

# Influence of Different Potash Levels on Spring Maize Hybrids



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## Abstract

An experiment was conducted during 2014 on spring maize hybrids and potash levels at Agronomy Research Farm of The University of Agriculture Peshawar, Khyber Pakhtunkhwa Pakistan. A set of four hybrids and four potash levels were evaluated in randomized complete block (RCBD) design having four replications. Experimental results revealed significant differences for days to tasseling, days to silking, mean single leaf area, plant height, and number of plants at harvest, thousand grains weight, grain yield and biological yield. Mean data ranged from days to tasseling (62 to 67), days to silking (69 to 74), mean single leaf area (440.15cm<sup>2</sup> to 494.28cm<sup>2</sup>), plant height (204cm to 215cm), number of plant at harvest not effected by potash level, grain ear (520g to 547g), 1000 grain weight (375g to 414g), grain yield (3424 kg ha<sup>-1</sup>) to (4192 kg ha<sup>-1</sup>), biological yield (11118 kg ha<sup>-1</sup> to 13580 kg ha<sup>-1</sup>). Based on the result of this study significantly delay in tasseling was observed with 120 kg K ha<sup>-1</sup>. Among the hybrids tasseling was delayed (67 days) in 30K08. Silking was delayed (74 days) with 120 kg K ha<sup>-1</sup>. Potash applied at the rate of 120 kg ha<sup>-1</sup> had the largest leaf area (494.28 cm<sup>2</sup>). Among the hybrids, larger leaf area (479.73 cm<sup>2</sup>) was recorded for CS200. Plants height (215.25 cm) was produced when potash was applied at the rate of 120 kg ha<sup>-1</sup>. In case of hybrids, 30K08 produced taller plants (212.87 cm). The hybrids, CS 200 produced higher number of grains ear-1 (538.87). Hybrids CS200 produced heavier thousand grains weight (395.18 g), followed by 3025 (384.87 g). The hybrids higher grain yield (4143 kg ha<sup>-1</sup>) was produced by CS200, followed by 3025 (3873 kg ha<sup>-1</sup>). Higher biological yield Application of potash at the rate of 90 kg ha<sup>-1</sup> resulted in higher biological yield (13580 kg ha<sup>-1</sup>). Among the hybrids, CS200 produced higher biological yield (13630 kg ha<sup>-1</sup>). In this experiment our study that application of potash at the rate of 90 kg ha<sup>-1</sup> improved yield and yield components. Hybrid-CS200 performed well in terms of yield and yield components. Hence for obtaining higher grain yield, Hybrid-CS200 with application of potash at the rate of 90 kg ha<sup>-1</sup> is recommended.

**Keywords:** Potash levels; Maize hybrids; Grain yield; Biological yield

**Abbreviations:** RCBD: Randomized Complete Block Fertilizer; FUE: Fertilizer use efficiency; H: Hybrids; K: Potash

## Introduction

Maize (*Zea mays* L.) belongs to gramineae family of plant kingdom. It is an important position in the existing cropping systems of Pakistan. Maize is grown in almost all the provinces of the country, but Punjab and Khyber Pakhtunkhwa are the main areas of production [1]. It is not only consumed by human beings in the form of food grain but it is also used as feed for livestock and poultry besides being good forage crop [2]. It is also gaining importance due to being a commercial/industrial crop, where a large number of products are being manufactured out of its grain. Maize grain contains about 72% starch, 10% protein, 4.8% oil, 5.8 % fiber, 3.0% sugar and 1.7% ash [3]. The area under maize cultivation in Pakistan and Khyber Pakhtunkhwa Province was 935.1 Kg/ha-1 and 421.9 Kg/ha-1, respectively with production of 3261.5 Kg/ha-1 tones and 752.2 Kg/ha-1 tones and the average

