

Original Research Article

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Growth and Quality Parameters of Popcorn (*Zea mays* var. *Everta*) as Influenced by Application of Potassium and Sulphur Levels

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ABSTRACT

Keywords

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A field experiment was conducted during 2013-14 rabi season, at the Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh to assess response of popcorn (*Zea mays* L. *everta* Sturt) to four levels each of potassium viz., 0, 30, 60 and 90 kg K₂O ha⁻¹ and sulphur viz., 0, 20, 40, 60 kg S ha⁻¹. The results of different potassium and sulphur levels depicted that application of potassium @ 60 kg K₂O ha⁻¹ as well as sulphur @ 40 kg S ha⁻¹ significantly increased the plant height, stem thickness, number of leaves per plant and crude protein content in seed.

Introduction

Maize is one of the most important cereal crop next to rice, wheat and jowar in respect of area and production in India. According to the character of the kernels, it is classified in various groups among which “popcorn” is major one. Popcorn (*Zea mays* L. var. *everta* Sturt) also known as popping corn. Popcorn is popular and nutritious snack food in many parts of World. All parts of corn such as grain, branches and leaves, even corn cob and corn silk is used numerously in human nutrition, fed livestock and poultry and pharmaceutical industry. Potassium and sulphur play a vital role in the nutrition of plants. Fertility analysis of Indian soils has indicated that the soils are deficient in sulphur and medium to low in the potash. In fact,

these nutrients are lacking mostly in the soils of Saurashtra region. Therefore, application of chemical fertilizers becomes essential to raise the crop yield. Potassium is an essential element for plant growth and development and is the most abundant cation in plants, making up 3-5% of a plant's total dry weight. Sulphur plays an important role in enhancing the productivity of pop corn crop.

Materials and Methods

The experiment was conducted during *rabi* season 2013-14 in D-5 plot of Instructional Farm at Krushigadh, College of Agriculture, Junagadh Agricultural University, Junagadh. It is Geographically Junagadh is situated at

21.5⁰ N latitude and 70.5⁰ E longitude with an altitude of 60 m above the mean sea level. The experiments were laid out in Factorial Randomized Block Design having 16 treatments with three replications. The gross and net plot sizes were 5.0 m X 3.6 m and 4 m X 2.40 m, respectively. The experiment consisted of 4 levels of potassium (0, 30, 60 and 90 kg K₂O ha⁻¹) and 4 levels of sulphur (0, 20, 40, 60 kg S ha⁻¹).

The soil of the experimental field was medium black calcareous soil with pH 7.9 and EC 0.35 dS m⁻¹. The crop was fertilized with potassium and sulphur as per treatment allotted to each plot in the form of MOP and Cosavet fertis. WG. (90%) in basal application and nitrogen and phosphorus in the form of urea, diammonium phosphate in the furrows, respectively 1/3rd nitrogen applied before sowing, 1/3rd at 20 days after sowing and remaining 1/3rd at 40 days after sowing, and phosphorus applied as basal. Amber popcorn variety was used as planting material in this study.

The seeds were dibbled at a spacing of 60 cm x 20 cm using a seed rate of 15 kg ha⁻¹ during the last week of November.

Five plants were selected at random from each plot to record individual plant growth parameters like plant height, stem thickness, number of leaves per plant, 50% silking, 50% tasseling by using standard procedure. All other recommended agronomic practices and plant protection measures were carried out to all treatments uniformly during the course of study.

Results and Discussion

Effect of potassium

Growth parameters

Statistical analysis of the data (Table 1 and Fig. 1) revealed that among the different

levels of potassium, the K₃ (60 kg K₂O ha⁻¹) as level was recorded significantly the higher plant height at 60 DAS (150.92 cm) and at harvest (197.91 cm), which was found statistically at par with 90 kg K₂O ha⁻¹ (K₄) at 60 DAS (144.97cm).

The lowest plant height was observed under K₁ (control), while it did not exert their significant influence on plant height at 30 DAS.

