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Status of different forms of potassium under foxtail millet crop as influenced by graded levels of potassium in *Alfisols* of Chikkaballapura region, Karnataka

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Abstract
The present investigation in relation to "effect of graded levels of potassium on different forms of potassium under foxtail millet cultivation in *Alfisols* of Chikkabalapura region, Karnataka" was carried out during *kharif* 2016 and 2017 at Devapalli village of Chintamani taluk, Chikkaballapura district, which comes under eastern dry zone of Karnataka. The experiment was conducted using Randomized complete block design with five potassium levels. Totally twelve treatments (recommended nitrogen, phosphorus (40 kg N & 40 kg P_2O_5) and 50 kg N, 45 kg P_2O_5 along with 5 levels of potassium, only recommended NP and absolute control) were tested under foxtail millet as a test crop. The results of the pooled data revealed that, application of recommended N, P_2O_5 with 40 kg K_2O ha^{-1} + 6 t of FYM (T_6) recorded higher grain yield (2266.07 kg ha^{-1}) and straw yield (3814.95 kg ha^{-1}) of foxtail millet in the both the years, which was found to be on par with the application of T_{11} (50 kg N, 45 kg P_2O_5 + 40 kg K_2O ha^{-1} + 6 t of FYM). Soil application of 50 kg potassium with 50 kg N and 45 kg P_2O_5 + 6 t of FYM ha^{-1} recorded the higher water soluble (6.53 mg kg^{-1}), exchangeable (72.10 mg kg^{-1}) and non-exchangeable K (208.08 mg kg^{-1}). Highest lattice (2308.59 mg kg^{-1}) and total K (2582.29 mg kg^{-1}) were recorded in T_7 which received recommended N, P_2O_5 + 50 kg K_2O ha^{-1} + 6 t of FYM in the post-harvest soils of foxtail millet.

Keywords: Potassium forms, foxtail millet, *Alfisols*

Introduction
Foxtail millet (*Setaria italica* L.) is one of the oldest cultivated cereal and the most economically important species of the Setaria genus. Foxtail millet commonly known as navane in Karnataka. It can be grown on dry lands even under aberrant weather condition when the major crops cannot be grown. It is also called as famine reserve and it is extensively grown under low rainfall area. Foxtail millet is the second most widely grown species of millet and the most important food crop in East Asia. In India, foxtail millet is important crop in arid and semi-arid regions. In South India, it has been a staple diet among people for a long time and it is a warm season crop, typically grown in late spring season and harvest for grain in 75–90 days (800–900 kg ha^{-1}).

Potassium is an essential macronutrient required for better development of plants. In addition to activation of numerous enzymes, potassium plays an important role in the maintenance of electrical potential gradients across cell membranes, generation of turgidity, major cation in the maintenance of cation-anion balances and also provides the winter hardness to the crops. Potassium comprises, on an average 2.6 per cent of the earth crust and the seventh most abundant element. The higher amount of soil potassium occurs in the potassium bearing minerals, such as mica and feldspars, the orthoclase makes up 16 per cent of the total potassium, biotite mica constitutes 3.8 per cent and muscovite mica contributes 1.4 per cent of the total potassium content and 98 per cent is bound in the mineral form, whereas 2 per cent is in soil solution and exchangeable form. Hence, in reality, the availability of potassium in soil is a complex phenomenon. The red soils of Southern Karnataka are natively rich in potassium, being not recommended for foxtail millet in eastern dry zone of Karnataka. However, long-term intensive cropping without its application resulted in low to medium status and reduced potassium supply to crop plants and consequently reduce the crop yields.

High crop K removal than K addition to soil by farmers and imbalanced use of NPK fertilizers contributed to large-scale K mining and K deficiency in soils and crops (Ramamurthy *et al*., 2017) [3]. Balanced and adequate fertilization is essential for increasing crop yields and ensuring sustainable agriculture. Foxtail millet being low nutrient demanding crop, but responds well for addition of potassium. Depleted soil potassium status due to higher crop removal as equal as or higher than nitrogen, without application of potassium fertilizers and cultivation of improved varieties of foxtail millet needs balancing potassium through external fertilizers. From this brief background, research work has been carried out to know the potassium supplying power of soil without application of potassium since several years and status of potassium forms with the application of different levels of potassium in *Alfisols* of Chikkaballapura region, Karnataka.

