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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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A B S T R A C T

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 (M_1: Drill sown and M_2: Transplanted), three levels of potassium application (K_1: 25 kg/ha, K_2: 37.5 kg/ha and K_3: 50 kg/ha) and two different time of application of potassium (T_1: 100% basal dose and T_2: 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, P_2O_5, K_2O 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_2O ha^{-1} has recorded 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_2O 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_2O 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_2O 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 Channabasappa *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 up 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_2O_5 ha^{-1}, 122.88 kg K_2O 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_2O_5, K_2O 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_2O_5, K_2O than others there by leaving behind more in the soil. Significantly lower available N, P_2O_5, K_2O (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

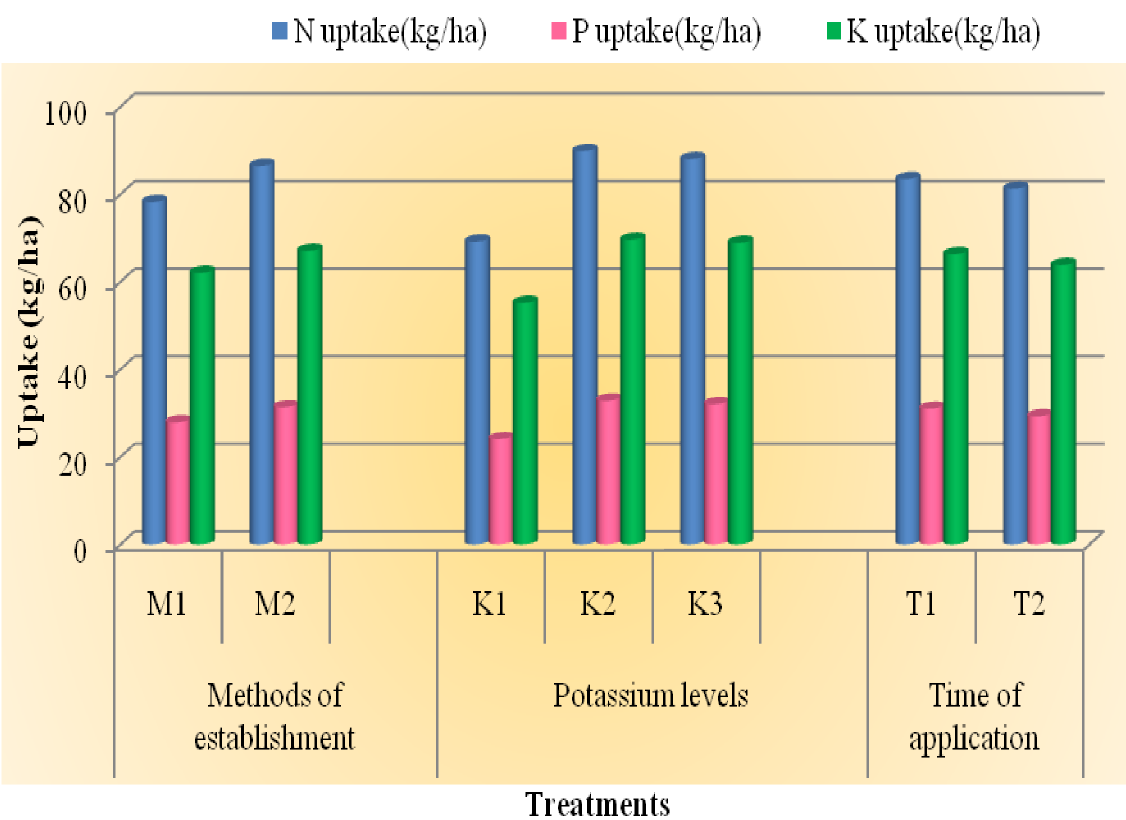

Table.1 Potassium uptake at different growth stages and Soil nutrient status after harvest of the finger millet as influenced by establishment methods, different potassium levels and time of application

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						
M_1 : Drill sown	32.73	37.88	42.63	182.65	64.54	127.62
M_2: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						
K_1: Recommended dose 25 kg ha^{-1}	29.24	33.88	38.58	205.93	72.98	130.83
K_2:37.5 kg ha^{-1}	34.99	42.49	47.15	145.30	49.66	120.94
K_3:50 kg ha^{-1}	34.56	42.09	46.76	167.36	56.37	123.98
SEm±	0.52	0.198	0.12	6.86	1.44	0.24
CD at 5%	1.54	0.58	0.36	20.12	4.22	0.71
Time of application						
T_1:100% basal	33.25	39.92	44.59	165.93	57.94	124.00
T_2:50% 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						
M_1K_1	28.50	32.14	36.78	215.34	75.16	132.03
M_1K_2	35.15	40.93	45.73	156.80	55.37	124.05
M_1K_3	34.55	40.55	45.37	175.82	63.08	126.78
M_2K_1	29.97	35.61	40.38	196.52	70.80	129.63
M_2K_2	34.84	44.04	48.57	133.80	43.96	117.82
M_2K_3	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						
K_1T_1	29.98	34.95	39.63	198.61	71.81	130.28
K_1T_2	28.50	32.81	37.53	213.25	74.16	131.37
K_2T_1	35.05	42.59	47.25	135.89	48.32	120.15
K_2T_2	34.93	42.38	47.05	154.71	51.00	121.72
K_3T_1	34.71	42.22	46.89	163.28	53.69	123.20
K_3T_2	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 125.95kg ha^{-1}) was noticed with split application of potassium compared to basal application. While this treatment had taken up less NPK than others there by 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, P_2O_5 and 150% K_2O 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.

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