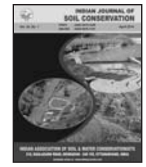
Vol. 42, No. 2, pp 188-195, 2014
Indian Journal of Soil Conservation
Online URL:http://indianjournals.com/ijor.aspx?target=ijor:ijsc&type=home



Potassium nutrition on yield and economics of rainfed finger millet in eastern dry zone of Karnataka

B.K. Ramachandrappa[1], A. Sathish[1,3], G.N. Dhanapal[1], P.C. Balakrishna Reddy[1], M. A. Shankar[2] and P.N. Srikanth Babu[1]

[1]*All India Co-ordinated Research Project for Dryland Agriculture, Gandhi Krishi Vigyan Kendra, Bangalore-560 065;*
[2]*Directorate of Research, University of Agricultural Sciences, Bangalore-560 065, Karnataka.*
[1]*E-mail: a_sathish@rediffmail.com*

ARTICLE INFO

Article history :
Received : July, 2013
Revised : March, 2014
Accepted : April, 2014

Key words :
Nutrient balance,
Potassium management,
Rainfed finger millet,
Sustainability

ABSTRACT

In rainfed agriculture, application of potassium is neglected by most of the farmers in finger millet. A field experiment was conducted from 2009 to 2011 during *kharif* at the All India Coordinated Research Project for Dryland Agriculture, GKVK, Bangalore under rainfed situation on deep, yellowish red, sandy loam soils to study the response of finger millet to the application of different grades and time of application of potassium. The studies were also conducted at farmer's field. The results have clearly showed the importance of potassium in finger millet, when applied in conjunction with recommended N (50 kg ha^{-1}) and P (40 kg ha^{-1}). Application of 150% of recommended K (37.5 kg ha^{-1}) to finger millet significantly increased the grain yields (3,857 kg ha^{-1}) and straw yields (8,125 kg ha^{-1}), as compared to the yields obtained with the recommended K (25 kg ha^{-1}) application (3,380 and 7,651 kg ha^{-1}, respectively). Application of FYM or *Gliricidia sepium* registered significantly lower grain yield compared to application to 150% of recommended K. Further, when applied as basal dose, it recorded highest benefit: cost ratio and rain water productivity (3.26 and 9.98 kg ha^{-1} mm, respectively) indicating higher sustainability over other treatments with a sustainability yield index of 0.908. Similar results were obtained on farmers' field also. Application of potassium more than the recommended dose registered higher NPK uptake at the end of third year. The nutrient balance worked out for NPK was positive when potassium was applied at higher rate as basal dose along with recommended N and P.

1. INTRODUCTION

Finger millet is one of the important cereals grown on the *Alfisol* of Southern Karnataka. The productivity of crop is limited due to imbalance in nutrients coupled with adverse climatic conditions. Majority of the area is under dryland situation with soils having low to medium in potassium. Inadequate application of potassium (K) combined with excess application of nitrogen (N) is a serious problem in modern intensive agricultural production systems. It leads to large N losses, environmental pollution and low nitrogen use efficiency (NUE) (Vasuki *et al.*, 2009; Srinivasarao, 2010). At the beginning of scientific crop production, the potassium was not recommended to dryland crops. As a consequence of intensive monocropping in the rainfed areas, potassium @ 25 kg ha^{-1} has been advocated to finger millet in the later years (Anon., 2006). Further, with the release of improved high yielding varieties of finger millet, the current recommendation is found to be inadequate. K application has been neglected in many developing countries, including India, which has resulted in soil K depletion in agricultural ecosystems and a decline in crop yields (Regmi *et al.*, 2002; Ladha *et al.*, 2003; Panaullah *et al.*, 2006; Lal *et al.*, 2007). Higher yields and crop quality can be obtained at optimal N: K ratios. K is an essential macronutrient required for proper development of plants. In addition to activation of numerous enzymes, K plays an important role in the maintenance of electrical potential gradients across cell membranes and the generation of turgor (Khanna-Chopra *et al.*, 1994). It is also essential for photosynthesis, protein synthesis, and regulation of stomatal movement and is the major cation in the maintenance of cation-anion balances (Marschner, 1995). A field study was conducted from 2009 to 2011 at the AICRPDA, GKVK, Bangalore under rainfed situation to study the response of finger millet to different levels and time of potassium application. Simultaneously, studies were conducted at farmer's field in Kanakapura taluk, Ramanagara District.

