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Phenology and productivity response of maize (*Zea mays* L.) hybrids to different levels of mineral potassium under semiarid climate

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ABSTRACT

An experiment was conducted at Agronomy Research Farm of The University of Agriculture Peshawar during summer 2016. Hybrids (WS-666, SB-92K97, and SB-909) and Potassium (K) levels (0, 40, 80, 120, and 160 kg ha^{-1}) laid out in randomized complete block design with split plot arrangement. Hybrids were allotted to main plots and potassium levels to subplots. Sowing was performed on 10 July. Each experimental unit was 3m x 4.2m accommodating six rows at 0.70m distance from each other. All standard agronomic practices were constantly applied for each experimental unit. Hybrids and potassium levels significantly ($P \leq 0.05$) affected crop phenology (days to tasseling, silking, and maturity), growth (plant height) and yield traits (grains ear^{-1}, thousand grain weight), biological and grain yield. Maize hybrids showed significant variation in phenology, growth and yield traits. As level of K increased from 0 to 160 kg ha^{-1} days to tasseling, silking and maturity decreased accordingly and more days for these traits were recorded in control plots. Similarly, with increase in K level plant height, grains ear^{-1}, thousand grain weight, biological yield and grain yield also increased up to 160 kg ha^{-1} which showed a non-significant difference from 120 kg ha^{-1} K. The study concludes that sowing of maize hybrid SB-92K97 with application of K at the rate of 120 kg ha^{-1} gives higher maize return in terms of yield.

Key words: sulphate of potash, hybrids, plant height, grains ear^{-1}, thousand grain weight

Introduction

Pakistani soils are deficient in nitrogen and phosphorus in comparison to potassium (K). However, K application is still required in some places. Potassium reserves in Pakistani soils are decreasing day by day due to less or no application of potassium to the crops/soils (Ahmad and Rashid 2003). Responses of cultivars are different to potassium (K), because of differences in their mode of uptake of nutrients, translocation, accumulation, growth and utilization (Minjian *et al*., 2007). Potassium use efficiency of different cultivars varies which reduce cost of inputs and conserve environment (Rengel and Damon 2008 and Baligar *et al*., 2001). Greater plasticity (Sparlangue *et al*., 2007), higher grain yield and harvest index stability are the characteristics of hybrids. The characteristics of hybrids are due to their genetic yield improvement attributes. Different genotypes have different potassium uptake and use efficiencies (Allan *et al*., 1998). Hybrids have greater potassium uptake which resulted in higher grain yield. Variation in grain yield among hybrids is due to many physiological aspects which can genetically lead to the overall variability in yield (Rengel and Damon 2008).

Potassium plays a vital role in life cycle of a crop and performed an energetic role in plant growth and development (Bukhsh *et al*., 2012). K increases leaf area (Meille and Pellerin, 2008 and Rasheed 2002), plant height (Pandey *et al*., 2000), enhances crop growth rate (Cassman *et al*., 1989), net assimilation rate (Akhtar *et al*., 1999), and increases grain yield (Pettigrew, 2008). K increases enzymes performance and photosynthesis (Van and Hunt, 1998), carbohydrates and protein synthesis (Patil, 2011). K helps in energy metabolism, physiological processes such as xylem and phloem transport, uptake of nutrients, and osmoregulation (Thomas and Cohrane, 2009). The present research was therefore conducted to identify various maize hybrids for their yield at various level of potassium.

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The study aimed to find out optimum level of potassium for a suitable maize hybrid to achieve higher maize yield.

