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Role of Potassium in Maize Production: A Review

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Abstract

In all over the world Maize (Zea mays L.) crop is used both for food and feed purpose. Various factors which contributes toward slow production of corn in Pakistan are nutritional in-balance, insufficient use of fertilizer, low soil organic matter contents, inadequate plant density, weeds problem, scarce water supply, selection of unsuitable varieties and insect pest attack. Potassium is considered as most ambient macronutrients required for proper growth, development and sustainable crop yield. Keeping in mind the importance and role of potassium (K) in improving both chemical and physical properties of soil the present review focuses on the effect of potassium on growth yield and quality of maize.

Introduction

In all over the world Maize (Zea mays L.) crop is used both for food and feed purpose [1]. In Pakistan, maize ranks 3rd among the cereal crops after rice and wheat [2]. Maize is cultivated in subtropical, tropical, and temperate provinces of all world therefore, this crop has worldwide adaptability [20]. Maize crop matures more quickly because of its foliage distribution and size [3]. Worldwide area under the cultivation of maize crop is about 159 million hand total yield is 796.48 million [4]. Maize crop is used as a multipurpose which provides fodder for animals, fuel and food for humans being [5]. It is used in cake formation, porridge and bread making in all over the world especially in Africa, America and Asia [2]. Various factors which contributes toward slow production of corn in Pakistan are nutritional in-balance, insufficient use of fertilizer, low soil organic matter contents, inadequate plant density, weeds problem, scarce water supply, selection of unsuitable varieties and insect pest attack [6]. Balanced nutrition is an imperative feature which shows a main function in achieving quality production of maize. Presence of nutrients like magnesium, phosphorus, nitrogen and potassium in well-adjusted forms is necessary for plant growth, development and final yield [7]. Potassium is considered as most ambient macronutrients required for proper growth, development and sustainable crop yield [8]. Maize consumed 5.2 kg P2O5 ha-1 per day during peak flowering period [9]. After sowing during 38 to 52 days, the maize plants require the total potassium up to 38% for whole growing season [10]. It improves the overall yield of maize [30]. It also helps plant to regulate the movement of stomata [11]. Potassium plays major role in stimulation of enzymes, photosynthesis, regulation of osmotic pressure, movement of the stomata's, protein synthesis, phloem transport, transfer of the energy, cation-anion balance in soil and improves resistance against stress [12]. In depth of soil, potassium application in association with the other inorganic nutrients, such as phosphorus and nitrogen produce the deeper roots of plants [13]. Keeping in mind the importance and role of potassium (K) in improving both chemical and physical properties of soil the present review focuses on the effect of potassium on growth yield and quality of maize.

Effect of Potassium on growth and Yield of Maize

[14] Observed the influence of different levels of potassium and phosphorus fertilizers on the yield and yield attributes of maize (Zea mays L.) varieties. The results indicated that higher rates of both potassium and phosphorus fertilizers have significantly enhanced the weight per ear, No of grains per ear and the 1000-grains weight. Sole effect of potassium was found non-significant for grain yield but in interaction with phosphorus levels and maize varieties potassium produced the better yield. But alone the phosphorus levels and it interaction with potassium levels and maize hybrids showed significant effect on grain yield. Moreover, 90 kg ha-1 phosphorus and 60 kg ha-1 potassium gave the maximum grains yield [15] studied

the effect of potassium maize and reported that Potassium @ 200 kg ha-1 produced maximum grains yield. [16] Studied the response of maize to potassium and reported that increase in potassium levels the maize showed an increase in yield constituents. The maize exhibited maximum yield when potassium was used @ 125 kg ha-1 as compared to the control treatment. They also concluded that potassium @ 125 kg ha-1 produced the economical yield of maize hybrids. [17] Studied the effect of potassium application on maize (Pioneer-3062, Pioneer-3012, Pioneer–30D55). Maize hybrid (Pioneer-30D55) gave more no. of grains row-1, no. of grains cob-1 and higher grains weight cob-1 when potassium was applied @ 200 kg ha-1. [18] Studied the effect of potassium on maize (Pioneer 3062) yield in Pakistan. Potassium was applied @ 0, 60 and 120 kg ha-1 in K2O. The results showed that maximum grains yield of maize (8014 kg ha-1) was obtained in the plot where 120 kg ha-1 of potassium was used in three splits and minimum grains yield was recorded in control plots. [19] reported that higher potassium application (60.0 kg ha-1) was expressively better to lower rate of potassium application as (30.0 kg ha-1). The production of biomass and growth of maize i.e. diameter of shoot, length of shoot, fresh biomass of shoot, dry biomass of shoot, no. of leaves of plant per hectare and leaf area improved by the potassium application @ 60.0 kg ha-1.

