International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 998-1001

Received: 01-01-2019
Accepted: 03-02-2019

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# Effect of potassium mobilizing bacteria on growth and yield of potato (*Solanum tuberosum* L.) In loamy sand

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## Abstract
A field experiment on "Effect of potassium mobilizing bacteria on growth and yield of potato (*Solanum tuberosum* L.) in loamy sand" was carried out at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *rabi* season of 2017-18. The soil of experimental plot was loamy sand in texture, neutral to alkaline in reaction and soluble salt content under safe limit. It was low in organic carbon and available N; medium in available $P_2O_5$, $K_2O$, S and DTPA-extractable Fe and Zn and having sufficient DTPA-extractable Mn and Cu status. The results revealed that an application of 75% RDK along with soil application of KMB (potassium mobilizing bacteria) *i.e. Frateuria aurentia* ($T_7$) was significantly higher which was par with 100% RDK ($T_1$) and 75% RDK + soil application of KMB strains *i.e Enterobacter asburiae* + *Frateuria aurentia* ($T_8$) significantly enhanced grade wise tuber yield such as small, medium and large size, total tuber yield as well as haulm yield of potato over rest of treatments. Similar trend was also noticed in case of total tuber yield on dry weight basis. The improvement in total tuber yield was the tune of 6.42 per cent over $T_1$treatment.

**Keywords:** KMB (potassium mobilizing bacteria), potato, yield and growth

## Introduction
Potassium is one of the three major essential nutrient elements required by plants. Among the three major nutrients, potassium (K) has a special position as evident by its role in increasing the crop yield by adding tolerance to various biotic and abiotic stresses. Potassium plays a major role in growth and yield as it is involved in assimilation, transport, and storage tissue development (Nathiya *et al*, 2015) [10]. Most crops take up as much or more potassium than nitrogen. It is a key element in many physiological and biochemical processes. Current agriculture is facing increased cost of synthetic fertilizer now, certain species of micro-organism are widely used which has unique properties to provide natural products and serve as a good substitute of chemical fertilizers. Hence, potassium-solubilizing bacteria (KSB) could serve as inoculants which convert insoluble potassium in the soil into a form that plants can access. A wide range of bacteria namely *Pseudomonas*, *Burkholderia*, *Enterobacter*, *Acidothiobacillus ferrooxidans*, *Bacillus mucilaginosus*, *Bacillus edaphicus*, *Bacillus Circulans* and *Paenibacillus*sp. *Frateuria*, *Citrobacter*etc. have been reported to release potassium in accessible form from potassium-bearing minerals in soil (Lian, 2002, Li, 2006; Liu, 2012) [7, 6, 8]. Potato (*Solanum tuberosum* L.) is one of the important crops of the world and is consumed by billions of people across the globe both as food and as vegetable. Potato is short duration crop belong to family *Solanaceae*, with an average cropping period of 90-110 days along with higher yield potential (221 kg $day^{-1}$ $ha^{-1}$) as compared to rice and wheat *i.e.*18 and 23 kg $day^{-1}$ $ha^{-1}$, respectively. Therefore, it has great potential to solve the food demands of human population (Anon., 2010). Potato contain 77.2 % water and rest is dry matter which includes 16 % starch, 0.9 % sugar, 4.4 % protein (2.8 % crude and 1.6% true protein), 0.9 % minerals, 0.5 % fibres, 0.14% crude fat and considerable amount of vitamin A and C (Bose., 1993) [4]. The average biological value of potato protein is better than that of most of other vegetables and is comparable to that of cow's milk and hence considered as 'complete food' and is consumed as boiled, fried or processed. No other food crop has such an inherent capacity as that of potato to produce many diverse processed products.

Potato crop is known as heavy feeder and requires large amount of soil nutrients because of shallow root system where in potassium plays a vital role in improving potato quality and yield.