2. MATERIALS AND METHODS

Details of Location and Soil

A field experiment was conducted from 2009 to 2011 during *kharif* at the All India Coordinated Research Project for Dryland Agriculture, GKVK, Bangalore under rainfed situation on deep, yellowish red, sandy loam soils to study the response of finger millet to the application of different grades and time of application of potassium. The initial soil pH was 5.70, EC: 0.07 dSm^{-1}, organic carbon: 0.46% (low), available nitrogen: 159 kg ha^{-1}(low), available phosphorus: 60 kg ha^{-1} (high) and available potassium: 110 kg ha^{-1}(low). The experiment was laid out in a randomized block design with nine treatments (different levels and time of potassium application) and replicated three times with a gross plot size of 6.0 m × 5.4 m and net plot size of 5.4 m × 4.8 m. Treatment details are T_1: Rec. NP + Zero K; T_2: Rec. FYM (10 t ha^{-1}); T_3: *Gliricidia sepium* (7 t ha^{-1}); T_4: Rec. N, P + rec. K in one dose (basal); T_5: Rec. N, P + rec. K in two splits; T_6: Rec. N, P + 150% of rec. K in one dose (basal); T_7: Rec. N, P + 150% of rec. K in two splits; T_8: Rec. N, P + 200% of rec. K in one dose (basal); T_9: Rec. N, P + 200% of rec. K in two splits.

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 in the form of urea. The potassium was supplied in the form of muriate of potash as per the treatments. The average composition of FYM consisted of 0.54, 0.35 and 0.63% N, P and K, respectively while *Gliricidia sepium* contained 0.68, 0.16 and 0.80% N, P and K, respectively. The organic manure to supply required quantity of nitrogen was used in the experiment. The finger millet cv. 'GPU-28' was sown with a spacing of 30×10 cm. All agronomic practices were carried out as per the schedule.

Distribution of Rainfall during Cropping Seasons

The earliest date of sowing of finger millet was on 17th July in 2010, while the latest was on 5th August in 2009. The earliest date of harvest of the crop was on 16th November in 2010, while the latest was on 28th November in 2009. The crop had a minimum duration of 114 days in 2011 compared to maximum of 123 days in 2010 with mean of 118 days (CV of 4.0%). The rainfall received from July to November was in the range of 466.3 mm in 2009 to 638.0 mm in 2010 with mean of 556.9 mm (CV of 15.5%). July received a mean rainfall of 97.7 mm (CV of 44.4%); while August received a mean rainfall of 171.7 mm (CV of 42.1%). September received a mean rainfall of 126.9 mm (CV of 92.0%); while October received a mean rainfall of 91.7 mm (CV of 58.8%). November received 68.9 mm (CV of 75.3%) during 2009 to 2011. The mean maximum rainfall of 171.7 mm was received in August with CV 42.1% while minimum was in July (97.7 mm) with CV 44.4%. The details of crop growing period, monthly rainfall of July to November, date of sowing and harvest of finger millet during 2009 to 2011 are given in Table 1.

Analysis of Data

The data on growth, yield attributes and yield was recorded and subjected to statistical analysis. The economics of the system was worked out considering the prevailing cost of inputs and price of output. Finger millet grain and straw sample were collected, dried, powdered and used for estimating the N, P and K contents. The nitrogen content in the grain and straw was estimated by Micro Kjeldhal method (Jackson, 1967) and expressed in

Table: 1
Monthly rainfall (mm) and crop growing period (days) of finger millet at Bangalore

Year	DOS	DOH	CGP	July	Aug.	Sept.	Oct.	Nov.	CRF
2009	5-Aug	28-Nov	116	55.6	106.8	231.7	29.6	42.6	466.3
2010	17-Jul	16-Nov	123	142.2	158.6	89.4	119.2	128.6	638.0
2011	28-Jul	18-Nov	114	95.4	249.7	59.6	126.4	35.4	566.5
Minimum	-	-	114	55.6	106.8	59.6	29.6	35.4	466.3
Maximum	-	-	123	142.2	249.7	231.7	126.4	128.6	638.0
Mean	-	-	117.7	97.7	171.7	126.9	91.7	68.9	556.9
S.D.	-	-	4.7	43.3	72.3	92.0	53.9	51.9	86.2
C.V. (%)	-	-	4.0	44.4	42.1	72.5	58.8	75.3	15.5

