Research Article

Yield and yield attributes of maize (*Zea mays* L.) as affected by detasseling and potassium fertilization

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Abstract

Maize yield is low due to inadequate use of fertilizers and management practices in Pakistan. A field trial was carried out on potassium application and detasseling at Agronomy Research Farm, The University of Agriculture Peshawar, in 2015. The objectives were to find out the effect of six potassium levels (0, 25, 50, 75, 100 and 125 kg ha⁻¹) and three detasseling stages (Tassel not removed, Detasseling at complete pollen shedding stage and Detasseling at complete post dried silking stage) on maize yielding attributes. The research was designed through randomized complete block design RCBD with split plot arrangements replicated four times. Detasseling at complete pollen shedding stage produced significantly higher 1000 grains weight (242 g), grain yield (3850 kg ha⁻¹) and biological yield (10672 kg ha⁻¹). Potassium fertilization at the rate of 75 kg ha⁻¹ produce higher number of ears m⁻² (6.60), number of grains ear⁻¹ (325), 1000 grains weight (250 g), grain yield (4101 kg ha⁻¹) and biological yield (11207 kg ha⁻¹). The interactive effect of detasseling and potassium were found significant only for grain yield. According to the result detasseling at complete pollen shedding stage and potassium at 75 kg ha⁻¹ were best than others in relations to yield and yield attributes of maize.

Keywords: Maize (*Zea mays* L.); Potassium; Detasseling; Yield and yield components

Introduction

More maize (*Zea mays* L.) is produced worldwide than any other cereal grain and it is of huge importance to subsistence farmers and commercial farmers alike. In Pakistan, it is the third most important cereal grain crop after wheat and rice and is used as a staple food for humans, as feed for livestock and as raw material for industry [1]. Maize is

chiefly sown for livestock feed, manufacturing foodstuffs such as starch, dextrose, glucose and specific commodities. Its seed has much more nutritive significances (72% starch, 10% protein, 4.8% oil, 8.5% fiber and 1.7% ash). Maize still retained a famous important dietary source for less earning populations [2]. In Pakistan maize was cultivated on an area of

1.168 million hectare with total production of 4.944 million tons having an average of 3800 yield kg ha⁻¹. In Khyber Pakhtunkhwa maize was cultivated on an area of 0.446 million hectare with production of 0.887 million tones having an average yield of 1900 kg ha⁻¹ [3]. Potassium is a major factor affecting maize growth and yield. Application of potassium increases the uptake of micronutrients. Fertilization of maize with potassium fertilizers had no any negative effects on the content of the micronutrients in the maize biomass [4]. Root length, volume and surface area were significantly higher with K treated plot than those of non-treated and also lateral roots were dramatically higher in applied K than non- treated K [5]. Addition of potassium increased the maize resistance to diseases. The occurrence of diseases decreased with the increase of potassium in the fertilizer and lower susceptibility to pathogen was observed. Potassium plays a significant role in plants and therefore increased the final yield [6].

Potassium fertilization had a positive effect on soil potassium, maize quality and yield. It also rises the level of mobile potassium in soil is proportional to the increased dose of mineral fertilizers with phosphorus and potassium. The highest soil potassium content values occur when the nitrogen fertilizer does not apply. High doses of potassium and phosphorus on plots pre-fertilized with small and fairly large amounts of nitrogen (0 and 50 kg·ha⁻¹) lead to an increased level of starch in the grains of corn [7]. Grain yield of maize was significantly increased by potassium fertilizers over control plots. Furthermore tissue Cl, S and K contents at silking stage were significantly increased with the addition of their potassium fertilizer in maize crop [8]. Potassium application increased growth rate, grain yield, N, P, K concentration in stalk and improved crude

starch, protein and oil contents in grains over control [9]. Potassium application enhances grains ear⁻¹, weight ear⁻¹, and 1000 grains weight [10]. Detasseled young maize plants significantly produced more cobs per plant (2.87) longer cobs (8.29 cm) and heavier cob (1261.67g plot⁻¹ or 16669.53 kg ha⁻¹) than tasselled plants [11]. Barrenness in maize is significantly decreased with detasseling and also increases the number of ears plant⁻¹, and ear (without grain) weight in both years of the study and ultimately resulted in increased the total corn yield [12]. Grain yield increased in detassled maize plants due to significantly maximum grain weight [13]. Removal of tassel, either partial or total, did not significantly enhance grain yield and components, regardless of plant density or cultivar. No differences in grain yield were observed between male-sterile and fertile counterparts [14]. Detasseling significantly increased the ear total number and ear total weight and contributed more to final grain yield [15]. Soil and climatic conditions of Pakistan are suitable for maize growing, however optimum fertilizers and management practices are pre-requisite for its production. The present study was performed to compare effects of different potassium levels and detasseling on growth and yield of maize.