The application of 60 kg K₂O ha⁻¹ (K₃) and 90 kg K₂O ha⁻¹ (K₄) remained comparable and recorded significantly the higher stem diameter (Table 1 and Fig. 2) of 2.03 cm and 2.36 cm, respectively at 60DAS and harvest, whereas at harvest, it was also at par with 30 kg K₂O ha⁻¹ (K₂) and 90 kg K₂O ha⁻¹ (K₄) with the value of 2.29 cm and 2.34 cm, respectively, while it exhibited their non-significant influence on stem diameter at 30 DAS.

The application of 60 kg K₂O ha⁻¹ (K₃) recorded significantly higher number of leaves per plant (14), whereas potassium exerted their non-significant influence on number of leaves per plant at 30 and 60 DAS (Table 1 and Fig. 3).

The perusal of data (Table 1) observed that these potassium levels were unable to exert their significant influence on days to 50% silking, days to 50% tasseling or leaf stem ratio.

Potassium is known to augment cell division and cell expansion resulting in increasing in positive effect on growth parameter like plant height, stem thickness and number of leaves per plant.

The similar findings were recorded by Ahmed *et al.*, (1992), Kalpana and Krishnarajan (2002), Maurya *et al.*, (2004) and Brar *et al.*, (2012).

Effect of sulphur

Growth parameters

Statistical analysis of the data (Table 1 and Fig. 1) revealed that among the different levels of sulphur, the S₃ (40 kg S ha⁻¹) level was registered significantly the higher plant height at 60 DAS (151.13 cm) and at harvest (197.96 cm), which was found statistically at par with 60 kg S ha⁻¹ (S₄) at 60 DAS (146.25cm) and with 20 kg S ha⁻¹ (S₂) and 60 kg S ha⁻¹ (S₄) at harvest with the value of 192.18 cm and 194.18 cm, respectively.

The lowest plant height was observed under S₁ (control), while different levels of potassium and sulphur did not exert their significant influence on plant height at 30 DAS.

The application of 40 kg S ha⁻¹ (S₃) recorded significantly the maximum stem diameter at 60 DAS (2.01 cm) and at harvest (2.33 cm), which were found significantly at par with 60 kg S ha⁻¹ (S₄) at 60 DAS with the value of 1.89cm, whereas at harvest, it was at par with S₂ (20 kg S ha⁻¹) and S₄ (60 kg S ha⁻¹) with the value of 2.23 cm and 2.28 cm, respectively, while it did not executed their significant influence on stem diameter at 30 DAS (Table 1 and Fig. 2).

Application of 40 kg S ha⁻¹ (S₃) recorded significantly higher number of leaves per plant (12.89). Sulphur manifested their non-significant influence on number of leaves per plant at 30 and 60 DAS (Table 1 and Fig. 3).

The perusal of data (Table 1) observed that these sulphur levels were unable to exert their significant influence on days to 50% silking, days to 50% tasseling or leaf stem ratio.

The increase in growth parameters might be due to the beneficial effect of sulphur on the

various metabolic activities and also because of its important role in cell division, photosynthetic process and formation of chlorophyll in the leaf and also increases the plant height, stem thickness and number of leaves per plant were also observed by Bhatt and Jain (2012), Aslam *et al.*, (2013), Dechassa *et al.*, (2013).

Interaction effect

The interaction effect of potassium and sulphur levels on plant height, stem thickness, number of leaves per plant, days to 50% silking and days to 50% tasseling at 30, 60 DAS and at harvest was found non-significant

Quality parameters

Crude protein content in seed

Effect of potassium

An assessment of data (Table 1) revealed that by application of 60 kg K₂O ha⁻¹ (K₃) potassium recorded significantly the higher crude protein content of cob (12.07 %), whereas, the lowest crude protein content in seed (10.68 %) was recorded under K₁ (control) and potassium did not imparted their significant influence on moisture content in cob.

Potassium plays an important role in the synthesis of amino acid which constitutes building block of protein.

The whole structure of proteins and protein activity needs high concentrations of K⁺ in the cytosol for optimum plant functions.

It might have resulted in higher protein content. The results are in accordance with those reported by Haji *et al.*, (2009) and Brar *et al.*, (2011).