DoS-Date of sowing; DoH-Date of harvesting; CGP-Crop growth period; CRF-cumulative rainfall percentage on dry weight basis. The phosphorus and potassium in the plant sample was digested in di-acid mixture (900 ml concentrated nitric acid + 400 ml of perchloric acid) as described by Piper (1966) and estimated by Vanadomolybdo phosphoric yellow colour method (Jackson, 1967) and flame photometer method (Jackson, 1967), respectively. The plant uptake of nutrients was expressed in percentage on dry weight basis while the crop removal was calibrated using grain and straw yield data and nutrient balance were worked out.

Soil samples were collected after the harvest of finger millet and analyzed for different chemical properties. A representative portion of each soil sample was air dried, powdered and passed through 0.2 mm sieve for determination of organic carbon (OC) by Walkley and Black's method (Jackson, 1967). Available soil nitrogen was determined by alkaline-$KMnO_4$ method given by Subiah and Asija (1956), which primarily measures easily oxidizable N using Auto Analyzer. Available P (Bray P) was extracted by hydrochloric acid + ammonium fluoride (Bray and Kurtz, 1945) and subsequent estimation by colorometry. Soil available K (Hanway and Heidal, 1952) using neutral normal ammonium acetate method. Electrical conductivity and pH of 1:2.5 soil water suspension (Richard, 1954 and Jackson, 1973, respectively) were measured using conductivity and pH meter, respectively.

All the results were then analyzed statistically for drawing conclusion using Analysis of Variance (ANOVA) procedure (Gomez and Gomez, 1984).

Sustainability yield index was worked out for mean yield of 3 years (2009-11) as given by Singh *et al.* (1990).

Sustainability yield index (SYI) = (A-SD) /Y max

Where, A= Average yield over the years for a particular treatment; SD= Standard deviation for the treatment; and Y max= Maximum yield obtained in any of the treatment over the years.

The total rainfall received during the crop growth period (July to November) was used to work out the rain water use efficiency (RWUE) taking the ratio of grain yield (kg ha^{-1}) to the rainfall (mm) according to Wani *et al.* (2013) and was expressed as kg ha-mm^{-1}.

3. RESULTS AND DISCUSSION

Growth and Yield Parameters

The data on pooled analysis of three years on growth and yield parameters of finger millet is presented in Table 2. It indicated that plant height increased significantly with increase in potassium application especially as basal application up to 200% K_2O, but 150% and 200% K_2O application were on par with each other. Higher number of productive tillers, ear head weight, grain weight and straw weight per hill were recorded with the application of recommended N, P_2O_5 and 150% of K_2O compared to application of recommended N, P_2O_5 and 100% of K_2O. Hagras (1985) also observed the similar response of increase in productive tillers. The total dry matter hill^{-1} were significantly higher with 150% K_2O application, recording 21% increase over 100% K_2O application. A similar kind of results of increase in growth and yield parameters was reported by Abdullahi Baque *et al.* (2006) in wheat. Optimum N: K ratios favor healthy plant growth and development whereas imbalance of N and K supply is detrimental to plant growth (Wells and Wood, 2007).

Yield and Economics

Significantly higher grain yield (3,851 kg ha^{-1}) was

Table: 2
Growth and yield parameters of finger millet as influenced by potassium nutrition (Pooled data of 3 years)