**Materials & methods**

A field experiment was carried out at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *Rabi* season of 2017-18. Eight treatments *viz.*, $T_1$ (100% RDK (275 kg $K_2O$ $ha^{-1}$), $T_2$ (75% RDK (206.25 kg $K_2O$ $ha^{-1}$), $T_3$ (75% RDK + tuber inoculation with KMB (*Enterobacter asburiae*), $T_4$ (75% RDK + tuber inoculation with KMB (*Frateuria aurentia*), $T_5$ (75% RDK + tuber inoculation with KMB (*Enterobacter asburiae*) + KMB (*Frateuria aurentia*), $T_6$ (75% RDK+ soil application of KMB (*Enterobacter asburiae*), $T_7$ (75% RDK + soil application of KMB (*Frateuria aurentia*), $T_8$ (75% RDK + soil application of KMB (*Enterobacter asburiae*)+ KMB (*Frateuria aurentia*) were tried in randomized block design with four replications. Potato variety Kufri pukhraj was used as test crop. The details of treatments tested in the present investigation on "Effect of potassium mobilizing bacteria on growth and yield of potato (*Solanum tuberosum* L.) in loamy sand" are as follows:

**Treatment details**

| | | |
|---|---|---|
| $T_1$ | : | 100 % RDK (275 kg $K_2O$ $ha^{-1}$) |
| $T_2$ | : | 75 % RDK (206.25 kg $K_2O$ $ha^{-1}$) |
| $T_3$ | : | 75 % RDK + tuber inoculation with KMB (*Enterobacter asburiae*) |
| $T_4$ | : | 75 % RDK + tuber inoculation with KMB (*Frateuria aurentia*) |
| $T_5$ | : | 75 % RDK + tuber inoculation with KMB (*Enterobacter asburiae*) and KMB (*Frateuria aurentia*) |
| $T_6$ | : | 75 % RDK+ soil application of KMB (*Enterobacter asburiae*) |
| $T_7$ | : | 75 % RDK + soil application of KMB (*Frateuria aurentia*) |
| $T_8$ | : | 75% RDK + soil application of KMB (*Enterobacter asburiae*) and KMB (*Frateuria aurentia*) |

**Note**

1) Common application of 275 kg N and 137.5 kg $P_2O_5$ $ha^{-1}$ and 20 t FYM $ha^{-1}$ were given to all the treatments
2) Tuber inoculation treatment: Mix 5 ml of culture having population of $10^8$ CFU $ml^{-1}$ in 1 litre of water prior to planting
3) Soil application: Mix one litre of KMB culture having population of $10^8$ CFU $ml^{-1}$ in 80 kg FYM and apply this material in furrow in one hectare.

The observations of the study was emergence percentage and days taken for emergence, plant growth i.e. plant height, haulm yield, number of tuber per plant and total yield, the haulm was dried at 75 days after planting and the data for number of tuber $plant^{-1}$ and total yield were taken at 25 days after of dried haulm and at harvesting. The furrows were opened at 50 cm distance with the help of cultivator and Farm Yard Manure @ 20 t $ha^{-1}$ was applied in open furrows. Before planting of the tubers, half dose of nitrogen (137.5 kg $ha^{-1}$) and full dose of phosphorus (137.5 kg $ha^{-1}$) were applied as a basal dose in the opened furrows at a depth of about 8-10 cm in the form of ammonium sulphate and DAP, respectively. The potassium was applied as per treatment in furrows in the form muriate of potash. The remaining half dose of nitrogen applied as top dressing in the form of urea after 45 day after planting. Light planking was done after basal application of fertilizers. Potatoseed tubers of variety *Kufri pukhraj* was procured from Potato Research Station, S.D. Agricultural University, Deesa, District, Banaskantha. Potato tubers of variety *Kufri Pukhraj* were cut in pieces, keeping two to three live eye bud with approximately 30 to 35 g weight. Cut pieces were treated with the mixture of Mancozeb @ 1 kg $ha^{-1}$ + Talc powder @ 5 kg $ha^{-1}$ before planting to control rotting of cut pieces of potato tubers. The strain of KMB (*Enterobacter asburiae*) was obtained from Biofertilizers Production Unit, Department of Plant Pathology, N. M. College of Agriculture, Navsari and another strain of KMB (*Frateuria aurentia*) was obtained from Department of Agricultural Microbiology and Biofertilizer Projects, An and Agricultural University, An and. For tuber inoculation with KMB, 5 ml of KMB liquid inoculant (having $10^8$ CFU $ml^{-1}$) was added in sufficient quantity of water and then 1 kg of tuber was dipped for 30 minutes in this solution and dried in shade prior to planting. For soil application with KMB, one litre of KMB liquid inoculant (having $10^8$ CFU $ml^{-1}$) was mixed with 80 kg well decomposed FYM. The mixture was blended well and applied in furrows in one hectare before planting. The treated cut pieces of potato tubers were planted 20 cm apart in opened furrows with seed rate @ 3000 kg tubers $ha^{-1}$ on $16^{th}$ November, 2017. Subsequently deep furrows were opened in the centre of row using country plough to form ridges and furrows. The field channels and beds were then prepared with manual labours according to plan of layout. Currently, very little information is available on mineral potassium solubilization by bacteria, their mechanisms of solubilization and their effect on growth, K uptake and yield of several crops. Therefore the present investigation was undertaken to study the influence of potassium mobilizing bacteria on yield of potato crop.