Material and Methods

The present experiment was laid out to study the different forms of potassium under foxtail millet by testing the different levels of potassium in low potassium soils of farmer's field at Devapalli village, Chintamani taluk and Chikkaballapura district of Eastern dry zone of Karnataka for two years from 2016 to 2018. Geographically it is located in the eastern part of the state, between 78º 18' 20.2" E longitude and 13º 56' 57.8" N latitude above the mean sea level. A composite surface (0-15cm) soil sample was drawn from the experimental site before initiation of experiment. The soil was air-dried, powdered and passed through 2 mm sieve and was analysed for initial physico-chemical properties and the results were given in Table 1. The soil type of experimental site was red sandy loam in texture, neutral in reaction (6.59) and low in soil organic carbon (0.47%). The soil was low in available nitrogen (136.42 kg ha^{-1}), phosphorus (16.62 kg ha^{-1}), potassium (119.84 kg ha^{-1}) and low in DTPA extractable zinc (0.43 mg kg^{-1}). The forms of potassium were analysed and the content was 6.34, 43.01, 123.58, 2208.32 and 2381.25 mg kg^{-1} of water soluble, exchangeable, non-exchangeable, lattice and total K, respectively. The field experiment was laid out in randomized complete block design with five potassium levels (K_2O at 10, 20, 30, 40 and 50 kg ha^{-1}) and totally ten treatments which includes absolute control (T_1), POP as per UAS (B) recommendation with 40 kg nitrogen and 40 kg phosphorus without potassium (T_2), RDF with 10, 20, 30, 40 and 50 kg K_2O (T_3, T_4, T_5, T_6 and T_7, respectively) and 50 kg nitrogen, 45 kg phosphorus along with same levels of potassium (T_8, T_9, T_{10}, T_{11} and T_{12}, respectively) and these treatments were replicated thrice. The land was prepared by ploughing and harrowing was carried using tractor. FYM @ 6.00 t ha^{-1} to soil 15 days prior to sowing was applied to all treatments except absolute control. The foxtail millet variety FIA 136 was sown at a spacing of 30×10 cm with a seed rate of 7.0 kg ha^{-1} and the full dose of P_2O_5 and K_2O was applied as per the treatment at the time of sowing in the form of single super phosphate and muriate of potash. 50 per cent of recommended dose of nitrogen was applied at the time of sowing and remaining 50 per cent of nitrogen was applied at 30 DAS in the form of urea. Gap filling was done one week after sowing where seeds are failed to germinate while excess seedlings germinated were thinned at 15 DAS to maintain optimum plant population. All the yield observations were recorded by adopting standard procedure. The experimental data on yield and yield parameters are subjected to analysis by using Fisher's method of "Analysis of Variance " (ANOVA) as outlined by Gomez and Gomez (1984) [9]. The level of significance was used in F test at 5 per cent and different forms of potassium were analysed by using the standard procures after harvest of the crop in both the years.

Results and Discussion

Pooled data of the two year's experimental results has been used to explain the effect of graded doses of potassium on yield of foxtail millet and different forms of potassium under foxtail millet crop in *Alfisols* of Chikkaballapura region of Southern Karnataka.

Grain and straw yield of foxtail millet

Potassium is one of three primary nutrients required by crops to complete their life cycle (Majumdar *et al*., 2012) [15]. In true sense it carries the meaning that potassium plays key role in enhancing the yield attributes and it ultimately reflected in significant increase in grain yield. The grain yield obtained due to graded doses of K was in ascending order of $T_1 > T_2 > T_{11} > T_6$ (Table 2 and Figure 1). Application of (T_6) recommended N, P_2O_5 + 40 kg K_2O ha^{-1} recorded more grain (2266.07 kg ha^{-1}) and straw (3814.95 kg ha^{-1}) yield of foxtail millet which was on par with T_{11} (2175.52 kg ha^{-1} of grain and 3704.96 kg ha^{-1} of straw) as compared to RDF as per UAS (B) package of practice (T_2) which recorded 1337.82 kg ha^{-1} of grain and 2615.44 kg ha^{-1} of straw yield. The lowest grain yield (1037.70 kg ha^{-1}) and straw yield (1802.98 kg ha^{-1}) was noticed in the absolute control (T_1). This clearly indicates that the response of foxtail millet with respect to grain and straw yield was more due to application of different levels of potassium from 10 to 40 kg K_2O ha^{-1}, beyond it crop yield was declined at 50 kg K_2O application. This showed that crop needs optimum nutrition for growth and development. This clearly indicated that the blanket recommendation of 100 per cent RDF as per UAS (B) recommendation without potassium application to foxtail millet crop is of no use in enhancing the yield specially in low P and K soils, where modification in the RDF is required through evaluation of different levels of potassium. These results are in conformity with Dakshina Murthy *et al*. (2015) [5] in rice. However, as the potassium levels increased from 0 to 40 kg K_2O ha^{-1}, increased in grain and straw yield was noticed. Potassium involved in activation of several enzymes, energy transformation and biochemical reactions for plant growth and development. Potassium supply increases cytokinin synthesis and photosynthates, ultimately which increases the grain yield of foxtail millet. Application of higher doses of K showed the significant difference over 2 years but application of 50 kg K_2O ha^{-1} has no effect over the 40 kg K_2O ha^{-1}. From the experiment, it cleared that application of 40: 40: 40 kg N, P_2O_5, K_2O ha^{-1} increased the yield of foxtail millet as compared to application of NP only. The similar results are noticed by Ramachandrappa *et al.* (2013) [20] that application of recommended N, P_2O_5 and 150 per cent recommended K (50: 40: 37.5 kg ha^{-1}) to finger millet has increased the mean grain and straw yields as compared to treatments having no K application. Similar findings were also reported by Islam *et al*. (2016) [11], Ashiana *et al*. (2017) [1] and Charate *et al*. (2018) [4].