Treatment	Plant height (cm)	Number of productive tillers hill^{-1}	TDM hill^{-1} (g)	Ear head weight hill^{-1} (g)	Grain weight hill^{-1} (g)	Straw weight hill^{-1} (g)
T_1: Rec. N, P + Zero K	101.6	3.5	51.8	22.5	15.8	33.2
T_2: Rec.FYM (10 t ha^{-1})	109.2	4.3	62.0	25.5	21.8	37.2
T_3: *Gliricidia sepium* (7 t ha^{-1})	107.3	4.6	66.3	30.0	26.9	34.9
T_4: Rec. N, P +100% K (basal)	114.0	4.7	68.3	31.1	27.2	37.3
T_5: Rec. N, P+100% K (basal and tillering)	111.5	4.5	69.1	27.9	24.0	46.0
T_6: Rec. N, P+ 150%K (basal)	116.8	4.9	82.3	33.5	28.5	49.3
T_7: Rec. N, P+150%K (basal and tillering)	114.5	4.5	75.3	28.9	25.0	46.0
T_8: Rec. N, P +200% K (basal)	117.0	4.8	75.3	28.5	23.9	47.4
T_9: Rec. N, P+200%K (basal and tillering)	112.6	4.5	69.8	27.1	22.8	43.9
S. Em. $\pm$	2.8	0.2	1.2	1.0	1.1	1.1
C. D. @ 5 %	8.1	0.5	3.4	2.8	3.2	3.2
C.V. (%)	7.7	12.9	5.2	10.7	14.0	8.2

recorded with the application of recommended N, P_2O_5 and 150% K_2O compared to application of recommended N, P_2O_5 and 100% K_2O application (3,380 kg ha^{-1}). Similar results of higher maize equivalent yield with higher dose of potassium than the recommended dose in different cropping systems was reported by Ghosh *et al.* (2007). Further, higher application of potassium beyond 150% of recommended dose had no significant effect in increasing the grain yield. This result is also in agreement with the findings of Robiul Alam *et al.* (2009) who stated that the grain yield of wheat progressively increased with the application of K and then decreased. The increase in grain yield was 14% higher over recommended N, P_2O_5 and 100% K_2O application. Similar response of K on grain yield has also been reported by Dwivedi (2001) in wheat and groundnut and finger millet by Srinivasarao (2006). The straw yield of finger millet was significantly higher with the application of recommended N, P_2O_5 and 200% K_2O compared to recommended N and P_2O_5 application but on par with recommended N, P_2O_5 and 150% K_2O application.

Table 3 shows the economic analysis and sustainability of different levels of K_2O application. The highest B: C ratio of 3.23 and Rain Water Use Efficiency (RWUE) of 9.98 kg ha^{-1} mm^{-1} was recorded with recommended N, P_2O_5 and 150% K_2O compared to lower B: C ratio (3.03) and RWUE (8.75 kg ha^{-1} mm^{-1}) with recommended N, P_2O_5 and 100% K_2O. Similarly, application of higher dose of K involved 17% higher cost than recommended dose but produced 50% more returns in maize/cowpea cropping system (Ghosh *et al*., 2011).The SYI worked out for different nutrient management system indicated that recommended N, P_2O_5 and 150% K_2O is highly sustainable with SYI of 0.908. Hence the economic and sustainable nutrient management would be application of recommended N, P_2O_5 and 150% K_2O.

Also in three years study from 2009 to 2011 conducted on farmers' field at Operational Research Project, Alanatha, Kanakapura Taluk, Ramanagara District, application of 50: 40: 37.5 kg NPK ha^{-1} has recorded higher grain yield in all the three years with a mean yield of 3297 kg ha^{-1} when compared to Farmers practice. The normal practice by the farmers is application of higher dose of nitrogen and phosphorus without addition of potassium (Table 4). It leads to large N losses, environmental pollution and low nitrogen use efficiency (NUE). Although fertilizer consumption is increasing quantitatively, the corresponding yield increase per unit of nutrient has diminished over the years (Benbi and Brar, 2011; Samra and Sharma, 2011). This has created an imbalance in nutrient availability leading to reduction in yield. Hence there is a need to improve nutrient use efficiency both for economical as well as environmental reasons.