**Results and discussion**

**Growth**

The data given in Table 1 revealed that different treatments of potassium mobilizing bacteria (KMB) did not alter any significant influence on plant population per meter row length at harvest. The results clearly indicated that plant population in experimental plots were uniform. Hence, various growth and yield attributes as well as yield of the potato crop was not influenced due to variation in plant population.

The perusal data given in Table 1 showed that the plant height measured at harvest was significantly influenced due to different treatments of KMB inoculation. It varied from 40.78 to 50.18 cm. Among different treatments tested, the treatment receiving 75% RDK along with soil application of KMB *i.e. Frateuria aurentia* ($T_7$) gave significantly higher plant height (50.18 cm) as compared to other treatments which was at par with the treatment receiving 100 % RDK ($T_1$), 75% RDK + soil application of KMB strains *i.e Enterobacter asburiae* + *Frateuria aurentia* ($T_8$) and 75% RDK + tuber inoculation with KMB *i.e. Frateuria aurentia* ($T_4$). The lowest plant height (40.19 cm) was measured under treatment of 75 % RDK ($T_2$). The beneficial effect of inorganic K fertilizer and KMB inoculation with tuber and soil on plant height could be due to adequate supply of potassium in building up the plant tissues, resulting to better vegetative growth which plays a vital role in photosynthesis, carbohydrate transport and other physiological process of the plant. This result is in the line of those reported by Prajapati *et al.* (2013) [12] in okra, Zhang and Kong (2014) [15] in tobacco, Alladi *et al*. (2014) [1] in brinjal and Joseph *et al.* (2018) [5] in potato.

**Table 1:** Effect of potassium mobilizing bacteria on plant height (cm), number of tubers per plant and plant population at harvest of potato

| Treatment | Plant height (cm) | Number of tubers per plant | Plant population (at harvest) |
|---|---|---|---|
| $T_1$: 100% RDK (275 kg $K_2O$ $ha^{-1}$) | 47.45 | 6.54 | 6.20 |
| $T_2$: 75% RDK (206.25$K_2O$ $ha^{-1}$ ) | 40.17 | 5.05 | 5.13 |
| $T_3$: 75 % RDK + tuber inoculation with KMB (*Enterobacter asburiae*) | 44.15 | 5.68 | 5.73 |
| $T_4$: 75 % RDK + tuber inoculation with KMB (*Frateuria aurentia*) | 46.10 | 6.33 | 5.95 |
| $T_5$: 75 % RDK + tuber inoculation with KMB (*Enterobacter asburiae*) + KMB (*Frateuria aurentia*) | 44.50 | 6.06 | 5.84 |
| $T_6$: 75 % RDK + soil application of KMB (*Enterobacter asburiae*) | 44.40 | 5.95 | 5.78 |
| $T_7$: 75 % RDK + soil application of KMB (*Frateuria aurentia*) | 50.17 | 7.25 | 6.46 |
| $T_8$: 75% RDK + soil application of KMB (*Enterobacter asburiae*)+ KMB (*Frateuria aurentia*) | 47.05 | 6.38 | 5.99 |
| S. Em ± | 1.42 | 0.28 | 0.25 |
| CD at 5 % | 4.18 | 0.82 | NS |
| CV (%) | 6.24 | 9.02 | 8.53 |

The data pertaining to number of tubers per plant as influenced by different treatments of KMB inoculation are presented in Table 1 revealed that the number of tubers per plant was significantly influenced due to different treatments of KMB inoculation. An application of 75% RDK along with soil application of KMB *i.e Frateuria aurentia* ($T_7$) recorded significantly more number of tubers per plant over rest of treatments except treatment receiving 100% RDK ($T_1$). The minimum number of tubers per plant was recorded under $T_2$ treatment which was at par with $T_3$ treatment. The positive effect of inorganic K fertilizer as well as KMB inoculation on number of tubers per plant has been reported by Badoni *et al.* (2017) [3] and Panwar and Negi (2017) [11] in potato.