Distribution of different forms of potassium as influenced by application of graded levels of potassium after harvest of foxtail millet crop

The different forms of potassium in soil *viz*., water soluble, exchangeable, non-exchangeable, lattice and total K are existing in dynamic equilibrium. Among these, water soluble and exchangeable K are most important for plant growth and development. Potassium is present in different minerals and formed by weathering of minerals. These forms in the soil after harvest of foxtail millet for two cropping sequence were analysed and expressed in mg kg^{-1}. The data pertaining to the effect of different levels of potassium on different forms of potassium are prescribed in the Table 3 and 4.

Water soluble potassium

The data showed (Table 3) that the contents of water soluble K in soil after harvest of foxtail millet differed significantly due to various levels of potassium application. The water soluble–K was observed in the range of 4.57 to 6.53 mg kg^{-1}. The highest (6.53 mg kg^{-1}) water soluble K was observed in the treatment T_{12}, which received the 50 kg N + 45 kg P_2O_5 + 50 kg K_2O ha^{-1} with FYM @ 6 t ha^{-1} followed by T_7, recommended N P_2O_5 + 50 kg K_2O ha^{-1} (6.30 mg kg^{-1}) as compared to (T_2) POP based on UAS (B) package (5.22 mg kg^{-1}) with only NP application, without K fertilizer and (T_1), absolute control (4.57 mg kg^{-1}). This might be due to application of higher (50 kg) level of K fertilizer, may be directly increased the K concentration in the soil solution, where the water soluble K is the representation of K in soil solution and production of organic acids from the added organic matter would have released the fixed potassium into available pool. Application of K fertilizer and FYM would enhanced the water soluble potassium to a considerable amount. In terms of depletion and build-up, application of 50 kg N + 45 kg P_2O_5 + 50 kg K_2O ha^{-1} with FYM @ 6 t ha^{-1}showed build up in water soluble–K. The similar results are found with Gangopadhyay *et al*. (2005) [8] and Sonu *et al*. (2018) [24].

Exchangeable Potassium

It is clearly evident from the Table 3, that exchangeable K content was significantly affected by various potassium levels. After harvest of foxtail millet, maximum value of exchangeable K (72.10 mg kg^{-1}) was noticed under 50 kg N + 45 kg P_2O_5 + 50 kg K_2O ha^{-1} (T_{12}) which was significantly superior over all the treatments. Where application of recommended N P_2O_5 + 50 kg K_2O ha^{-1} (T_7), recommended N P_2O_5 + 40 kg K_2O ha^{-1} (T_6) and 50 kg N + 45 kg P_2O_5 + 40 kg K_2O ha^{-1} (T_{11}) are statistically at par with status of exchangeable K of 71.10, 70.20 and 69.47 mg kg^{-1}, respectively. Which are superior to the treatment (T_2) POP based on UAS (B) package (62.99 mg kg^{-1}). However, minimum value of exchangeable K (57.69 mg kg^{-1}) was observed in absolute control (T_1) after harvest of foxtail millet crop. Addition of FYM enhanced the exchangeable K in soil by supplying K into soil solution (Harish, 2018). However, build-up of soil exchangeable K in foxtail millet cropping sequence might be due to the fact that application of FYM could increase the CEC of the soil which can hold more exchangeable K. The results are in accordance with Jagadeesh (2003) [12] and Divya (2013) [6].