[20] Studied the response of maize hybrid (32F10) to potassium fertilizer. They reported that application of potash fertilizer significantly improved the several characters of maize, viz. production of fresh biological yield (12 to 60%), grain yield (21 to 84%), cob yield (16to 76%), 1000-grains weight (2 to 30%) and accumulation of potassium (150.0 to 366.0%). [21] evaluated the influence of several potassium levels i.e. (0.0, 125.0, 150.0 and 175.0 kg ha-1) on the growth and production of maize hybrid (Hycron 11 Plus). The results showed that use of potassium significantly improved both the quality and yield parameters of the maize cultivar. It was observed that potassium @ 175.0 kg ha-1 gave the greater plant height (273.72 cm), cob size (22.30cm), no. of rows cob-1 (17.84), no. of grains cob-1 (541.76 No.) and 1000-grians weight (457.12 g). [22] Concluded that that increasing potassium fertilizer levels significantly improved the maize yields. [23] Evaluated the role of potassium nutrition under water deficit (50% field capacity) for improving the productivity of maize hybrids (P-32B33) and (NK-8441) at stem enlargement (BBCH-36) and at the tasseling (BBCH-59) stage by suppressing the irrigations. They reported that water deficit at both (BBCH-36 and BBCH-59) stages reduced the productivity of both maize hybrids. However, potassium application enhanced the root system, grain yield and net income of both tested hybrids under stress and optimal water conditions.

Therefore, it was suggested that potassium nutrition not only helped in reducing the damaging effects of drought due to maximum development of roots system but also improved the yield and net income. [24] studied the effect of several potassium levels i.e. (0, 60, 90 and 120 kg ha-1) on four spring planted maize hybrids i.e. (CS200, 30K08, 3025 and 2031). Potassium @ 90 kg ha-1 enhanced the maize yields and yields related constituents but increasing potassium level above 90 kg ha-1 showed no significant effect. Maize hybrid CS200 produced more grain and biological yield than that of other hybrids. From the results it was concluded that the hybrid-CS200 at potassium level (90.0 kg ha-1) should be used for obtaining the maximum grains yield of maize.

[25] Reported that usage of potassium enhanced the yields and growth of plants under drought stress condition. Therefore, it was suggested that potassium should be applied as an approach to minimize the water scarcity in maize crop. [26] studied the different characters of maize cultivar (Cv. Azam) at the different potassium levels (30.0, 60.0 and 90.0 kg ha-1) and reported that plots which received the potassium @ 90.0kg ha-1 produced the greater no. of leaf plant-1, maximum average leaves area, accumulated maximum dry matter into several parts of plants i.e. (stems, ears and leaves), gave higher biological yield and H. I of maize as compared to control. [27] Studied the efficiency of foliar applied potassium (K) against soil applied on hybrid maize.

Treatments were comprised of (control, soil applied potassium @75.0 kg ha-1 of K2O, foliar spray of 1% K2O, foliar spray of 2% K2O, foliar spray of 3% K2O, fertigation of Potassium @7 5.0 kg ha-1 in K2O form and split application of Potassium @75.0 kg ha-1 in K2O form in the soil. Foliar application of potash fertilizer increased the yield. And yield attributes along with the grains quality characteristics of maize hybrid. Foliar treatment of 3% K2O gave the maximum biomass production (15.0 tonnes ha-1) and grains yield (8.08 tones ha-1) of hybrid maize followed by foliar spray of 2% K2O. It was also determined that foliar application of potassium gave the greater net benefit and benefit cost ratio. Therefore, it was suggested that potassium foliar spray at 3% concentration more efficient for increasing the growth, development and yields of maize as equated to fertigation and soil applied of potassium fertilizer.