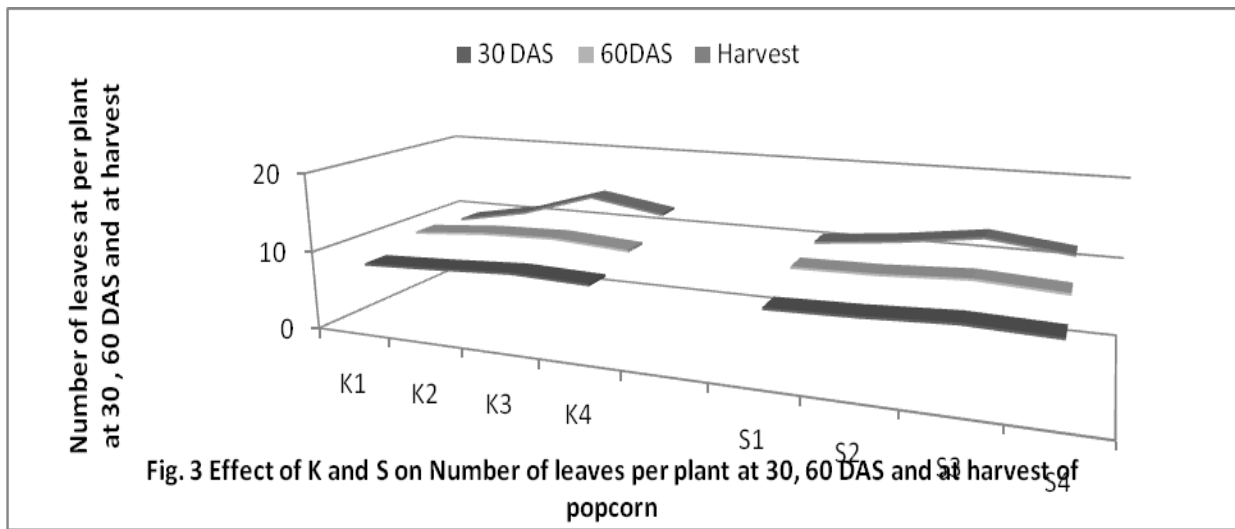
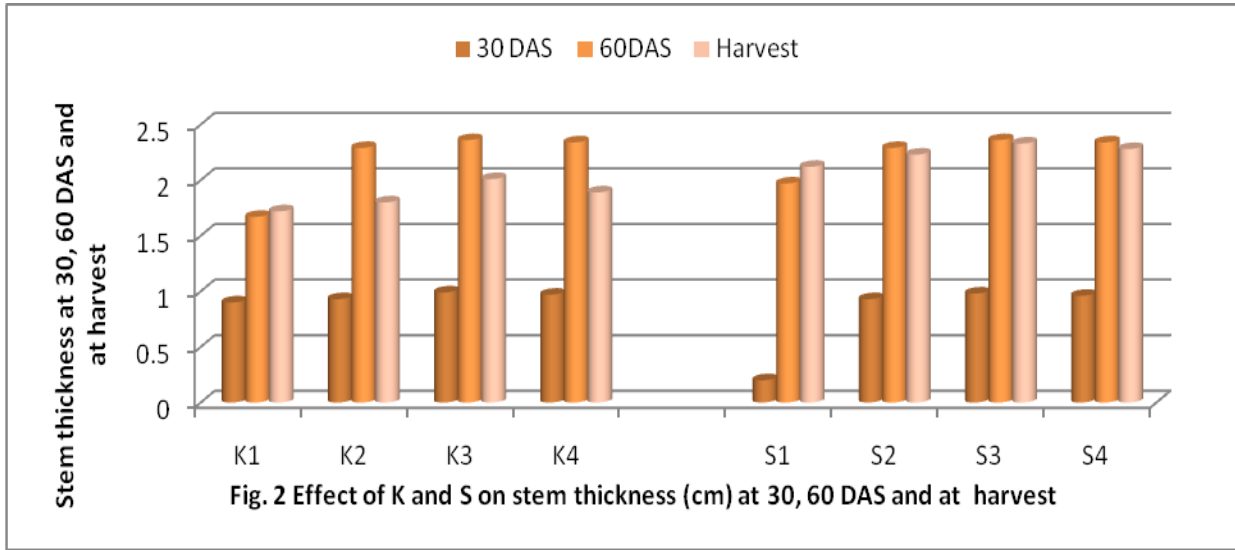
