Effect of Levels and Time of Potassium Application on Potassium Uptake Pattern and Nutrients Status under Drill Sown and Transplanted Finger Millet

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ABSTRACT

An experiment was conducted in Agricultural and Horticultural Research Station (AHRS), Bavikere, Tarikere taluk during Kharif 2016 to evaluate the K uptake Pattern and availability of nutrients as affected by level and time of K application under drill sown and transplanted condition. The factors comprising of two methods of establishment (drill and transplanting), three levels of potassium application (25, 37.5 and 50 kg ha⁻¹) and two different time of application of potassium (basal and split). The results revealed that basal application of potassium (50 kg ha⁻¹) under transplanted condition registered higher K uptake at different growth stages and also lower available nutrients after the harvest of crop due to higher grain and straw yields.

Keywords
Potassium uptake, Drill, Transplanted, Finger millet, Available nutrients

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Introduction

Finger millet is an important minor millet crop grown in India and has the pride place of having highest productivity among millets. It is the staple food of the millions of the arid and semi arid tropics of the world. Potassium is the third most important macronutrient required for plant growth after nitrogen and phosphorous, and is one of the principle plant nutrients underpinning crop yield, production and quality determination. As potassium is involved in many physiological processes, its impact on water relations, photosynthesis, assimilate transport and enzyme activation can have direct consequences on crop productivity (Pettigrew, 2008) by regulating the opening and closing of stomata and therefore regulating moisture loss from the plant. For this reason, potassium is colloquially known as “poor-man’s irrigation” because it assists crops to achieve yields more effectively (Soil Quality Organization, SQO, 2015). Additionally potassium also plays a
significant role in photophosphorylation, turgor maintenance, photoassimilate transport from source tissues via phloem to sink tissues, stress tolerance and enzyme activation in plants (Usherwood, 2000). Potassium is considered to be a key osmoticum in plants as it provides water relations for plants making them to survive under drought situations. Potassium enhances water uptake of a plant to keep hold of cell turgor required for development and growth of a crop when it accumulates in growth of a plant (De La Guardia and Benlloch, 1980) and stomatal opening and potassium is considered to be mobile in plant and can be translocated against strong electrical and chemical gradients (Brar and Tiwari 2004). Potassium plays a remarkable role in transpiration, stomatal opening and closing and osmoregulation (Cakmak 2005, Millford and Johnson 2002).

The neglect of potassium application in India is evident from the highly imbalanced fertilizer consumption ratio in respect of potassium.

The crop removal of nutrients is well above additions resulting in continuous depletion of soil fertility. In the year 2020, the deficit of potassium in Indian agriculture is projected to be around 10 million tons per annum while, the estimates of Nitrogen and Phosphorous balances are positive. Development of practices to improve the efficiency of nutrients requires an understanding of the fate of the applied nutrient and their effect on crop production. Greater opportunities exist for increased crop production by increasing rate, timing and establishment methods. In case of finger millet also potassium nutrition is being neglected. Therefore, fertilizer recommendations aim at providing balanced nutrition to crops in order to produce maximum yield.

Materials and Methods

The present investigation was conducted at AHRS, Bhavikere, UAHS, Shivamogga (Karnataka) India, during 2016 under rainfed situations on deep red sandy loam soils to study the effect of different potassium levels and time of application on potassium uptake pattern and nutrients status under drill sown and transplanted finger millet. The initial soil pH was 5.56, EC: 0.067 dSm−1, organic carbon: 0.40 % (low), available nitrogen: 156.80 kg ha−1 (low), available phosphorus: 33.9 kg ha−1 (low) and available potassium: 163 kg ha−1 (medium). The experiment was laid out in a RCBD with factorial concept having three factors. The factors comprising of two methods of establishment (M1: Drill sown and M2: Transplanted), three levels of potassium application (K1: 25 kg/ha, K2: 37.5 kg/ha and K3: 50 kg/ha) and two different time of application of potassium (T1: 100% basal dose and T2: 50% basal and 50% top dress) and replicated three times with a gross plot size of 4.2 m x 3.4 m and net plot size of 3.6 m x 3.0 m. Drill sowing and transplanting is done on the same day to avoid the staggered harvesting. Fifty per cent of N and entire dose of P was applied at the time of sowing in the form of urea and di-ammonium phosphate, respectively based on the nutrient combinations. The remaining 50% N was top dressed at 30 days after sowing. The potassium was supplied in the form of muriate of potash as per the treatments. The finger millet cv. 'ML-365' was sown with a spacing of 30×10 cm and recommended dose of fertilizer is 50: 40: 25 kg ha−1 of N, P2O5, K2O was applied.