Non - exchangeable K (1 N HNO_3 - K)

The data presented in Table 3, indicate that the boiling, 1 N HNO_3 extractable K differed significantly among the graded levels of potassium applied and the range was from 118.61 to 208.08 mg kg^{-1} after harvest of the foxtail millet crop. The highest (208.08 mg kg^{-1}) content of 1 N HNO_3- K was found in treatment (T_{12}) 50 kg N + 45 kg P_2O_5 + 50 kg K_2O ha^{-1} which significantly higher as compared to other treatments and which was on par with T_7, recommended N, P_2O_5 + 50 kg K_2O ha^{-1} (196.29 mg kg^{-1}). The lowest value was recorded in the absolute control (T_1). The lower values of non-exchangeable K were recorded in all the treatments with different levels of potassium as compared to initial (123.58 mg kg^{-1}). The reason might be due to replenishment of water soluble and exchangeable K in soil by release of K from non-exchangeable K and through added fertilizers. The forms of potassium exhibit a dynamic equilibrium among them in the soil. (Swamanna, 2015) [25]. The added FYM might have decreased the fixation of potassium in soil clay lattice by releasing the organic acids during mineralization of FYM and uptake of potassium by crop might be from the fixed portion of soil potassium. Further it can be presumed that the quantity of K released from FYM could not meet out the requirement of the crops (Manoj kumar, 2016) [16].

Lattice K

Due to application of graded levels of potassium, lattice potassium in soil was found to be significant after harvest of foxtail millet (Table 4). The numerically higher (2308.59 mg kg^{-1}) lattice potassium was recorded with treatment application of recommended N, P_2O_5 + 50 kg K_2O ha^{-1} along with 6 t of FYM (T_7) to the foxtail millet followed by T_6, T_{11} and T_{12}. The lower lattice K was recorded in the absolute control (T_1, 1934.76 mg kg^{-1}). The higher potassium application along with NP and FYM was recorded significant variation in lattice K as compared to (T_2) application of NP only as per UAS (B) package (2050.07 mg kg^{-1}). Application of higher dose of potassium with FYM might have increased the mineral K in the soil, which may be due to weathering of K bearing minerals by organic acids released during decomposition of FYM and organic manures also improves the soil structure (Sharma *et al.*, 2007) [23]. These results are in accordance with Kundu *et al*. (2014) [13].

Total potassium

The total potassium varied with the application of different levels of potassium to the foxtail millet crop and effect was found to be significant (Table 4). The significant higher (2582.29 mg kg^{-1}) and lower (2115.63 mg kg^{-1}) total potassium was recorded with the application of 40 kg N + 40 kg P_2O_5 + 50 kg K_2O along with FYM @ 6 t ha^{-1} (T_7) and absolute control (T_1), respectively. The potassium applied treatments from T_3 to T_{12} was found to be superior in total potassium content as compared to the without K application T_2, (only NP as per UAS (B) POP) and absolute control (T_1). This may be due to lack of external application of potassium fertilizers for several years under intensive cropping system and crop uptake (Brij *et al*. 2012) [2]. The higher total potassium was recorded in T_7, might be due to presence of higher K bearing minerals and/or external addition of potassic fertilizers along with FYM to meet the crop demand (Pal *et al.* 2001) [18]. The total K depends on amount of clay and mineral type or K bearing minerals in soil (Mushtaq and Raj, 2008) [17]. Among the different forms of potassium studied in the present investigation through foxtail millet cropping sequence, the water soluble, exchangeable and non-exchangeable potassium forms were found to be low as compared to lattice and total K. This might be due the continuous cropping without addition of external potassic fertilizers and higher removal of potassium by crop. The distribution of potassium fractions in the order of water soluble K < exchangeable K < non-exchangeable K < lattice K < total K and this mainly due to depletion of K by crop uptake.

Effect of graded levels of potassium on available NPK status after harvest of foxtail millet

The available N, P_2O_5 and K_2O content in soil after the harvest of foxtail millet crop in both the years has been significantly differed due to application of different levels of K (Table 5 and Figure 2).

The lowest (126.53, 17.11 & 132.75 kg ha^{-1}) and highest (153.11, 38.93 & 166.56 kg ha^{-1}) available N, P_2O_5 and K_2O contents in the soil after harvest of foxtail millet crop were recorded by T_1 (absolute control) and T_{12} (50 kg N + 45 kg P_2O_5 + 50 kg K_2O ha^{-1}), respectively. The nitrogen, phosphorus and potassium status were highest in T_{12}, which were on par with T_7 (147.28, 37.70 & 164.17 kg ha^{-1} of N, P_2O_5 and K_2O, respectively). These treatments were superior as compared to POP of UAS (B), T_2. Which clearly indicates that higher potassium levels were beneficial to nitrogen and phosphorus availability by its synergism. Among the different levels of potassium applied to the foxtail millet crop in the both the years, the highest potassium dose (50 kg ha^{-1}) recorded higher nitrogen, phosphorus and potassium in post-harvest soil, it may be due to crop responded up to 40 kg ha^{-1} of potassium application with respect to biomass production and crop yield. Due to higher dose of potassium application along with FYM might have improved the microbial activity to fix more nitrogen and even though, the mineralization of FYM, released the inorganic nitrogen from organic forms in to soil besides N in organic form is less prone to leaching and volatilization losses. Similar findings were reported by Uddin *et al*. (2013) [26], Sandhu and Mahal (2014) [22].

