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Effect of K solubilizing bacteria isolates on performance of maize in Inceptisol of Chhattisgarh

Sourabh Kumar Sahu, Anup Kumar Singh and SB Gupta

Abstract
The proposed investigation was carried out in Department of Agricultural Microbiology laboratory and field experiment was conducted in instructional cum research farm, Collage of Agriculture, IGKV, Raipur, Chhattisgarh during 2018-19 *Rabi* season on maize crop (sweet corn), variety sugar-75. The experiment was laid out in randomized block design with twelve treatments and three replications. Treatment details T1 (Absolute control no Potassium), T2 (GRD, NPK 120:60:60), T3 (Isolate No.1 + 75% K of GRD), T4 (Isolate No.2 + 75% K of GRD), T5 (Isolate No.3 + 75% K of GRD), T6 (Isolate No.4 + 75% K of GRD), T7 (Isolate No.5 + 75% K of GRD), T8 (Isolate No.6 + 75% K of GRD), T9 (Isolate No.7 + 75% K of GRD), T10 (Isolate No.8 + 75% K of GRD), T11 (Isolate No.9 + 75% K of GRD), T12 (Isolate No.10 + 75% K of GRD). The treatment T4 (Isolate No.2 + 75% K of GRD) is best bacterial isolates by which seed inoculation with KSB which improve crop growth, yield, plant height and also increased of grain and shoot weight. It improve better uptake of potassium by crop from soil.

Keywords: maize, RBD, isolates, potassium

Introduction
Soil microbes make up the biggest part of living organisms among unpredictable potential in their environment, physiological processes, biochemical with nutritive characteristics. They are participating important role in the fields of biomedicine, remediation, atmosphere as well as agriculture. Its significance in crop production through symbiosis, biological control agents counter to various plant pathogens, the creation of substances that promote growth of plant and the nutrient cycle (Archana *et al*. 2013) [1].
Potassium is the 3rd Major nutrient for development and growth of plant. It is a essential cation which is present in plant tissue and plays a vital role in the physiological and biochemical function of the plant. Most soils in India are K deficient in both available and unavailable forms of K. Some alternative green approaches need to be found to reduce dependence on expensive imported commercial potassic fertilizers.
Maize (*Zea mays* L.) is one of the majority main cereal crops in the earth belong to the *Poaceae* family. In India, corn is the 3rd most emergent crop together in area and production after rice and wheat. Maize is one of the most useful initial crops which has a wider adoptability in various agro-climatic conditions. From a nutritional point of view, corn has 60 - 68% starch and 7 - 15% protein. Corn has more vitamins B than wheat or rice and is rich in Phosphorus and potassium. Corn contains 1.2 to 5.7 percent edible oil. It is cultivated on an area of about 8.26 M.ha with a total production of about 16.72 mt per year and has the maximum productivity among the cereals. In India the main producers are Andhra Pradesh (17%), Rajasthan (14%), Madhya Pradesh (12%), Bihar (10%), Uttar Pradesh (9%), Karnataka (8%), Gujarat (8%) and Chhattisgarh (1.64%).
The edible part of corn 100g contains 286.0 mg of potassium. Potassium solubilizing microbes apply useful effects on plant development. There use as biofertilizers for the development of crops and ecological safety will be the focus of present research (Prajapati and Modi 2016) [7]. Some soil microorganisms can solubilize "unavailable" forms of K by producing organic acids that directly dissolve rock K or chelating silicon ions to bring the K into solution.
The application of potassium solubilizing bacteria (KSB) has a promising approach to increase the availability of K in soils, especially in light soils. However, there is a lack of knowledge on the mobilization of K waste mica as well as it's utilized as K-nutrient for maximum crop yield.

Material and Methods
All the laboratory experiments were conducted in Agricultural Microbiology Laboratory

under control conditions and field experiment was conducted in instructional cum research farm, college of agriculture Raipur, Indira Gandhi Krishi Vishwavidylaya, Raipur (C.G.) during rabi season 2018-19 on maize crop.

Composition of Aleksandrov agar medium were dissolved in water, mixed thoroughly and medium was sterilized at 15 lbs pressure at 121ºC for 15 min in autoclave (vertical Autoclave), cooled (45ºC) and poured in to sterilize petri plates and allowed them to solidify.

Purification of potassium solubilizing bacteria provided by department of Agricultural Microbiology- Colony rising on agar plate was transferred to agar slant and purified by frequent striking on agar plate. In the refrigerator, pure isolates were stored on agar slant at low temperatures.

For its growth morphology and biochemical characteristics, 10 efficient KSB isolates showing greater K-solubilization capacity during primary screening were characterized. Colony morphological characteristics of an effective KSB strain have been analyzed based on their characteristics, such as colony elevation and plaque size (Gerhardt *et al.* 1981) [3].

Efficient bacterial K-strains used for field trial were grown in broth and isolates used were having. For seed treatment inoculant and seeds were carefully mixed and air dried in shad. Control seeds were not treated with bacterial K-isolates. The experiment was consist of twelve treatment and three replication laid in Randomized Block Design in field experiment. Treatments were selected seed inoculation of potassium solubilizing bacteria and with 75% K GRD of NPK. Potassium levels are 0, 45 and 60 kg ha-1.

The nitrogen (N), phosphorus (P2O5) and potassium (K2O) were applied @120:60:60 NPK kg/ha by using urea, di ammonium phosphate and muriate of potash respectively. Height of the plants, dry weight of plants, yield attributes and estimation of potassium in plant sample was measured. The replicated data recorded during the whole experiment were statistical analysis by following the Randomized Block Design (RBD) with the appropriate ANOVA (Panse and Sukhatme 1978) [5].