grain yields of 3488 kg/ha-1 and 1854 kg/ha-1 in Pakistan and Khyber Pakhtunkhwa, respectively [4]. Maize crop is planted more than 500,000 ha land area in high mountain and plains of Khyber Pakhtunkhwa but its production is much lower in these areas. Maize grains have great economic importance and are used for food, fodder, pharmaceutical and industrial purposes. Its grains contain starch, protein, fiber, oil and ash [5]. In Pakistan maize is grown twice in a year (spring and autumn). There is a gradual increase in planting of maize during spring season, since the introduction of spring maize cultivation in Pakistan. Since the active involvement of multinationals in Pakistan, cultivation of spring maize has been increased. Though the climatic and soil conditions of Pakistan are satisfactory for maize production but it's per hectare yield is very low as compared to other maize growing countries of the world. Potassium as a macronutrient

plays a vital role in plant growth and sustainable crop production [6]. It sustains turgor pressure of cell which is essential for cell expansion. It assists in opening and closing of stomata and helps in osmoregulation of plant cell [7]. It plays an important part in activation of more than 60 enzymes.

Application of K has primitive effect on growth and development and grain yield in maize [6]. Application of K is known vital for effective N utilization and have a fairly consistent effect on lowering tissue concentration of Ca and Mg [6]. Maize genotypes respond to potassium application contrarily due to modification in its uptake, translocation, accumulation, growth and utilization [8]. K-efficient genotype is a complex one involving a mixture of uptake and utilization efficiency mechanisms. One of the mechanisms of differential K uptake efficiency is the exudation of organic compounds to facilitate release of non-exchangeable K. Cultivars effective in K uptake and its utilization may have a larger surface area of leaf. Hybrids with reduced harvest index under poor K supply were K-inefficient. Ability to tolerate low concentrations of K in shoot tissue where K supply was scarce was also important in determining K efficiency for grain yield. Proficient plant cultivars could have better fertilizer use efficiency (FUE) and leave low soil K and nitrogen as it is now understood that both of these elements should be present in sufficient and balanced quantities for proper crop growth and hence may reduce input cost and conserve environment [9]. Potassium status of soils is rapidly declining at a stressful rate and net K draining rate is even steeper (0.3 kg ha<sup>-1</sup> year<sup>-1</sup>) in Pakistan. It might be due to the inappropriate (0.8 kg ha<sup>-1</sup> year<sup>-1</sup>) utilization of K in Pakistan in comparison to the world average K use (15.1 kg ha<sup>-1</sup> year<sup>-1</sup>) [10]. Consequently, it was needed to recognize spring maize hybrids effective in K uptake to provide best opportunities for future breeding research towards low input, sustainable and environment friendly agriculture. Therefore, the present study was aimed at exploiting the genetic variation among four spring maize hybrids for their suitable K level.

## Materials and Methods

A field experiment entitled "influence of different potash levels on spring maize hybrids" was conducted during spring, 2014 at Agronomy Research Farm, The University of Agriculture Peshawar. The experiment was consisting of two factors i.e. potash levels and maize hybrids. A randomized complete block design (RCBD) was used. Plot size was kept 3.5 m by 3 m with row to row and plant to plant distance of 70 cm and 25 respectively, having 5 rows. A uniform dose of 150 kg N ha<sup>-1</sup> and 90 kg P ha<sup>-1</sup> in the form of urea and DAP was applied. Pre-sowing soil test was carried for the N and K. Nitrogen was applied in two equal splits i.e. 50% at sowing and 50% at 2nd irrigation. Sulphate of potash was used as a source of potash. All P and K dose was applied at the time of sowing. All other agronomic practices were carried out uniformly for all the treatments. Pre-soil analysis was carried out for K, N and pH. The texture of the experimental area was silty clay loam with alkaline

nature (pH 7.5-7.8). The soil was deficient in total N ( $\leq 0.53$ g kg<sup>-1</sup> soil) and K  $\leq 92$  mg kg<sup>-1</sup> soil.