Effect of Potassium on Quality of Maize

[28] Studied the effect of potassium on stalk and quality

parameters of the maize. Potassium @ 200 kg ha-1 showed maximum P (0.082%), N (0.751%), K (1.87%) concentration in stalk, and beyond this limit these parameters tended to decline when phosphorus @ 250 kg ha-1 was used. But at the higher potassium dose (250 kg ha-1) increase protein (8.32%), crude starch (72.65%), and oil (4.53%) contents in grains. On the result basis it was concluded that maize performed best with potassium rate 200 kg ha-1 but the grain quality parameters were recorded best at potassium level 250 kg ha-1. [28] determined the influence of several potassium levels i.e. (1, 2, 4, 6 and 8 mM) and iron levels i.e. (30, 60, 90 and 120 micro M) on macro nutrients uptake of the maize in a hydroponic system. Increasing the potassium and iron levels showed an increase in the total iron and iron concentration uptake by the maize. But the highest potassium dose decreased the uptake of iron. It was examined that P, Mg and Ca concentration decreased in the leaves and roots of maize by increasing the potassium levels.

[29] studied the different potassium fertilizer levels i.e. (0.0, 150.0 and 300.0 kg ha-1) which affect water use efficiency and restricted irrigation methods: full irrigation, variable and fixed partial root zoon drying (PRD-V and PRD-F) on yield of corn. It was concluded that highest WUE and IWUE were observed in PRD-V where potassium was @ 300.0 kg ha-1 and minimum WUE was found in full irrigation where 0.0 kg ha-1 of potassium was applied. Conducted an experiment to evaluate the potassium use efficiency of maize and reported that except control all potassium levels produced statistically similar potassium use efficiency (KUE). [30] Conducted an experiment to study the impact of different levels of potassium on maize and reported that maximum crude protein (7.66 %) and crude oil (3.66%) were observed when potassium was applied @ 160 kg ha-1. [31] Reported that potassium has major effect on water potential of the leaves, turgidity potential, and comparative moisture content in plants, rate of transpiration and photosynthesis rate. Thus it was concluded that potassium could be helpful for the tolerance in plants against the water scarcity conditions as well to develop the good quality production of crops.

[32] Determined the response of growth and development of two maize hybrids [YH-1898 (drought sensitive) and 32-F-10 (drought tolerant)] to different potassium levels under drought conditions. Two levels of drought viz. 70% field capacity and 100% field capacity (no drought) with the application of different K doses i.e. (0.0, 50.0, 100.0, 150.0 and 200.0 mg/kg of soil) were used. They reported that potassium @ 100.0 mg/kg gave better performance of variety (32-F-10) for photosynthetic rate (18.72 µ mol/m2/s) and relative water contents (83.68%). Similarly, the variety YH-1898 at potassium dose (100.0 mg/kg) produced photosynthetic rate (10.42 µ mol/m2/s) and relative water contents (68.16%). From the results it was observed that application of potassium under the drought stress significantly enhanced all the studied characters of maize in comparison with control treatment. [33-35] investigated the effect of potassium fertilization on nutrient uptake, growth and physiology of maize crop. Potassium fertilizer was applied in five different doses 0.0, 70.0, 100.0, 130.0, and 160.0 kg ha-1. They observed that increasing potassium application rate the nutrient uptake, plant growth, and concentration in roots and shoots, respiration rate, net photosynthesis, stomatal conductance and sub stomatal CO2 concentration were considerably improved. Potassium also improved the water use efficiency (WUE) of maize and decreased the root: shoot dry weight ratio.

Conclusion

It is concluded from the above review that maize is an important crop. Potassium is considered as most ambient macronutrients required for proper growth, development and sustainable crop yield. Most of the scientists reported that application of 60 kg potassium per ha is the best dose to obtain higher yield of maize. However, it depends on cultivar and soil.

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