Materials and Methods

To study the response of various maize hybrids against different potassium levels, an experiment was conducted at Agronomy Research Farm of The University of Agriculture Peshawar during summer 2016. The experimental farm is located at 34.01° N latitude, 71.35° E longitude, at an altitude of 350 m above sea level in Peshawar valley. Peshawar (34.0167° N and 71.5833° E) is located about 1600 km North of the Indian Ocean and has continental type of climate. The experiment was laid out in randomized complete block design with split plot arrangement carrying three replications. Hybrids (WS-666, SB-92K97, and SB-909) were allotted to main plots and potassium having five levels (0, 40, 80, 120, and 160 kg ha^{-1}) were allotted to subplots. Potassium was applied as sulphate of potash. A subplot size of 3m x 4.2m having 6 rows equally spaced at 0.70m apart from one another was used. Days to tasseling and silking were recorded when 80% plants produced tassels/silks in each subplot. Maturity was recorded when 80% plants get matured in each subplot. The maturity stage was determined when grains showed a black scar at their base. Plant height of five random plants was measured from base to the tip including tassels with the help of a meter rod and then was averaged for a single plant height data. After harvesting five ears were randomly selected from each subplot. Grains in each ear were counted manually and were averaged. After threshing, thousand clean grains from each experimental unit were taken and weighed on electronic balance for 1000 grain weight determination. At harvest maturity four central rows in each subplot were harvested, sun dried for 5 days and was weighed for biological yield and the data was then converted into kg ha^{-1}. Ears were detached, dehusked and shelled from sample taken for grain yield. Grain yield was determined from these ears and were then converted into kg ha^{-1}. The collected data was analyzed by analysis of variance technique as recommended for randomized complete block design with split plot arrangement. Means were compared upon significant F-test through least significant difference test (Jan *et al*., 2009).

Results and discussion

Crop phenology plays an important role and contributes a lot to the yield of crop. Different hybrids and potassium levels had significantly affected the various phonological parameters of maize crop (Table 1).

Days to tasseling, silking and physiological maturity

Data regarding crop growth phenology (days to tasseling, silking and maturity) showed that maize hybrids and potassium levels had a significant effect on days to tasseling, silking and maturity of maize. Among hybrids maximum days to tasseling, silking and maturity was recorded for SB-92K97 followed by SB-909 while minimum days to tasseling, silking and maturity was recorded for WS-666. Difference in hybrids regarding phenology might be due to their variation in genetic constitution. Luque *et al*. (2006) and Gozubenli (2001) reported that variation in tasseling, silking and physiological maturity period of maize hybrids is due to its genetic makeup. The shorter season hybrids took less time to tasseling, silking and physiological maturity than did the longer season hybrids. Mean across hybrids data showed that as potassium levels decrease days to tasseling, silking and physiological maturity accordingly. Early tasseling, silking, and physiological maturity was recorded in plots which was treated with K 160 kg ha^{-1} which was non-significant from 120 kg ha^{-1} K. while delayed tasseling, silking and physiological maturity was recorded in control plots. Asif *et al*. (2007) reported that increase in potassium levels resulted in earlier in tasseling, silking and physiological maturity.

Plant height (cm)

Among hybrids highest plant height was recorded for SB-92K97 followed by SB-909 while lowest plant height was recorded for WS-666. Variation in plant height of maize hybrids could be due to difference in their genetic makeup as same result is also reported by Hussain *et al.* (2010). Mean values indicated that as level of potassium increased plant height increased and attained maximum value at 160 kg ha^{-1} potassium which was statistically non-significant from 120 kg ha^{-1} K. Similar results are reported by Pandey *et al*. (2000) and stone *et al*. (2001). They reported that application of potassium significantly increased plant height.

Grain ear^{-1}

Mean values across hybrids showed that SB-909 produced highest grains ear^{-1} followed by SB-92K97 while lowest grains ear^{-1} was recoded for WS-666. Liu *et al*. (2004); Luque *et al*. (2006) reported that difference in grains ear^{-1}among maize hybrids might be due to the variation in their ear length, ear diameter, and grain size. In potassium levels highest grains ear^{-1} was recorded for 160 kg ha^{-1} K which was statistically non-significant from 120 kg ha^{-1} followed by 80 kg ha^{-1} K. Lowest grains ear^{-1} was recorded in control plots. Brar and Singh (1995) and Davis *et al*. (1996) reported that application of potassium significantly increase grain ear^{-1} of maize.