The details of the factors and their levels were as follows:

### Factor A: Four K levels

K1	= 0 kg ha <sup>-1</sup>
K2	= 60 kg ha <sup>-1</sup>
K3	= 90 kg ha <sup>-1</sup>
K4	= 120 kg ha <sup>-1</sup>

### Factor B: Four Hybrids

H1	= 30K08
H2	= 2031
H3	= CS 200
H4	= 3025

## Procedure for recording data

Data regarding days to tasseling was recorded by counting number of days from the date of sowing to the date on which 80% plants developed tassels. Data regarding days to silking was recorded by counting number of days from sowing to the date on which 80% plants developed silks. Leaf area was taken manually of three plants in each plot at silking stage by using the following formulae:

$$L.A. = \text{Leaf length (cm)} \times \text{Leaf width (cm)} \times 0.75$$

Plant height was recorded by recording the plant height of five plants from ground level to tip of each plot with the help of meter rod. Plants in every plot were recorded and then converted to ha<sup>-1</sup> in order. The ears harvested for grains yield were used for the determination of number of grains per ear by selecting five ears randomly from each plot, dried and shelled for counting the grain ear<sup>-1</sup>. Data regarding 1000 grains weight was recorded by counting randomly selected grains from seed plot. Grain yield was recorded after shelling of ears from each three rows and was converted into kg ha<sup>-1</sup>. Biological yield was recorded by weighing all the plants harvested from three rows and then converted into kg ha<sup>-1</sup>. The data was analyzed statistically using analysis of variance techniques appropriate for randomized complete block design. Significant differences among treatments were determined using least significant difference (LSD) test for main as well as interaction effects [11].

## Results and Discussion

### Days to tasseling

Data concerning days to tasseling was significantly affected by potash (K) application and hybrids (H) (Table 1). The interaction between K x H was non-significant. Mean values for potash showed that tasseling was delayed with the increase in potash level. Delay

in tasseling was observed with 120 kg K ha<sup>-1</sup> (67 days) while early tasseling was observed with no application of potash (63 days). Among the hybrids, tasseling was delayed (67 days) in 30K08 however it was statistically at par with 2031, followed by 3025 (64 days) whereas early tasseling was observed for CS200 (62 days). Finding of our results are in accordance with the findings of [6,12,13]

### Days to silking

Data in accordance with days to silking was significantly affected by potash (K) application and hybrids (H) (Table 1). No K x H interaction occurred for days to silking. Mean values for potash indicated that silking was delayed (74 days) with 120 kg K ha<sup>-1</sup>. Early silking (70 days) was observed in plots receiving no potash. In case of hybrids there was significant difference for days to silking. Late silking (74 days) was observed for hybrid 30K08 which was statistically similar to 2031, followed by 3025 (71

days), while early silking (69) was observed for CS200. Finding of our results are in accordance with the findings of [6,12,13].

### Mean single leaf area (cm<sup>2</sup>)

Leaf area was significantly affected by potash (K) application and hybrids (H) and their interaction (K x H) (Table 1). Potash applied at the rate of 120 kg ha<sup>-1</sup> had the largest leaf area (494.28 cm<sup>2</sup>) which was statistically at par with 90 kg ha<sup>-1</sup>, followed by 60 kg ha<sup>-1</sup> (475.21 cm<sup>2</sup>), whereas less leaf area (376.95 cm<sup>2</sup>) was obtained where potash was not applied. Among the hybrids, larger leaf area (479.73 cm<sup>2</sup>) was recorded for CS200, followed by 3025 (467.79 cm<sup>2</sup>) and 30K08 (451.79 cm<sup>2</sup>), while lower leaf area (440.15 cm<sup>2</sup>) was recorded for 2031. Interaction between K x H showed that all the hybrids produced larger leaf area when K was applied at the rate of 90 kg ha<sup>-1</sup> (Figure 1). Findings of our study are in line with [14,15] who also found improvement in growth parameters in different cultivars with the application of potash.