Results and Discussion

Data pertaining to potassium uptake pattern at different growth stages of the finger millet are presented in Table 1 and Fig. 1.
Establishment methods

Significantly higher uptake of potassium by plant at all the growth stages (33.12, 41.09, 45.70 and 52.04 kg ha\(^{-1}\) at 30 days, 60 days, 90 days and at harvest, respectively) were recorded with transplanted crop as compared to drill sown crop. Pronounced nutrient uptake with transplanted crop could be attributed to higher dry matter production. Spectacular increase in nitrogen, phosphorous and potassium uptake due to transplanting was earlier reported by Padhi et al., (2010).

Levels of potassium

Improved growth, yield attributes and yield of finger millet might be interpreted as the manifestation of higher nutrient uptake by the crop. Application of 37.5 kg K\(_2\)O ha\(^{-1}\) has recorded significantly higher uptake of potassium by plant at all the growth stages (34.99, 42.49, 47.15 and 53.77 kg ha\(^{-1}\) at 30 days, 60 days, 90 days and at harvest, respectively) as compared to application of 25 kg K\(_2\)O ha\(^{-1}\). The nutrient uptake is a function of biomass and nutrient concentration in plant. Thus, significant improvement in uptake of potassium might be attributed to their increased concentration in plant. Use of higher dose of potassium might have helped for good vegetative growth and root system, which increased the higher K uptake by plants and hence increased yield and yield components of finger millet. The present findings are close association with the report of Thippeswamy and Shivakumar (2000) and Shruthi et al., (2014).

Time of Potassium application

In the present study, time of application significantly influenced the growth parameters of finger millet crop. Basal application of potassium has recorded significantly higher uptake of potassium by plant at all the growth stages (33.25, 39.92, 44.59 and 50.93 kg ha\(^{-1}\), respectively) compared to split application. Potash behaves partly like nitrogen and partly like phosphorus. From the point of view of the rate of absorption, it is like nitrogen, being absorbed, up to the harvesting stage. But potash fertilizer like phosphate becomes available slowly. As such, it is always advisable to apply the entire quantity of potash at sowing time (Indrajit, 1998). The higher uptake of nutrients from the soil is attributed to higher dry matter accumulation. When the crop growth was superior the yield levels will be superior as reported by Venugopal et al., (2005), Shukla and Mishra (1998).

Potassium levels × time of application was found to be significant for potassium uptake at different growth stages. Basal application of 37.5 kg K\(_2\)O ha\(^{-1}\) recorded significantly higher potassium uptake by plant (42.59, 47.25 and 53.91 kg ha\(^{-1}\) at 60 days, 90 days and at harvest, respectively) compared to all other treatments and it was on par with the split application of 37.5 kg K\(_2\)O ha\(^{-1}\). More quantity of potassium nutrients along with recommended dose of nitrogen and phosphorous made available at early stages as basal dose in finger millet crop which is very important for the initiation of leaves for its viable functionality over time for carbohydrate production and also timely cell division orienting towards increase in tallness, which helps in maintaining further growth without nutrient stress. Higher nutrient uptake is well reflected in terms of higher grain and straw yield. Obviously this could be due to supply of more nutrients from basal application of nutrients and also due to higher uptake of nutrients by the crop. These results are in conformity with the findings of Channasapper et al., (1996).

The data pertaining to final nutrient status of soil has been depicted in Table. 1, the nutrient...
Retained in the soil after harvest of the crop mainly depends on both supply of nutrients through various sources and uptake by the crop. In general, higher the uptake of nutrients by crop lower will be the residual available nutrients in the soil. Further, higher the supply of nutrients higher is the residual soil nutrients. However, several factors influence the uptake as well as availability of nutrients. Final nutrient status was found low (163.07 kg N ha\(^{-1}\), 54.81 kg P\(_2\)O\(_5\) ha\(^{-1}\), 122.88 kg K\(_2\)O ha\(^{-1}\)) in transplanted condition as compared to drill sown crop. This might be due to higher grain and straw yields of crop, which results in extraction of the soil nutrients. Similar view was also expressed by Padhi et al., (2010).

Available nitrogen, phosphorous and potassium status of soil after the crop harvest was significantly influenced by the application of different levels of potassium. Significantly higher available N, P\(_2\)O\(_5\), K\(_2\)O was recorded in the treatment received 25 kg ha\(^{-1}\) of potassium (205.93, 72.98, 130.83 kg ha\(^{-1}\), respectively). While this treatment had taken up less N, P\(_2\)O\(_5\), K\(_2\)O than others thereby leaving behind more in the soil. Significantly lower available N, P\(_2\)O\(_5\), K\(_2\)O (145.30, 49.66, 120.94 kg ha\(^{-1}\), respectively) was recorded with the application of 37.5 kg ha\(^{-1}\) of potassium. This might be due to higher grain and straw yields of crop, which results in extraction of most of the soil nutrients. Similar views are expressed by Arulmozhiselvan et al., (2013).