Materials and methods

Site description

The effect of detasseling and potassium was determined at Agronomy Research Farm, The University of Agriculture Peshawar, in summer 2015. The experiment was laid out in a randomized complete block design (RCBD) with split plot arrangement having four replications. Detasseling was assigned to main plots, while potassium was used as sub plot factor. Single replication was consisted of 18 treatments with a sub plot size of 2.5 m x 4.2 m (6 rows, 2.5 m long and 70 cm distant) was used.

Potassium was applied from sulphate of potash (SOP) containing 50 % K₂O. Nitrogen and phosphorus was applied as a recommended dose as basal of 120 kg N and 60 kg P ha⁻¹ from urea and Single super phosphate (SSP) respectively. Phosphorus was applied at seedbed preparation while nitrogen was applied at two equal splits one at seedbed preparation while other at knee height stage. Azam variety was planted and row to row distance was kept 70 cm to get normal plant population. Ears m⁻² was calculated by counting the total ears in four central rows in each subplot and then was converted to ears m⁻² by using the following expression

$$\text{Ears m}^{-2} = \frac{\text{Ears counted}}{\text{R-R distance} \times \text{Row length} \times \text{No. of rows}} \times 1\text{m}^2$$

$$\text{Biological yield (kg ha}^{-1}\text{)} = \frac{\text{Weight of the sample plants}}{\text{R-R distance} \times \text{Row length} \times \text{No. of rows}} \times 10000$$

$$\text{R-R distance} \times \text{Row length} \times \text{No. of rows}$$

Statistical analyses

Data was statistically analysed according to method suitable for randomized complete block design with split plot arrangements and means were compared using least significant differences (LSD) test ($P \leq 0.05$) [16].

Results and discussion

Ears m⁻²

Ears m⁻² was significantly affected by different potassium levels, while detasseling and their interaction was non-significant. More ears m⁻² (6.60) was recorded in plots treated with 75 kg ha⁻¹ potassium followed by 100 kg ha⁻¹ potassium (6.55 m⁻²). Less ears m⁻² (5.98) were recorded in control plots. Detasseling effect is however non-significant but still higher number of ears m⁻² (6.43) were recorded with detasseling at complete pollen shedding stage. Lower number of ears m⁻² (6.29) were recorded at tasseled plots. Ears m⁻² were significantly increased with potassium fertilization [17]. Number of ears m⁻² was significantly increased with detasseling of maize plant [15].

R-R distance x Row length x No. of rows

Grains ear⁻¹ were calculated on ten randomly selected ears from each subplot and then average was worked out. Grains weight of randomly 1000 grains was taken from seed lot of each subplot and was weighted with the help of electronic balance. Four central rows of each treatment was harvested, dried, threshed and weighted and then was converted into grain yield (kg ha⁻¹). Grain yield (kg ha⁻¹) = $\frac{\text{Grain yield}}{\text{R-R distance} \times \text{Row length} \times \text{No. of rows}} \times 10000$

R-R distance x Row length x No. of rows

Biological yield was recorded by harvesting four central rows in each subplot, the material was sun dried for several days and weighed, and then was converted into biological yield kg ha⁻¹.

Grains ear⁻¹

Grains ear⁻¹ showed that, different potassium levels significantly affect number of grains ear⁻¹. Higher number of grains ear⁻¹ (325) was recorded in plots treated with 75 kg ha⁻¹ potassium followed by 100 kg ha⁻¹ potassium (324). Lower number of grains ear⁻¹ (313) were recorded in control plots. Detasseling however showed non-significant results but maximum number of grains ear⁻¹ (321) was recorded with detasseling at complete pollen shedding stage. Minimum number of grains ear⁻¹ (319) was recorded at tasseled plots. Potassium significantly increases the number of grains ear⁻¹, the possible reason for more grains ear⁻¹ could be due to application of potassium significantly increases the total uptake of N, P and K [18]. Application of potassium to maize increases grains ear⁻¹ as compared to control [19].

1000-grains weight (g)

Detasseling and potassium levels significantly influenced 1000 grains weight

(g). Interaction of detasseling and potassium was non-significant. Maximum 1000 grains weight (250 g) was attained in plots treated with 75 kg ha⁻¹ potassium followed by 100 kg ha⁻¹ potassium (245 g). Minimum 1000 grains weight (228 g) was attained in control plots. Among detasseling higher 1000 grains weight (242 g) was recorded with detasseling at complete pollen shedding stage. Lower 1000 grains weight (237 g) was recorded at tasseled plots. Heavier grains might be due to application of potassium fertilizer maximize the photosynthetic ability, CO₂ assimilation and translocation of leaf made materials to the final productive unit which results in best seed filling and heavier grains. Potassium fertilization increases thousand grains weight in maize [20]. Detasseling can increase the grains weight because it reduces the antagonism for leaf made materials and nutrients between male and female parts [15].