### Plant height (cm)

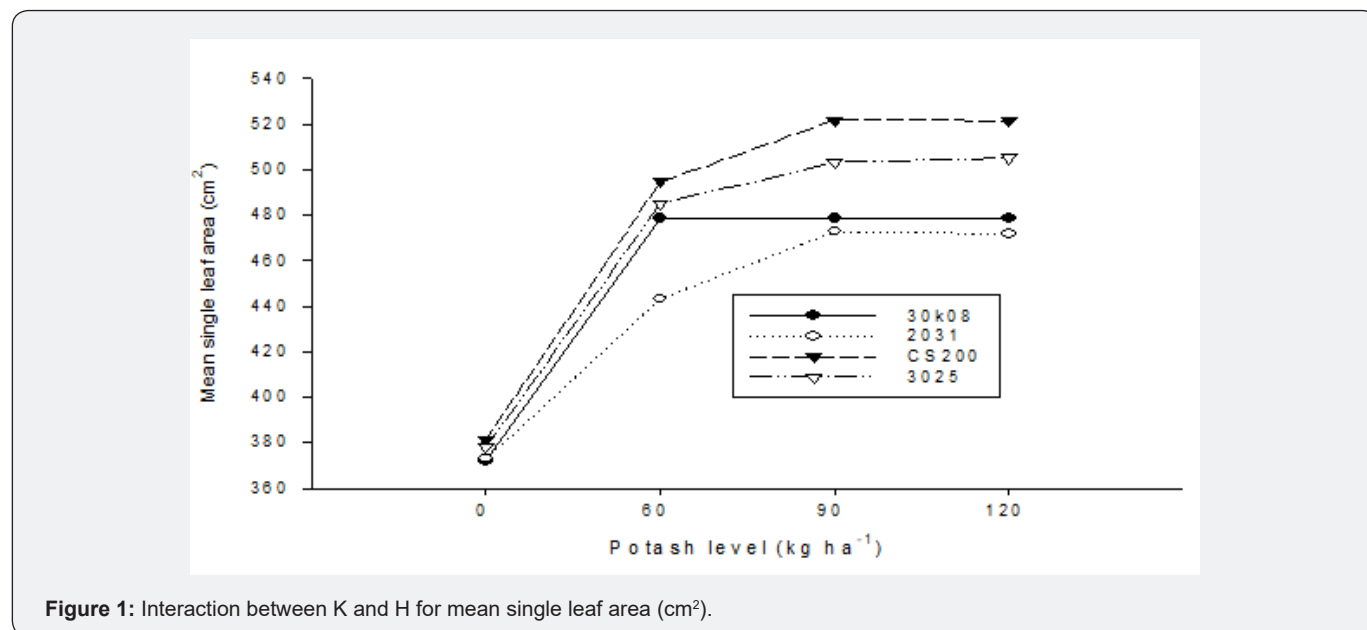


Figure 1: Interaction between K and H for mean single leaf area (cm<sup>2</sup>).

Potash (K) application and hybrids (H) as well as their interaction significantly affected plant height (Table 1). Long stature plants (215.25 cm) were produced when potash was applied at the rate of 120 kg ha<sup>-1</sup> which was statistically similar to 90 kg ha<sup>-1</sup>, followed by 60 kg ha<sup>-1</sup> (198.37 cm) whereas short stature plants (179.43 cm) were produced in plots where potash was not applied. In case of hybrids, 30K08 produced taller plants (212.87 cm), followed by CS200 (205.87cm) and 3025 (199.81 cm) whereas short stature plants (189.62 cm) were recorded for 2031. As for as concerned with the interaction between K x H, mean data revealed that plant height increased significantly with the increase in potash level up to 90 kg ha<sup>-1</sup> in all hybrids (Figure 2). Findings of our study are in line with [5,15] who also found improvement in growth parameters in different cultivars with the

application of potash.

### Number of plants at harvest (ha-1)

Number of plants at harvest was neither affected by potash (K) application nor by hybrids (Table 1). Interaction between K x H also did not significantly affected number of plants at harvest.

### Grains ear-1

Statistical analysis of the data revealed that potash (K) application and hybrids (H) had significantly affected grains ear-1 (Table 2). Interaction between K x H showed no significant difference for grains ear-1. Application of potash at the rate of 120 kg ha<sup>-1</sup> resulted in more number of grains ear-1 (547.37) however it was statistically at par with 90 kg K ha<sup>-1</sup>, followed by 60 kg K

ha<sup>-1</sup> (515.31), while lower grains ear<sup>-1</sup> (483.62) were recorded for the plots where potash was not applied. Among the hybrids, CS 200 produced higher number of grains ear<sup>-1</sup> (538.87), followed by 3025 (530.87) then by 30K08 (518.87), while 2031 resulted in lower number of grains ear<sup>-1</sup> (504.06). Similar trends were also reported by [16-18].