The higher available phosphorus in T_{12} which received N (50 kg), P_2O_5 (45 kg) and K_2O (50 kg ha^{-1}) along with FYM @ 6 tones might be due to the release of organic acids during microbial decomposition of FYM which helped in the solubility of native phosphates thus increasing available phosphorus. The applied organic matter may have led to formation of coating on the sesquioxide clay minerals, because of which the phosphate fixing capacity of soil is reduced in FYM treated plots (Pallavi *et al*., 2016) [19]. Besides FYM itself could contributed the 0.21 percent of P_2O_5 to the available pool upon mineralization (Chandrakala *et al*., 2017) [3]. Application of K increases the root activity of the growing plants considerably which resulted in the greater absorption and utilization of P have ultimately increased the P uptake (Magare *et al*., 2018) [14]. The control recorded least available phosphorus might be due to crop uptake without application of any fertilizers.

Wherever there is no application of potassium, the depletion of potassium was observed and available K was depleted in either no K (T_1 & T_2) or reduced dose of K fertilizer treatments. Continuous omission of K in crop nutrition has caused mining of its native pools which has resulted in the decreased crop yields (Vaghani *et al*., 2010) [27]. The available K decreased with advancement in crop growth, the lowest being recorded at harvest due to crop removal in T_6 & T_{11}. Among treatments, the combined application of FYM @ 6 t ha^{-1} with 50 kg N, 45 kg P_2O_5 and 50 kg K_2O (T_{12}) recorded highest soil available potassium. Such enhanced soil available K status might be due to the application of FYM that generally contains higher amounts of K (0.5% K_2O) and the reduction of K fixation and release of K from inter lattice space of clay minerals due to interaction of organic matter with clay (Robiul *et al*., 2009) [21]. Organic acids of different strength and composition produced during decomposition of applied organic manures could possibly solubilize the fixed potassium from clay matrix resulting an increased availability of K to crop and direct effect of applied potassium fertilizers during crop growth. Similar results were also recorded by Ramachandrappa *et al*., (2013) [20] and Gajanand *et al*., (2014) [7].

Table 1: Initial physico-chemical properties of the experimental soil

Sl. No	Parameters	Values obtained
1	Sand (%)	64.20
2	Silt (%)	19.50
3	Clay (%)	16.10
4	Textural class	Sandy loam
5	pH (1:2.5)	6.59
6	EC (1:2.5) (dSm^{-1})	0.10
7	CEC (c mol (p^+) kg^{-1}	14.37
8	Soil organic carbon (SOC) (%)	0.47
9	Available N (kg ha^{-1})	136.42
10	Available P_2O_5 (kg ha^{-1})	16.62
11	Available K_2O (kg ha^{-1})	119. 84
12	Available S (mg kg^{-1})	46.69
13	DTPA extractable Zn (mg kg^{-1})	0.43
14	Water soluble K (mg kg^{-1})	6.34
15	Exchangeable K (mg kg^{-1})	43.01
16	Non-Exchangeable K (mg kg^{-1})	123.58
17	Lattice K (mg kg^{-1})	2208.32
18	Total K (mg kg^{-1})	2381.25

Table 2: Effect of different levels of potassium on grain yield and straw yield of foxtail millet during 2016 and 2017.