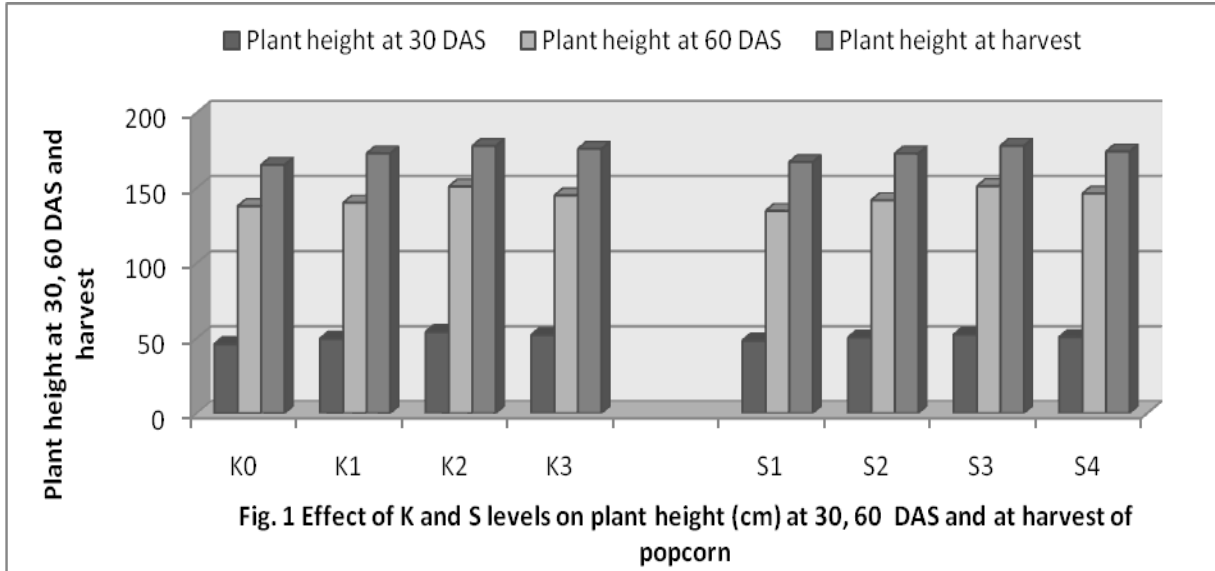