**Fig. 1** Nitrogen, phosphorous and potassium uptake by total plant as influenced by method of establishment, different potassium levels and time of application

![Graph showing nitrogen, phosphorous and potassium uptake by total plant](image)
Table 1: Potassium uptake at different growth stages and Soil nutrient status after harvest of the finger millet as influenced by establishment methods, different potassium levels and time of application.

| Treatments | Straw at 30 days | Straw at 60 days | Straw at 90 days | N (kg ha⁻¹) | P (kg ha⁻¹) | K (kg ha⁻¹) |
|------------|-----------------|-----------------|-----------------|-------------|-------------|-------------|
| **Method of establishment** | | | | | | |
| M₁: Drill sown | 32.73 | 37.88 | 42.63 | 182.65 | 64.54 | 127.62 |
| M₂: Transplanting | 33.12 | 41.09 | 45.70 | 163.07 | 54.81 | 122.88 |
| **SEm±** | 0.43 | 0.16 | 0.10 | 5.60 | 1.17 | 0.20 |
| CD at 5% | NS | 0.47 | 0.30 | 16.43 | 3.45 | 0.58 |
| **Potassium levels** | | | | | | |
| K₁: Recommended dose 25 kg ha⁻¹ | 29.24 | 33.88 | 38.58 | 205.93 | 72.98 | 130.83 |
| K₂: 37.5 kg ha⁻¹ | 34.99 | 42.49 | 47.15 | 145.30 | 49.66 | 120.94 |
| K₃: 50 kg ha⁻¹ | 34.56 | 42.09 | 46.76 | 167.36 | 56.37 | 123.98 |
| **SEm±** | 0.52 | 0.198 | 0.12 | 6.86 | 1.17 | 0.24 |
| CD at 5% | 1.54 | 0.58 | 0.36 | 20.12 | 4.22 | 0.71 |
| **Time of application** | | | | | | |
| T₁: 100% basal | 33.25 | 39.92 | 44.59 | 165.93 | 57.94 | 124.00 |
| T₂: 50% basal and 50% top dress | 32.61 | 39.05 | 43.74 | 179.80 | 61.41 | 125.95 |
| **SEm±** | 0.43 | 0.16 | 0.10 | 5.60 | 1.17 | 0.20 |
| CD at 5% | NS | 0.47 | 0.30 | NS | 3.45 | 0.58 |
| **Method of establishment × Potassium levels** | | | | | | |
| M₁K₁ | 28.50 | 32.14 | 36.78 | 215.34 | 75.16 | 132.03 |
| M₁K₂ | 35.15 | 40.93 | 45.73 | 156.80 | 55.37 | 126.78 |
| M₁K₃ | 34.55 | 40.55 | 45.37 | 175.82 | 63.08 | 129.63 |
| M₂K₁ | 29.97 | 35.61 | 40.38 | 196.52 | 70.80 | 129.63 |
| M₂K₂ | 34.84 | 44.04 | 48.57 | 133.80 | 43.96 | 117.82 |
| M₂K₃ | 34.57 | 43.64 | 48.15 | 158.89 | 49.66 | 121.18 |
| **SEm±** | 0.74 | 0.28 | 0.18 | 9.70 | 2.04 | 0.34 |
| CD at 5% | NS | NS | NS | NS | NS | 1.01 |
| **Method of establishment × Time of application** | | | | | | |
| SEm± | 0.61 | 0.23 | 0.14 | 7.92 | 1.66 | 0.28 |
| CD at 5% | NS | NS | NS | NS | NS | NS |
| **Potassium levels × Time of application** | | | | | | |
| K₁T₁ | 29.98 | 34.95 | 39.63 | 198.61 | 71.81 | 130.28 |
| K₁T₂ | 28.50 | 32.81 | 37.53 | 213.25 | 74.16 | 131.37 |
| K₂T₁ | 35.05 | 42.59 | 47.25 | 135.89 | 48.32 | 120.15 |
| K₂T₂ | 34.93 | 42.38 | 47.05 | 154.71 | 51.00 | 121.72 |
| K₂T₃ | 34.71 | 42.22 | 46.89 | 163.28 | 53.69 | 123.20 |
| K₃T₁ | 34.40 | 41.96 | 46.63 | 171.43 | 59.06 | 124.77 |
| **SEm±** | 0.74 | 0.28 | 0.18 | 9.70 | 2.04 | 0.34 |
| CD at 5% | NS | 0.82 | 0.52 | NS | NS | NS |
| **Method of establishment × Potassium levels × Time of application** | | | | | | |
| SEm± | 1.051 | 0.40 | 0.25 | 13.72 | 2.88 | 0.49 |
| CD at 5% | NS | NS | NS | NS | NS | NS |
In the present study, time of application significantly influenced higher available nitrogen, phosphorous and potassium (179.80, 61.41 and 125.95 kg ha⁻¹) was noticed with split application of potassium compared to basal application. While this treatment had taken up less NPK than others thereby leaving behind more in the soil. This might be due to higher grain and straw yields of crop, which results in extraction of most of the soil nutrients. Similar views were also expressed by Ramachandrappa et al., (2014), Savitha et al., (2014).