Treatments	Grain yield (kg ha^{-1})			Straw yield (Kg ha^{-1})		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1: Absolute control	1067.46	1007.94	1037.70	1849.87	1756.08	1802.98
T_2: POP based on UAS (B) package	1333.57	1342.06	1337.82	2745.30	2485.58	2615.44
T_3: Rec. N P_2O_5+ 10 kg K_2O ha^{-1}	1367.62	1449.21	1408.41	2940.67	2747.49	2844.08
T_4: Rec. N P_2O_5 + 20 kg K_2O ha^{-1}	1409.13	1582.14	1495.63	3146.36	3149.34	3147.85
T_5: Rec. N P_2O_5 + 30 kg K_2O ha^{-1}	1782.14	1863.89	1823.02	3280.03	3581.75	3430.89
T_6: Rec. N P_2O_5 + 40 kg K_2O ha^{-1}	2225.00	2307.14	2266.07	3778.31	3851.59	3814.95
T_7: Rec. N P_2O_5 + 50 kg K_2O ha^{-1}	1820.63	1918.65	1869.64	3324.87	3498.41	3411.64
T_8: 50 kg N + 45 kg P_2O_5 + 10 kg K_2O ha^{-1}	1468.25	1506.75	1487.50	3073.81	3096.43	3085.12
T_9: 50 kg N + 45 kg P_2O_5 + 20 kg K_2O ha^{-1}	1511.90	1728.97	1620.44	3172.69	3118.25	3145.47
T_{10}: 50 kg N + 45 kg P_2O_5 + 30 kg K_2O ha^{-1}	1740.08	2006.75	1873.41	3231.35	3362.70	3297.02
T_{11}: 50 kg N + 45 kg P_2O_5 + 40 kg K_2O ha^{-1}	2120.08	2230.95	2175.52	3691.80	3718.12	3704.96
T_{12}: 50 kg N + 45 kg P_2O_5 + 50 kg K_2O ha^{-1}	1997.30	2090.48	2043.89	3293.52	3394.58	3344.05
S.E.m ±	72.97	61.14	51.52	98.20	89.36	65.63
CD @ 5 %	214.01	179.31	151.09	288.00	262.08	192.49

Note: 6 tonnes of recommended FYM ha^{-1} was applied to all treatments except T_1: Control

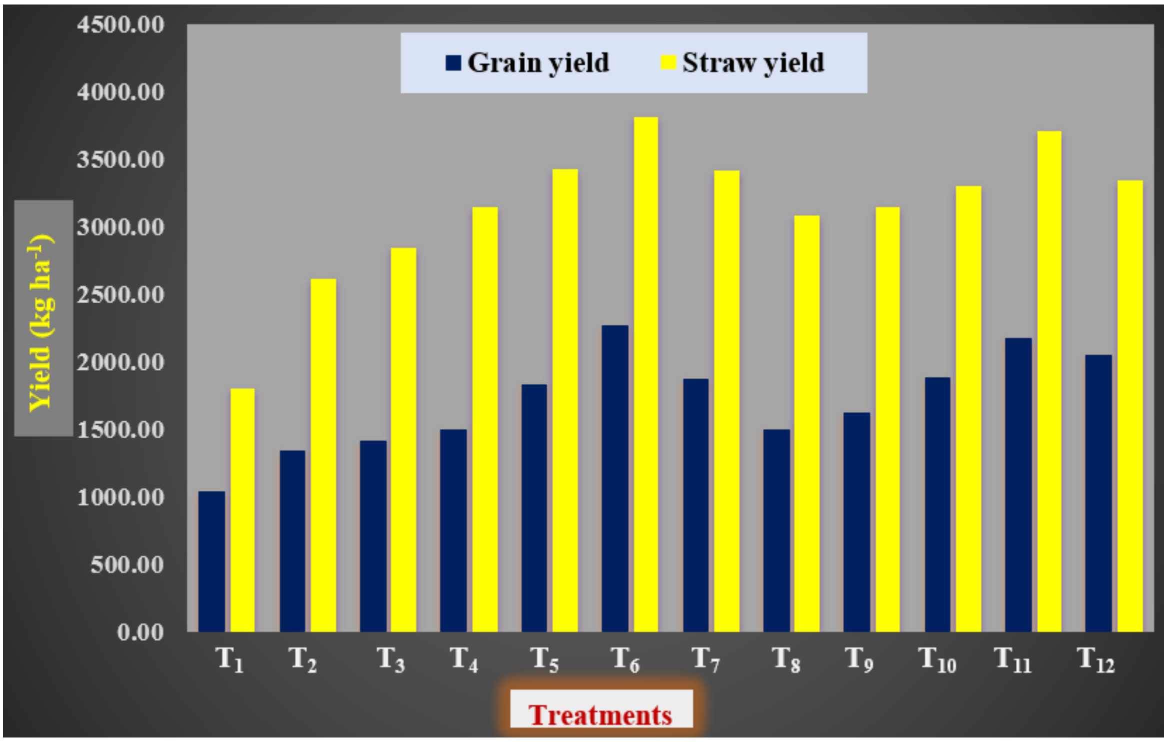

Fig 1: Effect of different levels of potassium on grain and straw yield (kg ha^{-1}) of foxtail millet

Table 3: Effect of different levels of potassium on water soluble K, exchangeable K and non-exchangeable K in post-harvest soil of foxtail millet during 2016 and 2017