**Table 1:** Days to tasseling, days to silking, Mean single leaf area (cm<sup>2</sup>), plant height (cm) and plants at harvest (ha<sup>-1</sup>) as affected by spring maize hybrids as affected by levels.

K Level (kg ha <sup>-1</sup> )	Days to tasseling	Days to silking	Mean single leaf area (cm <sup>2</sup> )	Plant height (cm)	Plants at harvest (ha <sup>-1</sup> )
0	63 d	70 d	375.9 c	179.4 c	54702
60	65 c	72 c	475.2 b	198.3 b	54642
90	66 b	73 b	494.0 a	215.1 a	51596
120	67 a	74 a	494.2 a	215.2 a	54583
<b>Hybrids</b>					
30K08	67a	74 a	451.7 c	212.8 a	51536
2031	67a	74 a	440.1 d	189.6 d	54642
CS200	62 c	69 c	479.7 a	205.8 b	5458
3025	64 b	71 b	467.7 b	199.8 c	54761
LSD for Potash (K)	0.48	0.52	5.57	2.42	ns
LSD for Hybrids (H)	0.48	0.53	5.57	2.42	ns
K x H	ns	ns	**	**	ns

Means of the same category followed by same letters are statistically similar at 5% level of significance.

ns= non-significant

\* = Statistical significance at 5% level of probability

\*\* = Statistical significance at 1% level of probability

**Table 2:** Grains ears<sup>-1</sup>, thousand grains weight (g), Grain yield (kg ha<sup>-1</sup>) and Biological yield (kg ha<sup>-1</sup>) as affected by spring maize hybrids as affected by levels.

K Level (kg ha <sup>-1</sup> )	Grains ears <sup>-1</sup>	Thousand grains weight (g)	Grain yield (kg ha <sup>-1</sup> )	Biological yield (kg ha <sup>-1</sup> )
0	483 c	353.75 d	3151 c	10496 c
60	515 b	376.37 c	3515 b	11502 b
90	546 a	391.18 b	4128 a	13580 a
120	547 a	414.06 a	4192 a	13462 a
<b>Hybrids</b>				
30K08	518 c	379.93 c	3547 c	11516 c
2031	504 d	375.37 d	3424 d	11118 d
CS200	538 a	395.18 a	4143 a	13630 a
3025	530 b	384.87 b	3873 b	12776 b
LSD for Potash (K)	5.52	3.5	66	327
LSD for Hybrids (H)	5.52	3.45	66	327
K x H	ns	**	**	**

Means of the same category followed by same letters are statistically similar at 5% level of significance.

ns= non-significant

\*= Statistical significance at 5% level of probability

\*\*= Statistical significance at 1% level of probability

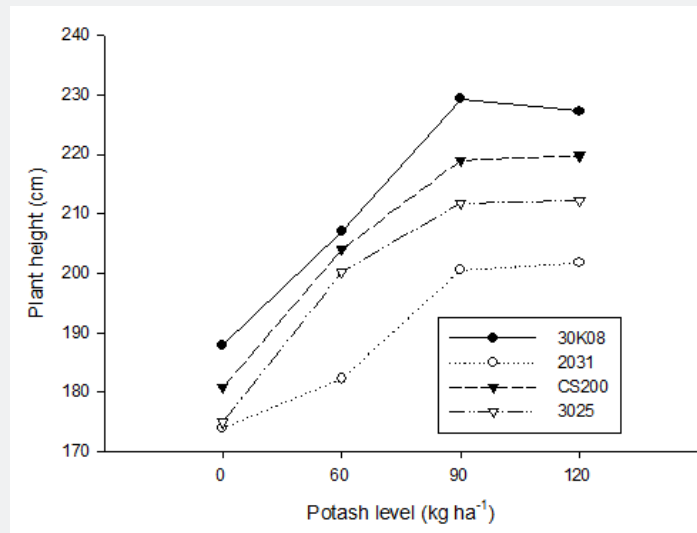


Figure 2: Interaction between K and H for plant height (cm).