Grain yield (kg ha⁻¹)

Grain yield (kg ha⁻¹) was significantly affected by detasseling, potassium levels and interaction of detasseling and potassium. Grain yield was significantly increased with the application of potassium. Highest grain yield (4101 kg ha⁻¹) was achieved in plots treated with 75 kg ha⁻¹ potassium followed by 100 kg ha⁻¹ potassium (3997 kg ha⁻¹). Minimum grain yield (3206 kg ha⁻¹) was achieved in control plots. Among detasseling higher grain yield (3850 kg ha⁻¹) was recorded with detasseling at complete pollen shedding stage. Lower grain yield (3591 kg ha⁻¹) was recorded at tasseled plots. Increasing potassium level from 0 to 75 kg ha⁻¹ significantly increase

grain yield (4162 kg ha⁻¹) and thereafter the yield declines. Detasseling at complete pollen shedding stage proven best in terms of grain yield. Potassium application significantly increase the grain yield this may probably due to the higher yield components recorded with higher potassium i.e. ears m⁻² [17]. Grains number ear⁻¹ is higher with potassium application [21]. Higher grains weight was also observed with potassium application [22]. Application of potassium fertilizer significantly increases grain yield in maize [23]. Positive affect of tassel removal on grain yield might be due to reduction in apical dominance and lessening the shading effect of tassel on the upper parts of maize [15].

Biological yield (kg ha⁻¹)

Biological yield (kg ha⁻¹) was significantly affected by detasseling and different potassium levels, while their interaction was non-significant. Maximum biological yield (11207 kg ha⁻¹) was recorded in plots treated with 75 kg ha⁻¹ potassium followed by 100 kg ha⁻¹ potassium (11112 kg ha⁻¹). Minimum biological yield (9358 kg ha⁻¹) was recorded in control plots. The effect of detasseling was also significant and higher biological yield (10672 kg ha⁻¹) was recorded with detasseling at complete pollen shedding stage. Lower biological yield (10291 kg ha⁻¹) was recorded tasseled plots. Potassium increases the total uptake of nitrogen and phosphorus by roots and increases the biological yield and also balance fertilization leads to luxurious growth and increases the total dry weight of the plant [24]. Biological yield can be significantly maximized with potassium application [25].

Table 1. Yield and yield attributes of maize as affected by detasseling stages

Detasseling	Ears m ⁻²	Grains ear ⁻¹	1000-grains weight (g)	G. Y (kg ha ⁻¹)	B. Y (kg ha ⁻¹)
Undetasseled	6.29	319	237 b	3591 c	10291 c
At pollen shedding	6.43	321	242 a	3850 a	10672 a
At post silking	6.35	319	241 a	3725 b	10490 b
LSD (0.05)	NS	NS	3.79	93.64	166.77

G.Y = Grain yield, B.Y = Biological yield

Table 2. Yield and yield attributes of maize as affected by potassium application

K (kg ha ⁻¹)	Ears m ⁻²	Grains ear ⁻¹	1000-grains wt.(g)	G. Y (kg ha ⁻¹)	B. Y (kg ha ⁻¹)
0	5.98 c	313 b	228 d	3206 d	9358 d
25	6.19 bc	316 b	236 cd	3591 c	10122 c
50	6.28 b	319 ab	242 abc	3704 bc	10425 bc
75	6.60 a	325 a	250 a	4101 a	11207 a
100	6.55 a	324 a	245 ab	3997 a	11112 a
125	6.54 a	320 ab	239 bc	3732 b	10681 b
LSD (0.05)	0.24	6.49	8.57	131.49	141.58

G.Y = Grain yield, B.Y = Biological yield

Figure 1. Grain yield (kg ha⁻¹) of maize as affected by the interaction of detasseling and potassium

Conclusion

Removal of tassels at complete pollen shedding stage significantly enhances 1000-seed weight (g), grain yield (kg ha⁻¹) and biological yield (kg ha⁻¹). Application of potassium at the rate of 75 kg ha⁻¹ produced higher number of ears m⁻², grains ear⁻¹,

1000-seed weight (g), grain yield (kg ha⁻¹) and biological yield (kg ha⁻¹). Detasseling at complete pollen shedding stage and potassium at the rate of 75 kg ha⁻¹ must be applied to produced higher yield and yielding components of maize viz. increase seed weight and grain yield.

Authors' contributions

Conceived and designed the experiments: Irfanullah & H Akbar, Performed the Experiments: Irfanullah & A Ali, Analyzed the Data: I Hussain & MW Khan, Contributed reagents/ materials/ analysis tools: MD Ahmadzai, Wrote the paper: A Ali.

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