Result and Discussion

A field experiment was designed for the response of native isolates of potassium solubilizing bacteria to Inceptisol grown sweet corn (*Zea mays* L. *saccharata*) in Department of Agricultural Microbiology, IGKV, Raipur, Chhattisgarh, during the year 2018-19.

In this content the plant height at harvest, (175.13 cm/plant) was recorded as highest in treatment T2 (GRD) followed by Treatment T4 (174.66 cm/plant) and minimum was observed in plant height of T1 control 160.80 cm. Due to no Potassium fertilizers. (Table No. 1).

After that we found treatment T4 maximum dry weight of plant (514.67 g), fresh weight of cob (500.33 g) and dry weight of cob (125.17 g). Maximum yield (green cob) were recorded by T2 (8570.9 kg/ha) due to (GRD) followed by T4 (8447.3 kg/ha) and least yield was observed in control T1 (6098.2Kg/ha.) (Table No. 2).

Table 1: Effect of K solubilizing bacteria isolates on performance of plant height of maize

Treatment	Plant height (cm)			
	45 DAS	60 DAS	75 DAS	At harvest
T1Absolute control (No Potassium)	15.00	43.67	103.06	160.80
T2GRD (NPK 120:60:60)	22.40	52.20	134.46	175.13
T3 (Isolate No.1 + 75% K of GRD)	20.33	51.33	126.40	173.20
T4 (Isolate No.2 + 75% K of GRD)	21.20	51.80	133.86	174.66
T5 (Isolate No.3 + 75% K of GRD)	19.60	47.93	123.13	171.60
T6 (Isolate No.4 + 75% K of GRD)	20.06	51.20	127.13	174.26
T7 (Isolate No.5 + 75% K of GRD)	18.73	47.60	123.06	171.40
T8 (Isolate No.6 + 75% K of GRD)	20.13	48.93	121.40	172.66
T9 (Isolate No.7 + 75% K of GRD)	19.20	49.73	131.40	173.60
T10 (Isolate No.8 + 75% K of GRD)	20.46	50.40	127.06	170.60
T11 (Isolate No.9 + 75% K of GRD)	19.00	48.00	122.73	171.73
T12 (Isolate No.10 + 75% K of GRD)	19.86	46.67	125.46	174.00
CD 0.05	3.93	6.35	22.94	10.51

Table 2: Effect of K solubilizing bacteria isolates on performance of plant biomass and yield of maize

Treatment	Dry weight of plant (g)	Fresh weight of cob (g)	Dry weight of cob (g)	Green cob weight (kg /ha)
T1 Absolute control (No Potassium)	402	390.23	106.33	6098.2
T2 GRD (NPK 120:60:60)	494	467.50	119	8570.9
T3 (Isolate No.1 + 75% K of GRD)	463	481.17	117.67	7989.1
T4 (Isolate No.2 + 75% K of GRD)	514.67	500.33	125.17	8447.3
T5 (Isolate No.3 + 75% K of GRD)	506.33	419.73	118.23	7334.5
T6 (Isolate No.4 + 75% K of GRD)	477.33	401.73	113.17	7770.9
T7 (Isolate No.5 + 75% K of GRD)	511	390.60	100.63	7272.7
T8 (Isolate No.6 + 75% K of GRD)	465.67	456.17	115.33	7301.8
T9 (Isolate No.7 + 75% K of GRD)	474.67	461.07	113.33	7174.5
T10 (Isolate No.8 + 75% K of GRD)	466	416.47	104.77	6945.5
T11 (Isolate No.9 + 75% K of GRD)	420	405.07	112.23	7298.2
T12 (Isolate No.10 + 75% K of GRD)	434.33	441.87	105.67	6592.7
CD	46.05	56.74	12.01	603.97

The highest potassium content in straw was observed in Treatment T2 (1.94%) followed by Treatment T4 (Isolate No.2 + 75% K of GRD) 1.6%. And highest potassium content was observed in grain is Treatment T2 (2.01%) followed by Treatment T4 (Isolate No.2 + 75% K of GRD) 1.92% and least K content was observed in T1 control (1.52%).

After that the population of bacteria in post-harvest soil is ranged from 15 to 19.67 cfu × 109 g-1 of soil which was higher than un-inoculated treatment and maximum population in treatment T4 (isolate no.2 + 75% K of GRD) is (19.67 cfu × 109 g-1 of soil). Further the population of potassium solubilizing bacteria (KSB) T4 (isolate no.2 + 75% K of GRD) caused maximum K-solubilizers population 14.33 cfu × 104 g-1 of soil and showed superiority over rest of the treatments.

Result shows that under field condition K uptake by maize is influenced by different bacterial K-isolates and levels of K mineral fertilization. Highest total K uptake was recorded under the GRD (NPK 120:60:60) T2 which is 11.95 g/plant and followed by isolate no.2 + 75% K of GRD (T4) which is 10.61 g/plant.

After 16 sRNA sequencing culture identify as *Bacillus aryabhattai* (KSBb). Keeping in view of above mentioned findings, it can be concluded that treatment T4 (Isolate no.2 + 75% K of GRD) was most effective potassium solubilizers followed by T11 (Isolate No.9 + 75% K of GRD) among all the test under the present investigation.

Conclusion

Keeping in observation of above mentioned in conclusion accomplished that treatment T4 (Isolate No.2 + 75% K of GRD) was most effective among all the bacterial isolates taken under this study. Seed inoculation with KSB (potassium solubilizing bacteria) which improve crop growth, yield, plant height and also increased of grain and shoot weight. It improve better uptake of potassium by crop from soil.

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