### Thousand grains weight (g)

Thousand grains weight was significantly affected by potash (K) application and hybrids (H) as well as their interaction (K x H) was also significant (Table 2). Application of potash at the rate of 120 kg h-1 produced heavier thousand grains weight (414.87 g), followed by 90 kg ha-1 (391.68 d) then by 60 kg ha-1 (378.12 g), while no application of potash resulted in lighter thousand grains

weight (354. 12 g). In case of hybrids, CS200 produced heavier thousand grains weight (395.18 g), followed by 3025 (384.87 g) whereas 2031 produced lighter thousand grains weight (375.37 g). As for as concerned with the interaction between K x H, mean data revealed that thousand grains weight increased significantly with increase in potash level in all hybrids (Figure 3). Similar trends were also reported by [18-20].

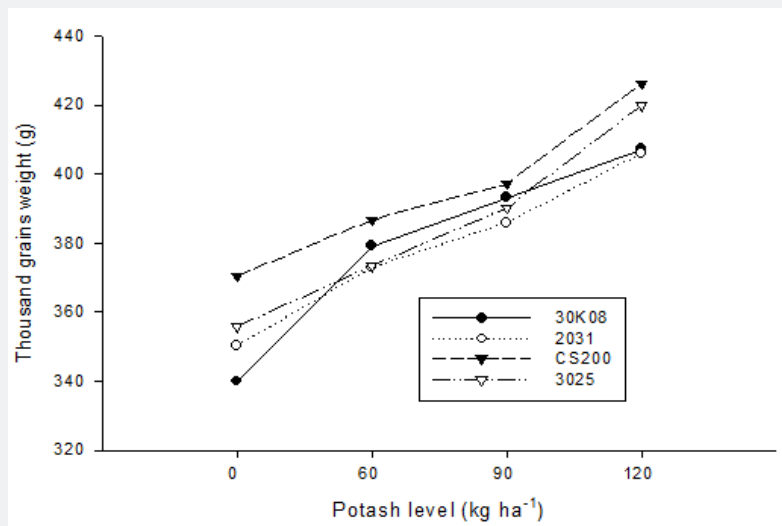


Figure 3: Interaction between K and H for thousand grains weight (g).

### Grain yield (kg ha-1)

Statistical analysis of the data showed that potash (K) application and hybrids (H) significantly affected grain yield (Table 2). Grain yield was also significantly affected by the interaction

of K x H. Mean values for potash (K) indicated that higher grain yield (4192 kg h-1) was obtained with 120 kg K ha-1 which was statistically similar to 90 kg K ha-1(4128 kg h-1), followed by 60 kg K ha-1(3515 kg ha-1), while no application of potash resulted in lower grain yield (3151 kg ha-1). Among the hybrids, higher

grain yield (4143 kg ha<sup>-1</sup>) was produced by CS200, followed by 3025 (3873 kg ha<sup>-1</sup>) and 30K08 (3547 kg ha<sup>-1</sup>), whereas lower grain yield (3424 kg ha<sup>-1</sup>) was produced by 2031. Interaction between K x H showed that there was significant variation among the grain yield of hybrids, increase in grain yield of all hybrids was

more pronounced up to 90 kg K ha<sup>-1</sup>, but there was no significant increase in grain yield of all hybrids when potash level was increased above 90 kg K ha<sup>-1</sup> (Figure 4). Findings of our study are in line with [19-21].

