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Effect of FYM, potassium mobilizing bacteria (KMB) and potassium on potassium and zinc content, uptake, periodic potassium status and KMB count of soil after harvest of wheat (*Triticum aestivum* L.)

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Abstract
Organic manures, which were perhaps the main sources of plant nutrients in traditional agriculture, receive less emphasis with the advent of high analysis chemical fertilizers. The application of FYM in the soil helps in increasing the fertility of the soil as physical condition including its water holding capacity. Microorganisms play a key role in the natural K cycle. K-mobilizing bacteria (KMB) are able to release potassium from insoluble minerals. The considerable populations of KMBs are present in rhizospheric soils which promote the plant growth. Potassium is the fourth most abundant nutrient constituting about 2.5 per cent of the lithosphere and exists in insoluble forms as rocks and silicate minerals, resulting in very low concentrations of soluble potassium in the soil for plant growth and development. Therefore experiment comprising twelve-treatment combinations of FYM, potassium mobilizing bacteria (KMB) and potassium (K). It was plotted out in Randomized Block Design (factorial) with three replications. The treatment comprising of two levels of FYM *viz*., 0 t ha^{-1} (F0) and 10 t ha^{-1} (F1) and two levels of Potassium Mobilizing Bacteria *viz*., without KMB (KMB0) and with KMB (KMB1) and three levels of potassium *viz*., 0 kg K2O ha^{-1} (K0), 20 kg K2O ha^{-1} (K1) and 40 kg K2O ha^{-1} (K2). The application of FYM showed that increased K content and uptake by grain and straw, Zn content and uptake by grain, available potassium in soil at 30 and 45 DAS and KMB count at harvest. Application of KMB recorded significantly highest K content and uptake by grain and straw and KMB count at harvest. With potassium application increased K content in straw and uptake by grain, Zn content in grain and straw as well as uptake by straw and KMB count in soil after harvest. Interaction effects on Potassium (39.83 kg ha^{-1}) and Zn uptake by wheat grain was obtained with the treatment combination F1KMB1K2 than other treatments, except treatment combination F1KMB1K0 in case of zinc uptake by wheat grain.

Keywords: Potassium, potassium mobilizing bacteria, FYM, potassium and zinc interaction

Introduction

Mexican Dwarf Wheat (*Triticum aestivum* L.) presently grown in India everywhere called common bread wheat was evolved by Dr. N. E. Borlaug of Mexico at CIMMYT. Wheat is a self-pollinated, C3 and hexaploid plant. It is the dominant crop in temperate countries being used for human food and livestock feed. It also contributes essential amino acids, minerals, vitamins, beneficial phytochemicals and dietary fiber components to the human diet and these are particularly enriched in whole-grain products. Wheat grains are comparatively better source of protein consumed in India. About 10-12% protein requirement is met by wheat. The decision on the optimum use of fertilizer required knowledge of crop response to applied fertilizer, inherent nutrients by soil and its short or long-term fate effects (Dobermann *et al.*, 2003) [8].

Microorganisms play a key role in the natural K cycle. K-mobilizing bacteria (KMB) are able to release potassium from insoluble minerals. The considerable populations of KMBs are present in rhizospheric soils which promote the plant growth (Sperberg, 1958) [21]. With the use of K-mobilizing microbes, the concentration of available K ions can be increased in the soil (Barker *et al.*, 1998) [5]. It is proven that microbial soil community is able to influence soil fertility through soil processes *viz.* decomposition, mineralization, and storage/release of nutrients (Parmar and Sindhu, 2013) [14]. It had been reported that inoculation with KMB produced beneficial effect on growth of different plants (Ahmad *et al.*, 2016; Bakhshandeh *et al.*, 2017) [2, 4]. Potassium is one of 17 vital nutrients required for the growth and reproduction. Potassium is one of the most abundantly absorbed cation in higher plants. Potassium 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; Cecílio Filho *et al*., 2015; Gallegos-Cedillo *et al*., 2016; Hussain *et al*., 2016; Yang *et al*., 2015) [3, 6, 8, 9, 22]. Although K is present as an abundant element in soil, only 1 to 2% of this element is available to plants. The rest are bound with other minerals and therefore are unavailable to plants. Potassium is present in several forms in the soil, including mineral K, non-exchangeable K, exchangeable K, and solution K. Depending on soil type, from 90 to 98% of soil K is mineral K and most of this K is unavailable for plant uptake (Sparks and Huang, 1985) [19]. Minerals containing K are feldspar (orthoclase and microcline) and mica (biotite and muscovite). The non-exchangeable form of K makes up approximately 1 to 10% of soil K and is trapped between the layers or sheets of certain kinds of clay minerals (Sparks, 1987) [18]. Solution K is the form of K that directly and readily is taken up by plants and microbes in soil. In addition, this form is most subject to leaching in soils.