Physico-Chemical Properties of Soil

Application of different potassium levels had no significant effect on soil properties such as pH, EC and organic carbon content. However, pH was higher in recommended N, P_2O_5 and 150% K_2O and lower in treatment receiving *Gliricidia sepium* @ 7.5 t ha^{-1}. The application of gliricidia might have reduced the acidity of soil over years. The EC was not influenced by nutrient but was less with addition of organic manure treatments like application of FYM @ 10 t ha^{-1} and *Gliricidia sepium* @ 7.5 t ha^{-1}. Higher organic carbon values were recorded with the application of organic manures FYM @ 10 t ha^{-1} and *Gliricidia sepium* @ 7.5 t ha^{-1}, compared to fertilizer treatments, leading to significantly higher available N content in soil. Thus, the available N content was significantly higher in FYM @ 10 t ha^{-1} compared to recommended N, P_2O_5 and 100 % K_2O but was on par with *Gliricidia sepium* @ 7.5 t ha^{-1}. This may be due to high organic carbon content of soil. Significantly higher

Table: 3
Yield and economics of finger millet cultivation as influenced by potassium nutrition (Pooled data of 3 years)

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	B:C Ratio	SYI
T_1: Rec. N, P +Zero K	2777	5906	2.49	0.628
T_2: Rec. FYM (10 t ha^{-1})	3091	6836	2.21	0.710
T_3: *Gliricidia sepium* (7 t ha^{-1})	3049	6876	2.14	0.699
T_4: Rec. N, P +100% K (basal)	3380	7651	3.03	0.785
T_5: Rec. N, P+100% K (basal and tillering)	3224	7028	2.86	0.744
T_6: Rec. N, P+ 150%K (basal)	3857	8125	3.26	0.908
T_7: Rec. N, P+150%K (basal and tillering)	3599	7769	3.00	0.841
T_8: Rec. N, P +200% K (basal)	3697	8136	3.13	0.867
T_9: Rec. N, P+200%K (basal and tillering)	3588	7789	2.97	0.839
S. Em. $\pm$	118.69	261.26	-	-
C.D. @ 5 %	336.83	741.42	-	-
C.V. (%)	10.59	10.67	-	-

Table: 4
Yield, economics and sustainability yield index of finger millet cultivation as influenced by potassium nutrition management at ORP site, Alanatha, Kanakapura Taluk, Karnataka State

Treatment	Grain yield (kg ha^{-1})				Straw yield (kg ha^{-1})				B:C Ratio	SYI
	2009	2010	2011	Mean	2009	2010	2011	Mean		
N, P_2O_5 and K_2O	2500	2000	1066	1855	5350	4350	2101	3934	1.96	0.364
Rec. N (50 kg), P_2O_5 (40 kg) and K_2O (25 kg)	4300	2900	1745	2982	9500	5400	3155	6018	3.11	0.705
Rec. N, P_2O_5 and 150 % of Rec. K_2O basal dose	4750	3250	1891	3297	10500	6500	3425	6808	3.39	0.801
Rec. N, P_2O_5 + 150 % Rec. K_2O in two splits (basal and tillering)	4550	3050	1840	3147	9900	6000	3257	6386	3.23	0.755

available P_2O_5 was recorded in recommended N, P_2O_5 and 200% K_2O followed by recommended N, P_2O_5 + 150% of recommended K_2O in two splits and least was in recommended N and P_2O_5. This may be due to synergetic effect of K on availability of P in soils. Application of Gliricidia and FYM recorded 71.42 and 75.51 kg ha^{-1} of P_2O_5, respectively and are on-par with each other. Availability of K_2O was higher with increase in rate of K_2O application and significantly highest K_2O was recorded in recommended N, P_2O_5 and 200% K_2O (split application) followed by recommended N, P_2O_5 and 150% K_2O (split application) and least was with recommended N and P_2O_5. This may be because, the crop needs K_2O in the initial stages and that applied as top dressing was left in soil. Further, higher value of residual K_2O in soil was observed than crop uptake with higher rate of K_2O application. Application of Gliricidia and FYM recorded 112.9 and 120.09 kg ha^{-1} of K_2O, respectively and are on par with each other (Table 5). Treatment with higher amount of K application has increased the soil K content in all the three years. Release of non-exchangeable K could have increased the available K. Increased trend in residual K even in organic manure treatments could be due to the mineralization of organic manure that has been applied in all the treatments as well as the silt fraction of the soil texture (Adhikary and Karki, 2006).