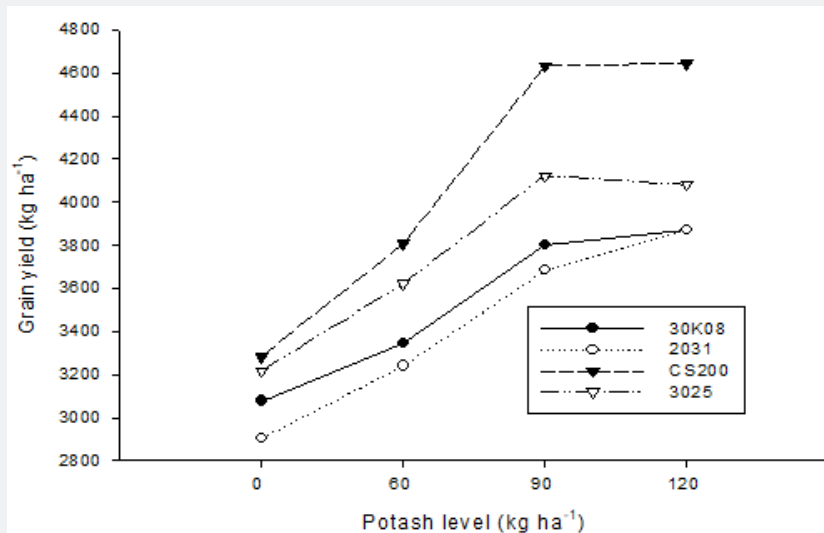


Figure 4: Interaction between K and H for grain yield (kg ha<sup>-1</sup>).

### Biological yield (kg ha<sup>-1</sup>)

Data in association with biological yield revealed that there was significant variation for potash (K) application and hybrids (H) (Table 2). Data collected on this plant parameter also revealed that interaction between K x H had significant. Application of potash at the rate of 90 kg ha<sup>-1</sup> resulted in higher biological yield (13580 kg ha<sup>-1</sup>) however it was statistically at par with 120 kg K ha<sup>-1</sup>, followed by 60 kg K ha<sup>-1</sup> (11502 kg ha<sup>-1</sup>), while plots where potash was not applied resulted in lower biological yield (10496

kg ha<sup>-1</sup>). Among the hybrids, CS200 produced higher biological yield (13630 kg ha<sup>-1</sup>), followed by 3025 (12776 kg ha<sup>-1</sup>) and 30K08 (11516 kg ha<sup>-1</sup>), whereas 2031 produced lower biological yield (11118 kg ha<sup>-1</sup>). As for as concerned with the interaction between K x H, biological yield tended to increase up to 90 kg K ha<sup>-1</sup> in all hybrids, however further increase did not significantly affected biological yield in all hybrids (Figure 5). Findings of our study are in line with [19-21].

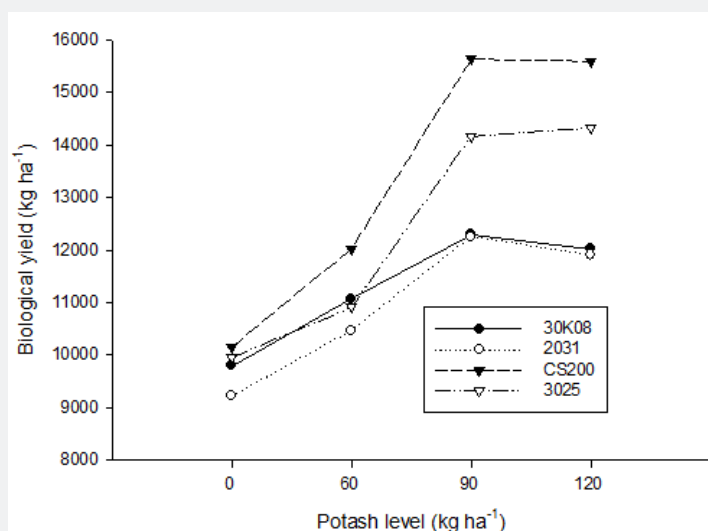


Figure 5: Interaction between K and H for biological yield (kg ha<sup>-1</sup>).



## Conclusion

It was concluded that Applying potash at the rate of 90 kg ha<sup>-1</sup> resulted in significantly higher mean single leaf area and plant height as compared to control plots. It was obtained in those plots which received potash at the rate of 90 kg ha<sup>-1</sup>. Hybrid-CS200 produced more grain yield and biological yield than the other hybrids. Interaction between K x H also occurred for grain yield and biological yield. The number of grains per ear and thousand grains weight were significantly affected by the application of potash. More number of grains per ear was recorded in plots which received potash at the rate of 90 kg ha<sup>-1</sup>. Heavier thousand grains weight was recorded in plots receiving potash at the rate of 120 kg ha<sup>-1</sup>. Hence for obtaining higher grain yield, Hybrid-CS200 with application of potash at the rate of 90 kg ha<sup>-1</sup> is recommended.

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