Hence, very limited concentration of K is available to plants. Although K deficiency is not as wide spread as that of nitrogen and phosphorus, many soils which were initially rich in K become deficit due to heavy utilization by crops and inadequate K application, runoff, leaching and soil erosion (Sheng and Huang, 2002) [14].

Materials and Method

Experimental details: The experiment was carried out at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during *rabi* season of the year 2019-20.The experimental site having soil texture Loamy sand in which Clay content are 5.10(%), Silt content are 10.33(%), Fine sand are 83.50(%), Coarse sand are 0.66(%), Bulk density 1.51(g/cc) and Water holding capacity is 38.05(%). The soil was alkaline in reaction (8.12 pH), EC of soil is 0.17(dS m^{-1}) with low in organic carbon (0.39%) and available nitrogen (150 kg ha^{-1}), medium in available phosphorus (37.22 kg ha^{-1}) and potassium (247 kg ha^{-1}).With respect to available S and DTPA- extractable micronutrients Zn, Mn, Fe and Cu were in sufficient (6.30, 1.33, 7.99, 7.22 and 2.94 mg kg^{-1} respectively)

Results and discussion

Effect of FYM on Potassium and Zinc content, uptake, periodical availability of potassium and KMB count

The result revealed that there was treatment containing application of 10 t FYM ha^{-1} Recorded significantly the highest K content in grain (0.57%) and straw (1.17%) of wheat. The similar results were supported by Singh *et al*., (2019) [17] in wheat. The treatment F1 (10 t FYM ha^{-1}) recorded significantly the highest Zn content (28.92 mg kg^{-1}) in wheat grain but fail to produce significant effect in Zn content in wheat straw. Significantly the highest K and Zn uptake by grain (28.97 kg ha^{-1} and 147.81 g ha^{-1}) was found with the application of 10 t FYM ha^{-1} (F1) as compared to 0 t FYM ha-1 (F0). The treatment of application of 10 t FYM ha^{-1} (F1) recorded significantly the highest K uptake by straw of wheat (76.44 kg ha^{-1}). It was found to be non- significant effect on Zn uptake by straw of wheat. Alike results were reported by Jat *et al*., (2013) [12] in wheat. Among different treatment of FYM, application of 10 t FYM ha^{-1} (F1) recorded significantly the highest available potassium at 30 DAS (291 kg ha^{-1}) and 45 DAS (287 kg ha^{-1}) but it was not recorded any significant effect at 60 DAS and at harvest. Application of FYM 10 t ha^{-1} (F1) recorded significantly the highest KMB count at harvest (9.0×106) followed by application of FYM 0 t ha^{-1} (F0).

Effect of KMB on Potassium and Zinc content, uptake, periodical availability of potassium and KMB count

The result revealed that there was treatment application with KMB recorded significantly the highest K content in grain (0.54%) and straw (1.15%) of wheat. Sheng (2005) [15] was found the similar results with the application of potassium mobilizing bacteria in cotton and rape. Also Sheng *et al*., (2003) [16] found similar result in chili. However, significantly the highest K uptake by grain (27.66 kg ha-1) and straw (75.44 kg ha-1) was recorded with KMB application (KMB1). There is no any significant effect of KMB application on Zn content and uptake by grain and straw, on available potassium in soil at 30, 45, 60 DAS and at harvest of wheat. Application of treatment with KMB (KMB1) recorded significantly the highest KMB count (9.19×106) at harvest of wheat than treatment application without KMB (KMB0).

Table 1: Effect of FYM, KMB and potassium levels on potassium and zinc content and Uptake by grain and straw of wheat

Treatments	K2O (%) content		K2O (kg ha^{-1}) uptake		Zn (mg kg^{-1}) content		Zn (g ha^{-1}) uptake	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Level of FYM								
F0	0.48	1.04	22.65	65.63	26.98	11.60	127.09	72.08
F1	0.57	1.17	28.97	76.44	28.92	12.30	147.81	80.15
S. Em. ±	0.012	0.02	0.86	2.43	0.39	0.35	3.33	2.79
CD (P=0.05)	0.03	0.06	2.52	7.13	1.15	NS	9.78	NS
Level of KMB								
KMB0	0.50	1.06	23.96	66.63	27.96	11.83	132.88	73.87
KMB1	0.54	1.15	27.66	75.44	27.95	12.08	142.02	78.37
S. Em. ±	0.012	0.02	0.86	2.43	0.39	0.35	3.33	2.79
CD (P=0.05)	0.03	0.06	2.52	7.13	NS	NS	NS	NS
Level of Potassium								
K0	0.46	1.04	22.39	66.55	27.3	10.93	132.22	68.46
K1	0.52	1.12	25.29	73.16	27.57	11.95	134.00	76.63
K2	0.58	1.15	29.73	73.40	28.99	12.96	146.12	83.26
S. Em. ±	0.015	0.02	1.05	2.98	0.48	0.43	11.97	3.42
CD (P=0.05)	NS	0.08	3.09	NS	1.41	1.28	NS	10.03
Interaction	-	-	Sig.	-	-	-	Sig.	-
CV%	9.93	8.74	14.15	14.53	5.96	12.70	10.29	15.57

