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Effect of potassium levels and potassium solubilizing bacteria on yield and economics of maize (*Zea mays* L.)

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Abstract
A field experiment was conducted during *kharif* 2020 at, Prakasam Krishi Vigyan Kendra (KVK), Jayaprakash Nagar, Jammikunta, Karimnagar District – 505 122, Telangana State. To study the effect of potassium and potassium solubilizing bacteria on yield and economics of maize (*Zea mays* L.). The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. It was observed that T6 - K2O 40 gm + KSB 20 ml/ kg Soil (SA) + KSB 30 ml/ kg Seed (SI) 80 DAS was found to be the best treatment for obtaining yield such as, Grain yield (5.78 t/ha) while Gross returns (1,28,100 INR/ha), Net returns (84,406.47 INR/ha) and B:C ratio (1.93) was to be found more productive in economics.

Keywords: Maize, potassium, potassium solubilizing bacteria, soil application, seed inoculation

Introduction

Maize (*Zea mays* L.) belongs to family Poaceae and is a highly cross-pollinated crop (95%), it is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions, globally and maize is known as "*Queen of Cereals*" because it has the highest genetic yield potential among the cereals. Nutritionally it contains 60 to 68% starch and 7 to 15% protein; also, it has more riboflavin content then wheat or rice crop and is rich in phosphorus and potash content. Maize protein 'Zein' is deficient in triptophane and lysine, the two essential amino acids. A maize grain has significant quantities of vitamin A, nicotinic acid, riboflavin and vitamin E.

Potassium (K) ranks at third among the essential plant nutrients after nitrogen and phosphorus and seventh among all the elements in the earth's crust (Manning 2010). It is the most essential macronutrient needed for the plant growth to increase crop yields with quality produce (Romheld and Kirk 2010). It activates enzymes, maintains cell turgor, enhances photosynthesis, reduces respiration, helps in transport of sugars and starches, helps in nitrogen uptake, and is essential for protein synthesis. In addition to plant metabolism, potassium improves crop quality because it helps in grain filling, kernel weight, strengthens straw, increases disease resistance and helps the plant better to withstand stress. Nevertheless, K not only participates in nutrient transportation and uptake but also confers resistance to abiotic and biotic stresses, leading to enhance in crop sustainability. In addition to increasing plant resistance to diseases, pests, and abiotic stresses, K is required to activate over 80 different enzymes responsible for plant and animal processes such as energy metabolism, starch synthesis, nitrate reduction, photosynthesis, and sugar degradation (Almeida *et al.* 2015; Hussain *et al.* 2016; White and Karley 2010; Yang *et al.* 2015). Maize response to applied potassium, however, found to vary considerably across soil types (Csatho 1992), availability of potassium in soils (Kapur *et al.* 1984) and season (Prasad and Shrivastava 1992). The available information on maize response to applied potassium suggests for the need to conduct experiments to workout site specific potassium recommendation to maize crop.

KSB can solubilize K-bearing minerals and solubilize insoluble K2O soluble forms of K available to plant uptake. It has general plant growth promoting characters like hormone production, biological nitrogen fixation, root colonization, micro nutrient solubilizing (Zn, Fe), it has biotic and a biotic stress tolerance induction (catalyse activity, antibiotic production, anti- oxidants production) and also produces organic acids. KSB application to the soil get activated and multiply by utilizing the carbon source of soil or excudates of the root and in this process secrete organic acids and enzymes.

It provides benefits to plants by forming nodules on host plants roots and fix nitrogen, those that are endophytic and colonize effects in host by competitively plant root surface. Plant growth by Direct action mechanisms by either providing plants with resources/nutrients regulating hormones levels of plants. Indirectly decreasing effects of various pathogens on plants as bio-control agents. (KSR) potassium solubilizing rhizobacteria can also solubilize minerals and play important role in weathering of these minerals which results in plant growth promotion leading to enhance and yield production. Potassium solubilizing bacteria microorganisms can be isolated by serial dilution method by using Aleksandrov medium. Field studies to see the effect of potassium and KSB application on maize.

Material and Methods

This experiment was carried out during *Kharif* 2020 at KVK, Prakasam Krishi Vigyan Kendra, Jammikunta, Karimnagar Dist, Telangana State, which is located an altitude of 243.4 m above mean sea level on 18º301'301" N latitude and 79º471'478" E longitude, organic carbon (0.62), available nitrogen (197.12 kg/ha), phosphorus (31.2 kg/ha) and potassium (198.71 kg/ha). The climate of the region is semi-arid subtropical.

Experimental design and treatment combinations

The experiment was laid out in Randomized Block Design. The treatments consist of Potassium Levels and Potassium Solubilizing Bacteria (Frateuria Aurentia) where two Potassium levels of treatments (20 gm and 40 gm) and two KSB levels of treatments are applied as soil application (20 ml/kg of soil, 30 ml/kg soil) and two KSB levels of treatments are applied as Seed Inoculation (20 ml/kg of seed, 30 ml/kg of seed) was used. The treatments comprised of T1 - K2O 20 gm + Soil application 30 ml of KSB/kg soil, T2 - K2O 40 gm + Soil application 20 ml of KSB/kg soil, T3 - K2O 20 gm + KSB 30 ml/kg soil (SA) + KSB 20 ml/kg seed (SI), T4 - K2O 40 gm + KSB 20 ml/kg soil (SA) + KSB 20 ml/kg seed (SI), T5 - K2O 20 gm + KSB 30 ml/kg soil (SA) + KSB 30 ml/kg seed (SI), T6 - K2O 40 gm + KSB 20 ml/kg soil (SA) + KSB 30 ml/kg seed (SI), T7 - K2O 20 gm + Seed inoculation 20 ml of KSB/kg seed, T8 - K2O 40 gm + Seed inoculation 20 ml of KSB/kg seed, T9 - K2O 20 gm + Seed inoculation 30 ml of KSB/kg seed, T1 - K2O 40 gm + Seed inoculation 30 ml of KSB/kg seed. There are ten treatments replicated thrice during *kharif* season 2020.