Plant Uptake and Nutrient Balance

Simplified approach was used for calculating net NPK balance on major inputs: fertilizers and added nutrients through organic manures and major outputs (above ground plant uptake). The results are presented in Table 6.

Application of potassium more than the recommended dose registered higher NPK uptake at the end of third year. The increase in nutrient uptake was due to higher availability of nutrients leading to higher dry matter yield and nutrient concentration in plant with increased potassium application. Similar results were observed in pearl millet by Bangar *et al.* (2004).

Table: 5
Soil chemical properties as influenced by potassium nutrition management in finger millet after the crop harvest (Pooled data of 3 years)

Treatment	pH (1:2.5)	EC (dS m^{-1})	OC (%)	Av. N (kg ha^{-1})	Av. P_2O_5 (kg ha^{-1})	Av. K_2O (kg ha^{-1})
T_1: Rec. N, P +Zero K	5.41	0.07	0.38	135.06	58.89	89.96
T_2: Rec. FYM (10 t ha^{-1})	5.42	0.06	0.53	194.11	75.51	120.09
T_3: *Gliricidia sepium* (7 t ha^{-1})	5.35	0.06	0.51	180.84	71.42	112.90
T_4: Rec. N, P +100% K (basal)	5.68	0.07	0.34	124.31	70.52	111.59
T_5: Rec. N, P+100% K (basal and tillering)	5.39	0.09	0.36	122.21	78.68	126.50
T_6: Rec. N, P+ 150%K (basal)	5.82	0.07	0.42	171.04	69.26	114.34
T_7: Rec. N, P+150%K (basal and tillering)	5.60	0.07	0.35	126.69	91.39	135.53
T_8: Rec. N, P +200% K (basal)	5.48	0.09	0.41	153.49	109.86	129.88
T_9: Rec. N, P+200%K (basal and tillering)	5.46	0.08	0.36	127.33	84.27	146.02
S. Em. $\pm$	0.12	0.01	0.02	5.54	3.09	3.23
C.D. @ 5 %	NS	NS	NS	15.73	8.78	9.17
C.V. (%)	6.71	28.18	11.44	11.21	11.77	8.02

Table: 6
Influence of Potassium Nutrition on soil nutrient apparent balance after the harvest of the finger millet crop (2011)

Treatment	Initial (kg ha^{-1})	Applied (kg ha^{-1})	Crop removal (kg ha^{-1})	Expected balance (kg ha^{-1})	Actual balance (kg ha^{-1})	Net gain (+) or loss (-) (kg ha^{-1})
			Nitrogen (N)			
T_1	134.26	50.00	69.81	114.45	132.53	18.08
T_2	192.32	80.00	59.82	212.50	190.40	-22.10
T_3	181.44	140.00	96.34	225.10	181.07	-44.03
T_4	123.37	50.00	109.78	63.59	138.13	74.54
T_5	119.75	50.00	104.35	65.40	123.20	57.80
T_6	181.45	50.00	157.06	74.39	181.07	106.68
T_7	127.00	50.00	154.17	22.83	126.93	104.10
T_8	152.41	50.00	155.86	46.55	158.67	112.12
T_9	127.01	50.00	156.60	20.41	132.53	112.12
			Phosphorous (P_2O_5)			
T_1	41.35	40.00	35.27	46.08	71.18	25.10
T_2	64.63	40.00	33.23	71.40	86.23	14.83
T_3	58.43	56.00	61.46	52.97	79.89	26.92
T_4	44.05	40.00	65.33	18.72	100.23	81.51
T_5	52.15	40.00	60.87	31.28	106.97	75.69
T_6	48.33	40.00	76.95	11.38	88.08	76.70
T_7	77.43	40.00	65.93	51.50	99.96	48.46
T_8	143.11	40.00	77.42	105.70	112.38	6.68
T_9	74.41	40.00	75.74	38.67	76.33	37.66
			Potassium (K_2O)			
T_1	139.30	0.00	33.07	106.23	107.20	0.97
T_2	192.10	67.00	54.83	204.27	113.96	-90.31
T_3	173.80	112.00	87.20	198.60	117.92	-80.68
T_4	182.30	25.00	79.84	127.46	123.40	-4.06
T_5	213.80	25.00	78.26	160.54	136.36	-24.18
T_6	174.20	37.50	115.95	95.75	129.36	33.61
T_7	219.80	37.50	109.54	147.76	137.16	-10.60
T_8	173.90	50.00	134.19	89.71	152.96	63.25
T_9	231.50	50.00	138.17	143.33	147.32	3.99