Treatments	Water soluble K			Exchangeable K			Non-exchangeable K		
	mg kg^{-1}								
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1	4.40	4.73	4.57	58.75	56.63	57.69	127.16	110.05	118.61
T_2	5.39	5.05	5.22	64.01	61.96	62.99	153.70	130.56	142.13
T_3	5.37	5.53	5.45	64.31	63.25	63.78	171.72	159.20	165.46
T_4	5.39	6.40	5.90	65.42	65.00	65.21	171.14	181.14	176.14
T_5	5.49	6.73	6.11	69.56	67.21	68.38	186.66	174.64	180.65
T_6	5.35	6.86	6.11	71.25	69.16	70.20	197.80	168.72	183.26
T_7	5.67	6.94	6.30	72.18	70.03	71.10	211.90	180.68	196.29
T_8	5.20	6.22	5.71	63.24	61.17	62.21	151.04	165.10	158.07
T_9	5.12	6.44	5.78	65.81	63.52	64.67	156.72	146.42	151.57
T_{10}	5.21	6.76	5.98	67.61	65.47	66.54	172.04	155.28	163.66
T_{11}	5.32	7.10	6.21	70.17	68.76	69.47	189.68	165.96	177.82
T_{12}	5.81	7.24	6.53	73.47	70.73	72.10	195.08	221.08	208.08
S.E.m ±	0.13	0.23	0.14	0.82	0.74	0.55	6.06	9.10	4.67
CD @ 5 %	0.39	0.66	0.41	2.42	2.16	1.60	17.79	26.69	13.71

Table 4: Effect of different levels of potassium on lattice K and total K in post-harvest soil of foxtail millet during 2016 and 2017

Treatments	Lattice K			Total K		
	mg kg^{-1}					
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1	2109.69	1759.83	1934.76	2300.00	1931.25	2115.63
T_2	2283.14	1817.01	2050.07	2506.25	1914.58	2210.42
T_3	2321.10	1831.60	2076.35	2562.50	1939.58	2251.04
T_4	2308.04	1884.21	2096.12	2550.00	1993.75	2271.88
T_5	2388.29	1907.67	2147.98	2650.00	2156.25	2403.13
T_6	2484.57	2009.15	2246.86	2756.25	2306.25	2531.25
T_7	2554.00	2063.19	2308.59	2843.75	2320.83	2582.29
T_8	2293.02	2048.76	2170.89	2512.50	2281.25	2396.88
T_9	2216.10	2052.37	2134.23	2443.75	2268.75	2356.25
T_{10}	2261.39	2078.74	2170.07	2506.25	2306.25	2406.25
T_{11}	2247.33	2226.93	2237.13	2512.50	2468.75	2490.63
T_{12}	2322.91	2147.06	2234.99	2600.00	2393.75	2496.88
S.E.m ±	75.95	73.02	52.30	72.88	73.49	51.83
CD @ 5 %	222.77	214.17	153.39	213.74	215.53	152.02

Table 5: Effect of different levels of potassium on post-harvest soil available nitrogen, phosphorus and potassium under foxtail millet during 2016 and 2017

Treat ments	Available Nitrogen			Available Phosphorus			Available Potassium		
	Kg ha^{-1}								
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1	125.44	127.62	126.53	16.21	18.00	17.11	132.78	132.72	132.75
T_2	130.81	133.54	132.18	19.70	21.47	20.58	144.67	145.08	144.87
T_3	132.71	137.14	134.93	21.96	27.35	24.65	145.33	148.48	146.91
T_4	134.00	140.64	137.32	24.98	30.84	27.91	147.86	153.29	150.58
T_5	138.51	143.19	140.85	26.90	32.61	29.76	157.20	158.62	157.91
T_6	140.37	148.40	144.39	30.70	35.36	33.03	161.02	163.17	162.09
T_7	142.69	151.87	147.28	34.86	40.55	37.70	163.13	165.20	164.17
T_8	131.84	135.43	133.63	25.24	31.85	28.55	142.93	144.46	143.70
T_9	135.38	138.29	136.84	28.34	32.89	30.62	148.73	149.99	149.36
T_{10}	140.73	142.77	141.75	32.24	34.81	33.52	152.80	154.73	153.76
T_{11}	144.34	147.64	145.99	34.96	36.62	35.79	158.58	162.51	160.54
T_{12}	150.66	155.57	153.11	36.57	41.28	38.93	166.05	167.08	166.56
S.E.m ±	1.85	2.48	1.79	1.57	1.13	1.09	1.86	1.63	1.23
CD @ 5 %	5.44	7.28	5.24	4.59	3.32	3.20	5.46	4.79	3.60