## Yield

The data pertaining to total tuber yield of potato as influenced by different treatments of KMB inoculation are presented in Table 2. Among different treatments tested, an application of 75% RDK along with soil application of *Frateuria aurentia* ($T_7$) produced significantly higher total tuber yield of potato as compared to other treatments but it was found at par with treatment receiving 100% RDK ($T_1$) as well as 75 % RDK along with soil application of KMB strains *i.e. Enterobacter asburiae* + *Frateuria aurentia* ($T_8$). The observed significant increases in total tuber yield of potato due to75% RDK along with soil application of KMB *i.e Frateuria aurentia* which is indicative of luxurious consumption of potassium by potato crop which ultimately increased the weight of the tuber and also equatorial diameter of the tuber. Moreover, cumulative effect of improvement in yield attributing characters under KMB treated plot might have contributed for the increase in the total yield of potato. These results are in conformity with those reported by Yashwant (2014) [14] in maize, Panwar and Negi (2017) [11], Badoni *et al.* (2017) [3] in potato and Meena and Maurya (2017) [9] in wheat.

A perusal of data given in Table 2 revealed that the different treatments of KMB inoculation had significant effect on haulm yield of potato. An application of 75% RDK along with soil application of KMB *i.e Frateuria aurentia* ($T_7$) being at par with 100% RDK ($T_1$) and 75 % RDK + soil application of KMB strains *Enterobacter asburiae* + *Frateuria aurentia* ($T_8$) produced significantly more haulm yield of potato as compared to other treatments. The significantly lowest haulm yield was recorded under treatment of 75% RDK ($T_2$). The per cent increase in haulm yield was 7.94 with 75% RDK along with soil application of KMB (*Frateuria aurentia)* over 100% RDK ($T_1$). The positive effect of potassium on haulm yield of potato observed in presence study could be due to fact that K facilitates the translocation assimilates to the sinks/tuber which could ultimately increase the growth parameters and thereby its biomass. Similar beneficial effect of potassium on haulm yield of potato were also reported by earlier workers (Sheng, 2005 and Archana, 2007) [13, 2].

The data regarding total tuber yield on dry weight basis as influenced by KMB inoculation are furnished in Table 2. Total tuber yield on dry weight basis was significantly influenced by KMB inoculation. Among different treatments, an application of 75% RDK along with soil application of *Frateuria aurentia* ($T_7$) produced significantly higher total tuber yield on dry weight than other treatment but it was at par with $T_1$ and $T_8$ treatments. The significantly the lowest yield of total tuber yield on dry weight basis was recorded under the treatment of 75% RDK ($T_2$).

**Table 2:** Effect of potassium mobilizing bacteria on total tuber yield and haulm yield (q $ha^{-1}$) of potato

| Treatment | Yield (q $ha^{-1}$) | | Tuber yield (q $ha^{-1}$) (Dry weight basis) |
|---|---|---|---|
| | Total tuber | Haulm | |
| $T_1$: 100% RDK (275 kg $K_2O$ $ha^{-1}$) | 313.2 | 14.23 | 62.31 |
| $T_2$: 75% RDK (206.25$K_2O$ $ha^{-1}$ ) | 216.4 | 9.15 | 43.01 |
| $T_3$: 75 % RDK + tuber inoculation with KMB (*Enterobacter asburiae*) | 257.5 | 11.13 | 52.67 |
| $T_4$: 75 % RDK + tuber inoculation with KMB (*Frateuria aurentia*) | 284.5 | 12.91 | 57.79 |
| $T_5$: 75 % RDK + tuber inoculation with KMB (*Enterobacter asburiae*) + KMB (*Frateuria aurentia*) | 274.2 | 11.59 | 54.83 |
| $T_6$: 75 % RDK + soil application of KMB (*Enterobacter asburiae*) | 266.4 | 11.37 | 53.19 |
| $T_7$: 75 % RDK + soil application of KMB (*Frateuria aurentia*) | 333.3 | 15.36 | 65.88 |
| $T_8$: 75% RDK + soil application of KMB (*Enterobacter asburiae*)+ KMB (*Frateuria aurentia*) | 300.7 | 13.66 | 60.33 |
| S. Em ± | 13.0 | 0.65 | 2.74 |
| CD at 5 % | 38.2 | 1.90 | 8.06 |
| CV (%) | 9.2 | 10.38 | 9.74 |

