. Enhanced shelling percentage over control was also observed in the study of Rasool *et al*., (1987). Maximum shelling percentage 80.07 was obtained from genotype MM-50 and a minimum shelling percentage of 72.75 were noted from genotype MM-44. The variations in shelling percentages were due to the difference in the genetic makeup of these genotypes from each other.

The data on stover yield (Table 1) revealed that application of potassium levels and genotypes significantly affected stover yield. Maximum stover yield of 7274 kg ha^{-1} was obtained from plots treated with 60 kg K ha^{-1} and a minimum stover yield of 6556 kg ha^{-1} was harvested from control plot. Among maize genotypes MM-50 produced highest stover yield of 7505 kg ha^{-1} and a minimum stover yield of 6159 kg ha^{-1} were achieved from genotype ZMS-40 closely followed by MM-44 giving 6303 kg k ha^{-1} of stover yield. Nazim *et al*., (2007) also reported differences in stover yield between maize varieties. Similarly, Iptas and Acar (2006) reported differences in the stover parameters among maize hybrids in their study.

Harvest index was significantly affected by application of K levels and genotypes (Table 1). Maximum harvest index was obtained from plots treated with 60 kg K ha^{-1} as compared to control plots which gave 44.99% harvest index. Alvi (1994) also found that harvest index was increased with increased fertilizer application. Among genotypes MM-50 produced maximum harvest index of 51.48%, whereas minimum harvest index of 43.55 % was given by genotype MM-44. Rehman (2009) also observed that effect of genotypes in maize was significant in all parameters in his study as well.

The data on 1000-grain weight are given in table 2. There was a significant interaction between application of potassium level and maize genotypes. A maximum 1000-grain weight (260.4g) was obtained from genotype MM-50, when 60 kg k ha^{-1} was applied. Whereas, a minimum 1000-grain weight of 203.9 g was received from genotype ZMS 40 in a control plot. Tsai and Huber (1996) reported a differential response of maize hybrids to levels of K application. The main effects of K levels and genotypes were also significant. Plots applied 60 kg K ha^{-1} produced heaviest 1000-grain weight (245.2g) as compare to control plots with

Table 2: Effect of potassium (K) application levels x genotypes on 1000 grain weight (g) in maize at New Developmental Farm, The University of Agriculture Peshawar during 2015-16.

Genotypes	K levels (kg ha^{-1})				Mean
	0	30	60	90	
MM-44	229.5	233.1	238.9	235.7	234.3 e
GV-41	231.0	239.0	245.5	239.0	238.6 b
ZMS-40	203.9	238.4	242.5	239.1	231.0 d
MM-50	237.3	238.9	260.4	239.2	243.9 a
ZMS-52	231.2	241.7	245.5	241.8	240.0 b
ZMS-51	232.1	239.9	242.3	239.9	238.5 b
ZMS-06	232.5	239.6	244.0	240.2	239.1 b
Babar-06	233.7	238.7	243.5	239.2	238.8 b
3025-PW	236.0	242.9	245.5	241.9	241.4 ab
Kiramat-2C	234.6	240.2	244.5	241.1	241.1 b
Mean	230.2 c	239.2 b	245.5 a	239.7 b	

* Mean followed by same letters (row wise) is non-significantly different = * significance at $p < 0.05$
LSD (0.05) for K = 2.65, LSD (0.05) for Genotypes (G) = 3.11 and K x G = 4.36

230.2 g of 1000-grain weight. The genotypes differed in their grain weight and a maximum 1000-grain weight of 243.9g was produced by MM-50 and a minimum 1000-grain weight of 234.3g was obtained from MM-44. Muhammad *et al*., (2002) noted that 1000-grain weight was significantly affected by varieties and fertilizer application in their research as well.

The data on grain yield (Table 3) showed significant interaction between K levels applied x genotypes. Maximum grain yield of 4593 kg ha^{-1} was obtained from MM-50 when 60 kg K ha^{-1} was applied. A minimum grain yield of 2890 kg ha^{-1} was obtained from a genotype G-41 in control plots. The main effects of potassium levels and genotypes were also significant. A maximum grain yield of 3982 kg ha^{-1} was harvested from a plot of 60 kg K ha^{-1} and a minimum grain yield of 3996 kg K ha^{-1} from control plot. Among genotypes MM-50 produced maximum grain yield of 3924 kg ha^{-1} and a minimum grain yield of 3148 kg ha^{-1} was received from genotype ZMS-40. Muhammad *et al*., (2009) also reported that the grain yield was affected by genotype in their study. Rehman (2009) observed that the effect of genotype was existed in almost all parameters in his study as well.