Table 1: Phenology and productivity response of maize genotypes to different levels of mineral potassium under Semiarid Climate

Treatment	Days to tasseling	Days to silking	Days to maturity	Plant height (cm)	Grainear^{-1}	1000 grains weight (g)	Biological yield (Kg ha^{-1})	Grain yield (Kg ha^{-1})
Hybrids								
WS-666	56 c	59 c	95 c	212 c	420 c	289 c	12750 c	3861 c
SB92k97	59 a	62 a	100 a	232 a	432 b	327 a	14796 a	4787 a
SB909	57 b	61 b	97 b	224 b	446 a	306 b	13858 b	4448 b
LSD (0.05)	1.05	0.79	1.95	8	11.29	16.28	714.22	249.10
Potassium levels (Kg ha^{-1})								
0	61 a	65 a	101 a	199 d	406 d	258 d	11359 d	3779 d
40	59 b	63 b	99 b	211 c	418 c	286 c	12788 c	4038 c
80	57 c	61 c	97 c	226 b	432 b	311 b	13666 b	4388 b
120	56 d	59 d	95 d	238 a	450 a	342 a	15646 a	4694 a
160	55 d	58 d	94 d	240 a	457 a	340 a	16203 a	4928 a
LSD (0.05)	0.92	1.25	1.67	7.74	8.63	7.39	626.87	144.79

LSD= Least significant difference *NS= Non significant*

Thousand grains weight (g)

Planned mean comparison of hybrids showed that highest thousand grain weight was recorded for SB-92K97 followed by SB-909 while lowest thousand grain weight was recorded for WS-666. Similar results were also reported by Sener *et al*. (2004), and Varga *et al*. (2004). They reported that differences in thousand grain weight among hybrids could be due to their genetic potential. Mean values across potassium levels indicated that highest thousand grain weight was recorded in plots which received potassium 160 kg ha^{-1} which was statistically non-significant from 120 kg ha^{-1} potassium plots. Lowest thousand grains weight was recorded in control plots. Davis *et al*. (1996) and Brar and Singh (1995) reported that potassium application significantly increase 1000 grains weight as compared to control plots.

Biological yield (Kg ha^{-1})

Biological yield was significantly affected by hybrids and potassium levels. Among hybrids highest biological yield was recorded for SB-92K97 hybrid which was significantly different from other hybrids. Ali *et al*. (2004) reported that maize hybrids significantly differed for all parameters including biological yield due to their genetic potential. Mean values across potassium levels showed that highest biological yield was recorded in plots which received potassium 160 kg ha^{-1} which was statistically non-significant from 120 kg ha^{-1} potassium plots. Lowest biological yield was recorded in control plots. Pettigrew (2008) reported that application of potassium significantly increased biological yield.

Grain yield (Kg ha^{-1})

Statistical analysis showed that grain yield was significantly affected by hybrids and potassium levels. However, interaction of hybrids and potassium levels had a non- significant effect on grain yield of maize crop. Highest grain yield was recorded for SB-92K97 hybrid which was significantly different from other hybrids. Pettigrew (2008) and Rengel and Damon (2008) concluded that different hybrids react differently for grain yield due to their genetic makeup and potential expressed in terms of difference in ear plant^{-1}, number of grains cob^{-1}, 1000 grains weight. In potassium levels highest grain yield was recorded for 160 kg ha^{-1} K which was statistically non-significant from 120 kg ha^{-1} followed by 80 kg ha^{-1} K. Lowest grain yield was recorded in control plots. Pettigrew (2008) reported that application of potassium significantly increase grain yield.

Conclusion and recommendations

In the light of the performed experiment it was concluded that among maize hybrids, SB-92K97 produced higher biological yield and grain yield followed by SB-909 and WS-666. Similarly, higher biological and grain yield was obtained with the application of K at the rate of 160 kg ha^{-1} which was non-significant from 120 kg ha^{-1} K. Thus, among the selected maize hybrids SB92K97 is recommended along with potassium application at the rate of 120 kg ha^{-1} for yield.

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