T_1: Rec. NP + Zero K; T_2: Rec. FYM (10 t ha^{-1}); T_3: *Gliricidia sepium* (7 t ha^{-1}); T_4: Rec. N, P + rec. K in one dose (basal); T_5: Rec. N, P + rec. K in two splits; T_6: Rec. N, P + 150 % of rec. K in one dose (basal); T_7: Rec. N, P + 150% of rec. K in two splits; T_8: Rec. N, P + 200% of rec. K in one dose (basal); T_9: Rec. N, P + 200% of rec. K in two splits

The nitrogen replenishment through organic manures was not enough to balance N removal by crop. Thus, the apparent N balance was negative in FYM @ 10 t ha^{-1} and gliricidia @ 7.5 t ha^{-1}, while positive for rest of the treatments. Nutrients supplied through FYM and gliricidia has to undergo mineralization so as to release the nutrients. Hence negative N balance was observed. The best use of available N is made possible by higher levels of K application, hence the nitrogen balance was found to be positive in all other treatments (Johnson and Reetz, 1995; Vasuki *et al.*, 2009; Srinivasarao, 2010).

The apparent P balance in the soil resulted from the different fertilizer management practices was positive ranging from 6.8 kg ha^{-1} in recommended N, P_2O_5 and 200% K_2O application to 76.70 kg ha^{-1} in recommended N, P_2O_5 and 150% K_2O. From this finding, it indicates that the P requirement for acid soils needs further investigation since more P values are recorded as residual P in soil. The application of K has enhanced the uptake of P in wheat under water stress conditions (Abdullahi Baque *et al.,* 2006).

The apparent balance of K in soil was highly negative for most of the treatments except for higher rate and basal application of K_2O similar to the studies of Toor and Bishnoi

(1996) under maize- wheat rotation. The highest negative balance was with the application of FYM @ 10 t ha^{-1} followed by gliricidia @ 7.5 t ha^{-1}. Negative K balance was observed under organic manure, recommended NPK and recommended N, P and 150% K in two splits due to crop removal under inadequate supply of external source of K required for crop growth through manures and fertilizers.

Though the available soil potassium varies from 139 to 231 kg ha^{-1} which is not made available to crops since there is low level of exchangeable and non-exchangeable K, application of additional potassium enhanced the uptake of other nutrients facilitating in better crop growth and yield (Srinivasarao *et al*., 2007).

4. CONCLUSIONS

It was observed that the recommended N, P_2O_5 and 150% K_2O produced higher grain and straw yields in *Alfisols* of the Eastern Dry Zone of Karnataka. The highest B: C ratio of 3.26 and SYI of 0.908 was obtained with recommended N, P_2O_5 and 150% K_2O.

It was observed that more N and P were removed from biomass of one hectare with supply of recommended NP+ 150% K_2O. The crop uptake of K was increasing up to 200% of recommended K_2O, but was less with 100% of recommended K_2O. Potassium application @ 25 kg ha^{-1} was not enough for cultivating finger millet in the Eastern Dry Zone of Karnataka (ACZ-5) and thus needs to be increased to maintain the soil K reserve, since there was an apparent negative balance of K in the soil with the use of recommended K_2O. The recommended dose of N and P @ 50 and 40 kg ha^{-1}, respectively created a positive balance of N and P. Thus, the ideal fertilizer recommendation for finger millet in the Eastern Dry Zone of Karnataka would be 50, 40 and 37.5 kg N, P_2O_5 and K_2O, respectively.

ACKNOWLEDGEMENTS

The data presented is generated by scientific research carried out at All India Co-ordinated Research Project for Dryland Agriculture, GKVK, Bangalore. The authors greatly acknowledge the services of earlier scientists and staff in carrying out this experiment. Financial and technical assistance by Project Co-ordinating Unit and CRIDA, Hyderabad is duly acknowledged.

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