Our results were somehow similar to the results of Ahmad *et al*., (2009), who conducted a field experiment in which results concluded that the potassium levels in every treatment significantly raised their N, P, K concentration in stalk, grain yield, improved crude starch, protein and oil contents, growth rate and in grains by the control. Maximum growth rate, K (1.86%), P (0.082%), N (0.751%) and grain yield (6.05 t ha^{-1}) concentration in stalk, were revealed, on the application of 200 kg K ha^{-1}, and beyond this limit, tended to decrease the rate of growth, K (1.76%), P (0.071%), N (0.743%) and grain yield (6.02 t ha^{-1}) concentration in stalk on the application of 250 kg K ha^{-1}. Their results revealed that Pioneer-30D55 performed best with 200 kg K ha^{-1} where K status was 124.5 ppm while the quality of the grain parameters were best at 250 kg K ha^{-1} application.

Our study was line with the experiment of Ijaz *et al*., (2014), who explored various effects of different potassium levels (0, 125, 150 and 175 kg ha^{-1}) on yield and growth of maize. Their results found that maximum 1000-grian weight (457.1 g), number of rows per cob (17.82 No.), number of grain/cob (541.74 No.), length of cob (22.30 cm) and plant height (273.73 cm) were observed where the application of potassium was at 175 kg ha^{-1}.

The study of Mastoi *et al*., (2013) is somehow related to our experiment, who conducted a research to evaluate the response of hybrid maize to integrated use of inorganic and organic fertilizers of K. Results revealed the K when applied at 60 kg ha^{-1}, either organic or inorganic, was good to 30 kg ha^{-1} in increasing the growth traits of maize crop. Further results concluded that potassium when applied at 60 kg ha^{-1}, by synchronizing organic and inorganic potassium fertilizers at the rate of 30 kg ha^{-1} both greatly increased the biomass production and growth of the maize.

CONCLUSION

The experiment revealed significant conclusion when various K levels were tested at different *Zea mays* genotypes. The grain yield and yield components resulted in significant conclusion. Maximum grains yield (4593 kg ha^{-1}) and 1000 grain weight (260.4g) were obtained from genotype (MM-50) at K level of 60 kg ha^{-1}, which proves to be a feasible way for the growers to increase maize production and overcome with the food security problems in the province Khyber Pakhtunkhwa, Pakistan, followed by the genotype GV-41, ZMS-52 and 3024-PW with the 1000 grain weight (245.5 each). The genotype Kiramat-2C showed 1000 grain weight of 244.5, following ZMS-06 (244.0), Babar-06 (243.5), ZMS-40 (242.5) and ZMS-51 with 1000 grain weight of 242.3. While the least significant value is

Table 3: Effect of potassium (K) application levels x genotypes on grain yield (kg ha^{-1}) in maize at New Developmental Farm, The University Agriculture Peshawar during 2015-16.

Genotypes	K levels (kg ha^{-1})				Mean
	0	30	60	90	
MM-44	3077	3020	3527	3200	3296 ef
GV-41	2890	3157	3533	3193	3193 ef
ZMS-40	2963	3130	3297	3203	3148 f
MM-50	3543	3900	4593	3700	3924 a
ZMS-52	3510	3633	4130	3717	3748 b
ZMS-51	2993	3120	3620	3347	3270 de
ZMS-06	2993	3370	3787	3220	3344 d
Babar-06	3157	3483	3910	3540	3523 e
3025-PW	3500	3810	4347	3853	3878 a
Kiramat-2C	3330	3547	4213	3557	3662 b
Mean	3196 c	3418 b	3892 a	3453 b	

* Mean followed by same letters (row wise) is non-significantly different = * significance at $p < 0.05$

LSD (0.05) for K = 184.6, LSD (0.05) for Genotypes (G) = 111.4 and K x G = 583.7

been recorded for 1000 grain weight at K level of 60 kg ha^{-1} by MM-44, which is 238.9. The genotype (MM-50) showed maximum grains yield (3924 kg ha^{-1}) and maximum yield components to all the genotypes, which revealed that the performance of the genotype MM-50 is highly suitable with the application of the 60 kg ha^{-1} of K levels. The genotype 3025-PW showed grain yield (3878 kg ha^{-1}), followed by ZMS-52 (3748 kg ha^{-1}), Kiramat-2C (3662 kg ha^{-1}), Babar-06 (3523 kg ha^{-1}), ZMS-06 (3344 kg ha^{-1}), MM-44 (3296 kg ha^{-1}), ZMS-51 (3270 kg ha^{-1}) and GV-41 (3193 kg ha^{-1}). While the least grain yield (3148 kg ha^{-1}) and least yield components to all the genotypes was revealed by the ZMS-40 genotype.

Author's contribution

Uzair Ahmad: He has participated in the research analysis, analysis design, drafted, revised and proof read the paper. Unab Begum: She has participated in the research experiment, prepared other material, participated in research analysis, discussed the results and proof read the paper.

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