Legend

T_1: Absolute control
T_2: POP based on UAS (B) package
T_3: Rec. N P_2O_5+ 10 kg K_2O ha^{-1}
T_4: Rec. N P_2O_5+ 20 kg K_2O ha^{-1}
T_5: Rec. N P_2O_5+ 30 kg K_2O ha^{-1}
T_6: Rec. N P_2O_5+ 40 kg K_2O ha^{-1}
T_7: Rec. N P_2O_5+ 50 kg K_2O ha^{-1}
T_8: 50 kg N + 45 kg P_2O_5 + 10 kg K_2O ha^{-1}
T_9: 50 kg N + 45 kg P_2O_5 + 20 kg K_2O ha^{-1}
T_{10}: 50 kg N + 45 kg P_2O_5 + 30 kg K_2O ha^{-1}
T_{11}: 50 kg N + 45 kg P_2O_5 + 40 kg K_2O ha^{-1}
T_{12}: 50 kg N + 45 kg P_2O_5 + 50 kg K_2O ha^{-1}

Note: 6 tonnes of recommended FYM ha^{-1} was applied to all treatments except T_1: Control

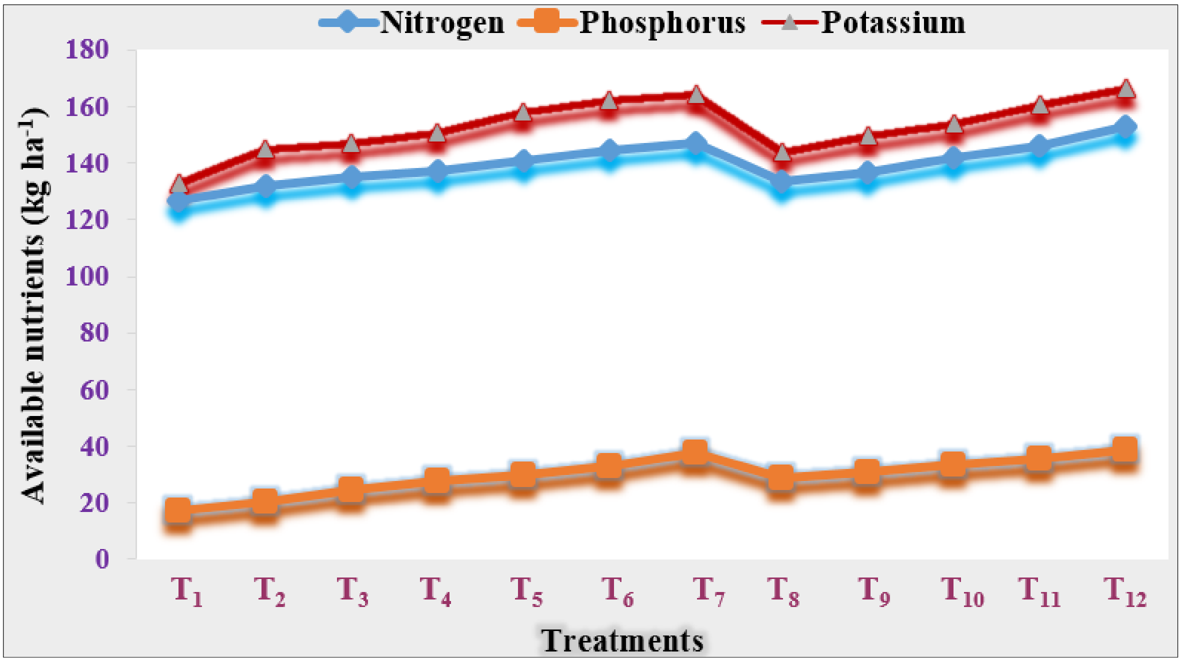

Fig 2: Effect of different levels of potassium on available nitrogen, phosphorus and potassium (kg ha^{-1}) in post-harvest soil of foxtail millet

Conclusion

Potassium fractions studied in the post-harvest soil of foxtail millet for the two years noticed that, the potassium forms *viz.*, water soluble, exchangeable, non-exchangeable, lattice and total K were significantly varied due to application of graded levels of potassium. Among the different forms in soil, total K was dominant, lattice K content was occupied 90 per cent of total K and water soluble K fraction was recorded low in post-harvest soil of foxtail millet crop. Application of 50 kg N, 45 kg P_2O_5 + 50 kg K_2O with 6 tonnes of FYM ha^{-1} (T_{12}) to foxtail millet was recorded significantly higher values with respect to different K fractions. The effect of application of graded levels of potassium to foxtail millet, the potassium fractions content was in the order of total K > lattice K > non-exchangeable K > exchangeable K > water soluble K in post-harvest soil. Application of nitrogen @ 40 kg, phosphorus @ 40 kg and potassium @ 40 kg ha^{-1} with 6 t of FYM is most optimum dose for realizing higher yield of foxtail millet in *Alfisols* of Eastern dry zone of Karnataka.

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