Effect of Potassium on Potassium and Zinc content, uptake, periodical availability of potassium and KMB count

Effect of potassium application on treatment with potassium @ 40 kg ha^{-1} was recorded significantly the highest K content in straw (1.15%) and K uptake by grain (29.73 kg ha^{-1}) of wheat. There was no any significant effect on K content in grain and K uptake by straw of wheat. The increased K uptake by wheat due to K fertilization might be due to combined effect of increased dry matter yield and higher K concentration in grain and straw (Abedin *et al.*, 1998) [1].

The better nutritional environment helped the plant to absorb more K from soil consequently leading to higher photosynthates and their translocation to different plant parts would have enhanced the K content in both seed and straw. Similar results were observed in wheat by Yadav *et al.* (2012) [21]. However the application with 40 kg K2O ha^{-1} was recorded significantly the highest Zn content in grain (28.99 mg kg^{-1}) and straw (12.96 mg kg^{-1}) as compared to other treatments. Treatment application with potassium was found to be no significant in case of Zn uptake in grain by wheat. However the treatment application with 40 kg K2O ha^{-1} was recorded significantly the highest Zn uptake by straw (83.26 g ha^{-1}) as compared to other levels of potassium. Available potassium in soil at 30, 45, 60 DAS and at harvest of wheat was not increased significantly due to application of different potassium levels. The application of 40 kg K2O ha^{-1} (K2) recorded significantly the highest KMB count (9.6×106) followed by other treatment application with potassium.

Table 2: Effect of FYM, KMB and potassium levels on available potassium at different growth stages (kg ha^{-1}) and KMB count (1 × 106 cfu g $^{-1}$ soil) of wheat

Treatments	Periodical Availability of Potassium (kg ha-1)				KMB count (1×106 cfu g-1 soil)
	30 DAS	45 DAS	60 DAS	Harvest	
Level of FYM					
F0	276	271	265	259	8.2
F1	291	287	279	272	9.0
S. Em. ±	5.0	5.0	5.0	5.0	0.17
CD (P=0.05)	13	13	NS	NS	0.50
Level of KMB					
KMB0	277	273	267	260	8.03
KMB1	289	285	277	270	9.19
S. Em. ±	5	5.0	5.0	5.0	0.17
CD (P=0.05)	NS	NS	NS	NS	0.50
Level of Potassium					
K0	278	275	269	262	7.7
K1	283	279	271	264	8.5
K2	288	284	276	270	9.6
S. Em. ±	6	6.0	6.0	6.0	0.21
CD (P=0.05)	NS	NS	NS	NS	0.61
Interaction	-	-	-	-	-
CV %	6.89	6.93	7.89	8.31	8.43

Interaction effect

Significantly the highest potassium and zinc uptake by wheat grain (39.83 kg ha^{-1} and 171.26 g ha^{-1}) was found with the treatment combination F1KMB1K2 (FYM @10 t ha^{-1} with KMB along with potassium @ 40 kg ha^{-1}). In zinc uptake it was at par with treatment combination F1KMB1K0. The beneficial role of Zn in increasing CEC of roots helped in increasing absorption of nutrients from the soil. Further, the favorable effect of Zn on photosynthesis and metabolic process augmented the production of photosynthetic and their translocation to different plant parts including seed which ultimately increased the Zn concentration in seed. Similar results were also reported in wheat by Jain (2004) [10].

Table 3: Interaction effect of FYM, KMB and potassium levels on potassium and zinc uptake by wheat

FYM (t ha^{-1})	Potassium (kg ha^{-1})	KMB0 (without KMB)		KMB1 (with KMB)	
		Potassium	Zinc	Potassium	Zinc
F0	K0	17.96	118.21	18.75	128.06
	K1	20.61	115.23	25.82	128.74
	K2	26.42	144.77	26.29	127.52
F1	K0	24.08	131.37	28.77	151.26
	K1	28.27	146.78	26.46	145.26
	K2	26.38	140.93	39.83	171.26
S. Em. ±	K2O	2.10	Zn	8.16	
CD (P=0.05)		6.18		23.95	
CV%		14.15		10.29	

Conclusion

The results of the present study suggested that application of 10 t FYM ha^{-1} along with potassium mobilizing bacteria (KMB) and 40 kg K2O ha^{-1} was beneficial to enhance the potassium and zinc uptake by grain of wheat.