In conclusion, recommended N, P₂O₅ and 150% K₂O as basal dose under transplanted condition referred higher nutrient uptake by crop and final soil nutrient status was found low under rainfed situations. Pronounced nutrient uptake with this treatment combination could be attributed to higher dry matter production and grain yields.

References

Arulmozhi Selvan, K., Elayarajan, M. and Sathya, S., 2013, Effect of long term fertilization and manuring on soil fertility, yield and uptake by finger millet on inceptisol. Madras Agric. J., 100 (4-6): 490-494.

Brar, M. S. and Tiwari, K. S., 2004, Boosting seed cotton yield in Punjab with potassium. Better Crops, 88: 28-30. Journal of Plant Nutrition and Soil Science., 168: 521-530.

Cakmak, I., 2005, the role of potassium in alleviating detrimental effects of abiotic stresses in plants. Journal of Plant Nutrition and Soil Science., 168: 521-530.

Channabasappa, S., Dineshkumar, M., Masthana Reddy, B. S. AND Manjunath Hebbar., 1996, Effect of split application of phosphorous and potassium on growth and yield of rice. Karnataka J. Agric. Sci., 11(1): 1-3.

DE LA Guardia, M. D. and Benlloch, M., 1980, Effects of potassium and gibberellic acid on stem growth of whole sunflower plants. Physiologia Plantarum., 49:443-448.

Inderjit et al., 1998, Managing soil fertility in organic farming systems. Canadian Journal of Botany., 76:1-5.

Millfrod, G. F. and Johnston, A. E., 2002, Potassium and nitrogen interactions in crop production. Proc. No: 615, International Fertilizer Society, York, UK.

Padhi, A. K., Jena, B. K. and Panigrahi, R. K., 2010, Performance of double cropping systems involving legume vegetables and finger millet under rain fed condition. Indian J. Agric. Res., 44 (1): 14 – 19.

Pettigrew, W. T., 2008, Potassium influences on yield and quality production for maize, wheat, soybean and cotton. Physiologia Plantarum., 133: 670-681.

Ramachandrappa, B.K., Satish, A., Dhanapal, G.N., Balakrishna Reddy, P.C., Shankar, M.A. and Srikanth Babu. P.N., 2014, Potassium nutrition on yield and economics of rainfed finger millet in Eastern Dry Zone of Karnataka. Ind. J. Soil Cons., 42(2): 188-195.

Savita, Dhanapal, G. N., Satish Kumar Verma, 2015, Influence of potassium on dry land finger millet productivity. Envi. Eco., 33(1): 6-9.

Shruthi, 2014, Management of phosphorus and potassium in finger millet under alfisols of Bangalore rural district in Karnataka. Ph.D. thesis, Univ. Agric. Sci., Bangalore, Karnataka (India). p. 16.

Shulk, A. K. and Mishra, R. R., 1998, Persistence of fertilizers on microbial population and enzyme activity field soil. Indian J. Agric. Sci., 68 (1):44-45.

Thippeswamy, H. M. and Shivakumar, B. G.,
2000, Effect of levels and time of potassium application on nitrogen and potassium uptake pattern in finger millet (Eleusine coracana G.). Ann. Agric. Res., 21(3): 441-442.

Usher Wood, N. R., 2000, The influence of potassium on cotton quality. Agri-Briefs, Agronomic News No.8. Spring

2000. Potash and Phosphate Institute. Norcross, GA, USA.

Venugopal, N. V., Shankar, M. A., Gajanana, G.N and Ganapati., 2005, Low till farming strategies and integrated plant nutrition supply for rain fed semi arid tropics. Annul progress report on dry land agriculture., p. 65-67.

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