Statistical Analysis: The data recorded were different characteristics were subjected to statistical analysis by adopting Fishers the method of Analysis of Variance (ANOVA) as described by Gomez and Gomez (2010). Critical Difference (CD) values were calculated the F test was found significant at 5% level.

Results and Discussion

Effect of Potassium Levels and Potassium Solubilizing Bacteria on yield of Maize

The data presented on yield attributes and yield of Maize were statistically analyzed and have been presented in Table.2. Maximum grain yield (5.78 t/ha) was recorded with application of K2O 40 gm + KSB 20 ml/ kg Soil (SA) + KSB 30 ml/ kg Seed (SI), which was significantly superior over all other treatments except with application of K2O 20 gm + KSB 30 ml/ kg Soil (SA) + KSB 30 ml/ kg Seed (SI) is (5.57 t/ha), K2O 40 gm + KSB 20 ml/ kg Soil (SA) + KSB 20 ml/ kg Seed (SI) is (5.41 t/ha) and K2O 20 gm + KSB 30 ml/ kg Soil (SA) + KSB 20 ml/ kg Seed (SI) is (5.39 t/ha) which were statistically at par with K2O 40 gm + KSB 20 ml/ kg Soil (SA) + KSB 30 ml/ kg Seed (SI). We observed (Panwar and Singh 2000), that application Showed higher grain yield and straw yield recorded with comparatively lesser cost than additional income under these treatments.

Effect of Potassium Levels and Potassium Solubilizing Bacteria on economics of Maize

The data pertaining to economics of growing as influenced by Effect of potassium levels and potassium solubilizing bacteria on growth and yield of maize has been exhibited and presented in Table 2. The highest Gross returns (1,28,100), Maximum net returns (84,406.47 INR/ha) and B:C ratio (1.93) were obtained with the application of K2O 40 gm + KSB 20 ml/ kg Soil (SA) + KSB 30 ml/ kg Seed (SI) which was superior over rest of all treatments. Application of Potassium and Potassium Solubilizing Bacteria fetched the maximum gross returns, net returns and B:C ratio respectively and by which the grain and straw yield increased these results were in line with (Savaliya *et al.* 2016) that application of 45 kg K2O/ha+ KSB seed inoculation + KSB soil application earned maximum net return (Rs. 46,946 INR/ha) and B:C ratio (2.14), this attributed to higher grain yield and straw yield recorded with low cost than additional income under the treatments. (Raghavendra *et al.* 2019) revealed that maximum net returns (112488/ha and 125604/ha), B:C ratio (1.9 and 2.1), output energy, system productivity (10.62 t/ha and 11.37 t/ha) were found 50% RDF + KSB consumed only 0.34 – 0.35% higher input energy over no K in maize.

Table 1: Effect of potassium levels and potassium solubilizing bacteria on yield and Economics analysis of Maize

Treatments	Grain yield (t/ha)	Stover yield (t/ha)	Cost of Cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
K2O 20 gm + Soil application 30ml of KSB/kg soil	4.87	9.96	42,450.24	1,07,580	65,129.76	1.53
K2O 40 gm + Soil application 20ml of KSB/kg soil	4.70	9.66	42,553.53	1,03,920	61,366.47	1.44
K2O 20 gm + KSB 30 ml/kg soil (SA) + KSB 20 ml/kg seed (SI)	5.39	10.62	43,210.24	1,18,260	75,049.76	1.73
K2O 40 gm + KSB 20 ml/kg soil (SA) + KSB 20 ml/kg seed (SI)	5.41	10.74	43,313.53	1,18,860	75,546.47	1.74
K2O 20 gm + KSB 30 ml/kg soil (SA) + KSB 30 ml/kg seed (SI)	5.57	12.00	43,590.24	1,24,260	80,669.76	1.84
K2O 40 gm + KSB 20 ml/kg soil (SA) + KSB 30 ml/kg seed (SI)	5.78	12.03	43,693.53	1,28,100	84,406.47	1.93
K2O 20 gm + Seed inoculation 20 ml of KSB/kg seed	4.45	9.61	42,070.24	99,320	57,249.76	1.36
K2O 40 gm + Seed inoculation 20 ml of KSB/kg seed	4.76	9.70	42,553.53	1,05,080	62,526.47	1.46
K2O 20 gm + Seed inoculation 30 ml of KSB/kg seed	4.66	9.89	42,450.24	1,03,660	61,209.76	1.44
K2O 40 gm + Seed inoculation 30 ml of KSB/kg seed	4.61	9.99	42,933.53	1,02,960	60,026.47	1.39
SEm (±)	0.29	0.60	--	--	--	--
CD (P=0.05)	0.86	NS	--	--	--	--

Blanket application of RDF- 150:60:40 NPK kg/ha

Note: SA - (Soil Application), SI - (Seed Inoculation)

Conclusion
On the basis of one season experimentation, it is concluded that treatment with application of T6 – K2O 40 gm + KSB 20 ml/ kg Soil (SA) + KSB 30 ml/ kg Seed (SI) was found to be more productive (5.78 t/ha) as well as economically (84,406.47 INR/ha) viable.

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