References

1. Abedin MJ, Saleque MA, Panullah GM, Mazid MA.

Evaluation of two concepts of fertilization for wheat in a calcareous soil of Bangladesh. Journal of plant nutrition, 1998;21(9):1843-1854.
2. Ahmad M, Nadeem SM, Naveed M, Zahir ZA. Potassium-solubilizing bacteria and their application in agriculture. In Potassium solubilizing microorganisms for sustainable agriculture. Springer, New Delhi. c2016, p.293-313.
3. Almeida HJ, Pancelli, MA, Prado RM, Cavalcante VS, Cruz FJR. Effect of potassium on nutritional status and productivity of peanuts in succession with sugar cane. Journal of soil science and plant nutrition. 2015;15(1):1-10.
4. Bakhshandeh, E, Pirdashti H, Lendeh KS. Phosphate and potassium-solubilizing bacteria effect on the growth of rice. *Ecological Engineering*. 2017;103:164-169.
5. Barker WW, Welch SA, Chu S, Banfield F. Experimental observations of the effects of bacteria on alumino silicates weathering. American Minerologist. 1998;83:1551–1563.
6. CecílioFilho AB, Feltrim AL, Mendoza Cortez JW, Gonsalves MV, Pavani LC, Barbosa JC. Nitrogen and potassium application by fertigation at different watermelon planting densities. Journal of soil science and plant nutrition. 2015;15(4)928-937.
7. Dobermann, A, Witt C, Abdulrachman S, Gines HC, Nagarajan, R, Son TT, Phung, CV. Soil fertility and indigenous nutrient supply in irrigated rice domains of Asia. Agronomy Journal. 2003;95(4):913-923.
8. Gallegos-Cedillo VM, Urrestarazu M, Álvaro JE. Influence of salinity on transport of Nitrates and Potassium by means of the xylem sap content between roots and shoots in young tomato plants. Journal of soil science and plant nutrition. 2016;16(4):991-998.
9. Hussain Z, Khattak RA, Irshad M, Mahmood Q, An P. Effect of saline irrigation water on the leachability of salts, growth and chemical composition of wheat (*Triticum aestivum* L.) in saline-sodic soil supplemented with phosphorus and potassium. Journal of soil science and plant nutrition. 2016;16(3):604-620.
10. Jain NK. Studies on phosphorus and zinc fertilization in wheat (*Triticum aestivum* L. emend. c2004
11. Fior, Paol. Their residual effect of pearlmillet (*Pennisetum glaucum* L. R.Br. emend. Stuntz.). Ph D Thesis, Rajasthan Agricultural University, Bikaner. c2004
12. Jat G, Majumdar SP, Jat NK. majumdar SP. Potassium and zinc fertilization of wheat in western arid zones of India. Indian Journal of Agronomy. 2013;58:67-71.
13. Parmar P, Sindhu SS. Potassium solubilization by rhizosphere bacteria: influence of nutritional and environmental conditions. Journal of Microbiol Research. 2013;3(1):25-31.
14. Sheng XF. Huang WY. Study on the conditions of potassium release by strain NBT of silicate bacteria. Scientia Agricultura Sinica. 2002;35(6), 673-677.
15. Sheng XF. Growth promotion and increased potassium uptake of cotton and rape by a potassium releasing strain of Bacillus adaphicus. Soil Biology and Biochemistry, 2005:37 (3), 1918- 1922.
16. Sheng XF, Xia JJ, Cheng J, Mutagenesis of the *Bacillus edaphicus* strain NBT and its effect on growth of chilli and cotton. Agriculture Science. 2003;32(3):258-265.
17. Singh P, Agrawal VK, Singh YV. Effect of potassium and FYM on growth parameters, yield and mineral composition of wheat (*Triticum aestivum* L.) inalluvial soil. Journal of Pharmacognosy and Phytochemistry. 2019;8(3):24-27.
18. Sparks DL. Potassium dynamics in soils. In Advances in soil science. Springer, New York, NY. c1987, p.1-63.
19. Sparks DL, Huang PM. Physical chemistry of soil potassium. Potassium in agriculture. c1985, p.201-276.
20. Sperberg JI. The incidence of apatite solubilizing organisms in the rhizosphere and soil. Australian Journal of Agricultural and Resource Economy. 1958;9:778.
21. Yadav SS, Tikkoo A, Singh JP. Effect of potassium on pearl millet-wheat Cropping system in coarse textured soils of Southern Haryana. Journal of the Indian Society of Soil Science. 2012;60(2):145-149.
22. Yang BM, Yao LX, Li GL, He ZH, Zhou CM. Dynamic changes of nutrition in litchi foliar and effects of potassium-nitrogen fertilization ratio. Journal of soil science and plant nutrition. 2015;15(1):98-110.