Table.1 Effect of potassium and sulphur on growth and quality parameters of popcorn

| Treatments | Plant height (cm) | | | Stem thickness (cm) | | | Number of leaves per plant | | | Days to 50% silking | Days to 50% tasseling | Leaf stem ratio | Quality parameters | |
|---|-------------------|--------|---------|---------------------|-------|---------|----------------------------|--------|---------|---------------------|-----------------------|-----------------|---------------------------|----------------------|
| | 30DA S | 60DAS | Harvest | 30DAS | 60DAS | Harvest | 30DA S | 60DA S | Harvest | | | | Crude protein percent (%) | Moisture content (%) |
| Potassium levels (kg K₂O ha⁻¹) | | | | | | | | | | | | | | |
| K ₁ -0 | 46.01 | 137.83 | 185.34 | 0.90 | 1.67 | 1.97 | 8.05 | 9.69 | 9.17 | 57.92 | 52.50 | 0.89 | 10.68 | 39.79 |
| K ₂ -30 | 49.55 | 140.10 | 192.97 | 0.93 | 1.81 | 2.29 | 8.46 | 10.44 | 10.98 | 53.75 | 49.88 | 0.94 | 11.04 | 37.30 |
| K ₃ -60 | 54.08 | 150.92 | 197.91 | 0.99 | 2.03 | 2.36 | 8.97 | 10.70 | 14.00 | 51.83 | 47.92 | 0.98 | 12.07 | 34.62 |
| K ₄ -90 | 52.07 | 144.97 | 195.98 | 0.97 | 1.91 | 2.34 | 8.64 | 10.03 | 12.38 | 52.67 | 48.67 | 0.96 | 11.35 | 36.94 |
| S.Em. ± | 2.04 | 2.50 | 2.60 | 0.03 | 0.04 | 0.05 | 0.28 | 0.26 | 0.35 | 1.59 | 1.60 | 0.03 | 0.21 | 1.26 |
| C.D. (P=0.05) | NS | 7.23 | 7.50 | NS | 0.12 | 0.13 | NS | NS | 1.01 | NS | NS | NS | 0.62 | NS |
| Sulphur levels (kg S ha⁻¹) | | | | | | | | | | | | | | |
| S ₁ -0 | 48.37 | 134.67 | 187.20 | 0.92 | 1.72 | 2.12 | 8.16 | 9.98 | 10.45 | 57.00 | 51.00 | 0.91 | 10.76 | 38.68 |
| S ₂ -20 | 50.36 | 141.77 | 192.86 | 0.93 | 1.80 | 2.23 | 8.43 | 10.14 | 11.48 | 53.50 | 50.67 | 0.93 | 11.13 | 37.55 |
| S ₃ -40 | 52.29 | 151.13 | 197.96 | 0.98 | 2.01 | 2.33 | 8.93 | 10.67 | 12.89 | 52.58 | 48.21 | 0.97 | 11.80 | 35.78 |
| S ₄ -60 | 50.68 | 146.25 | 194.18 | 0.96 | 1.89 | 2.28 | 8.61 | 10.08 | 11.70 | 53.08 | 49.08 | 0.95 | 11.46 | 36.65 |
| S.Em. ± | 2.04 | 2.50 | 2.60 | 0.03 | 0.04 | 0.05 | 0.28 | 0.26 | 0.35 | 1.59 | 1.60 | 0.03 | 0.21 | 1.26 |
| C.D. (P=0.05) | NS | 7.23 | 7.50 | NS | 0.12 | 0.13 | NS | NS | 1.01 | NS | NS | NS | 0.62 | NS |
| KxS Interaction | | | | | | | | | | | | | | |
| S.Em. ± | 4.08 | 5.0 | 5.2 | 0.06 | 0.08 | 0.09 | 0.55 | 0.53 | 0.70 | 3.18 | 3.21 | 0.5 | 0.43 | 2.51 |
| C.D. (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C.V.% | 14.02 | 6.07 | 4.66 | 11.06 | 7.51 | 7.06 | 11.21 | 8.95 | 10.41 | 10.19 | 11.17 | 9.75 | 6.60 | 11.70 |

Effect of sulphur

Application of 40 kg S ha⁻¹ (S₃) resulted significantly higher crude protein content of seed (11.80%), which was found statistically at par with 60 kg S ha⁻¹ (S₄) with the value of 11.46% (Table 1) and various levels of sulphur manifested their non-significant influence on moisture content in cob.

The probable result might be that sulphur plays an important role in synthesis of essential amino acids like cysteine, cystine, methionine and certain vitamins like Biotin, Thiamine, Vitamin B₁ as well as formation of ferredoxin an iron-containing plant protein that acts as an electron carrier in the photosynthetic process and chlorophyll formation, which required for the production of protein (Zehler and Kreipe, 1981).

A shortage in the S supply affects the utilization of the available nitrogen by crop (Likkineni and Abrol, 1994). Since, nitrogen and sulphur are required for the synthesis of proteins; the ratio of total N to total S in plant tissue has a direct bearing on protein synthesis. The findings close agreement with those obtained by Brunold and Suter, 1984, Jat *et al.*, (2002), Sharma *et al.*, (2004), Sheta *et al.*, (2010) and Roshan and Nepalia (2013).

Interaction effect

The interaction effect of potassium and sulphur levels on crude protein content of seed was found non-significant (Table 1). The findings are in accordance with those of Jones and Wendt (1994) and Chaudhari (2012).

Based on the experimental results, it can be concluded that significantly improved growth parameters and higher crude protein content were obtained from *rabi* popcorn (cv. Amber) by fertilizing the crop with potassium 60 kg

K₂O ha⁻¹ (K₃) and sulphur up to 40 kg S ha⁻¹ (S₃) in medium black calcareous soils of South Saurashtra region of Gujarat.

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