## Conclusions

Based on the result of present study, it is concluded that higher potato tuber yield can be secured from potato crop by application of 75% RDK along with soil application of KMB (*Frateuria aurentia*) @ 1 litre in 80 kg FYM $ha^{-1}$ besides recommended dose of NP (275-137.5 kg $ha^{-1}$) in light textured soil of North Gujarat.

**References**


1. Alladi A, Thakur KD, Satyakala K. Impact of nitrogen fixing, phosphorus solubilising and potassium mobilising bacteria on growth and yield of brinjal. Journal of Soils and Crops. 2014; 24(1):104-106.
2. Archana DS. Studies on potash solubilizing bacteria. Ph.D theses. Dept of Agricultural Microbiology, UAS Dharwad. India, 2007.
3. Badoni A, Chamoli V, Chandra M, Murugalatha N. Impact of potash mobilizing bacteria (KMB- seed treatment) on yield of potato crop. International Journal of Advanced Biological Research. 2017; 7(3):571-573.
4. Bose TK, Som MG, Kabir T. Vegetable crops in India. Naya Prakash, Calcutta, India, 1993.
5. Joseph R, Singh LN, Devi KP. Integration of different sources of organic manure and micro-nutrients on growth, yield and quality of potato (*Solanum tuberosum* L.) grown under new alluvial soil condition. Indian Journal of Agricultural Research. 2018; 52(2):172-176.
6. Li FC, Li S, Yang YZ, Cheng LJ. Advances in the study of weathering products of primary silicate minerals, exemplified by mica and feldspar. Acta Petrol Minerals. 2006; 25:440-448.
7. Lian B, Fu Mo DM, Liu CQ. A comprehensive review of the mechanism of potassium release by silicate bacteria. Acta Mineral Sinica. 2002; 22:179-183.
8. Liu D, Lian B, Dong H. Isolation of *Paenibacillus sp.* and assesment of its potential for enhancing mineral weathering. Geomicrobiology Journal. 2012; 29:413-421.
9. Meena G, Maurya BR. Potentiality of potassium solubilizing bacteria on enhancing the growth, yield and nutrient acquisition on wheat (*Triticum aestivum* L.). International Journal Current Microbiology Applied Sciences. 2017; 6(4):2443-2450.
10. Nathiya KV, Sanjivkumar V. Dynamics of potassium by the combined use of organic manures and inorganic potassium fertilizers on available nutrients of groundnut crop (*Arachis hypogea*) in Madukkur soil series. Journal of Applied and Natural Science. 2015; 7(1):197-202.
11. Panwar A, Negi S. Effect of various treatments on yield attributes of potato crop. Plantica-Journal of Plant Science. 2017; 1(1):18-26.
12. Prajapati K, Sharma MC, Modi HA. Growth promoting effect of potassium solubilizing Microorganisms on okra (*Abelmoschus Esculentus*). International Journal of Agricultural Science and Research. 2013; 3(1):181-188.
13. Sheng XF. Growth promotion and increased potassium uptake of cotton and rape by a potassium releasing strain of *bacillus edaphicus*. Soil Biology & Biochemistry. 2005; 37(1):1918-1922.
14. Yashwant PS. Isolation of potassium solubilizing bacteria and their effects on maize (*Zea mays L.*). M.Sc. thesis. Dept. of Plant Pathology and Agricultural Microbiology, Rahuri. India, 2014.
15. Zhang C, Kong F. Isolation and identification of potassium solubilizing bacteria from tobacco rhizospheric soil and their effect on tobacco plants. Applied soil ecology. 2014; 82:18-25.