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Response of *Rabi* Finger Millet to Nitrogen and Potassium in North Coastal Andhra Pradesh

G Pavani, A V Ramana, M Srinivasa Rao and S Govinda Rao.
Department of Agronomy, Agricultural College, Naira-532 185

ABSTRACT

A field experiment was conducted in finger millet on sandy loam soil of Agricultural College, Naira during *Rabi*, 2020-21 with graded levels of nitrogen and potassium along with foliar application of nutrients. The soil was sandy loam having pH 7.4, EC 0.15 dSm^{-1}, organic carbon 0.35 %, available N 187.3 kg ha^{-1}, available P_2O_5 28.0 kg ha^{-1} and available K_2O 260.5 kg ha^{-1}. The experiment was laid out in a Randomized Block design, replicated thrice with eleven treatments. The results revealed that application of 120 kg N and 60 kg K_2O ha^{-1} recorded significantly higher plant height (123.9 cm), number of tillers $hill^{-1}$ (4.0), dry matter production (6011 kg ha^{-1}), days to 50% earhead emergence (73.3) and maturity (108), number of earheads m^{-2} (106.3), number of fingers $earhead^{-1}$ (6.93), test weight (3.80), grain yield (2397 kg ha^{-1}) and straw yield (3564 kg ha^{-1}) of finger millet. The highest harvest index (41.3) was observed with application of 90 kg N and 45 kg K ha^{-1}. Among foliar application of nutrients, these parameters were found to be significantly higher with N90 and K0 + Foliar application of 1% KNO_3 twice at Active tillering and PI stages.

Keywords: *Fertilizers, Finger millet, Foliar application, Grain yield and Yield attributes.*

Finger millet (*Eleusine coracana* (L.) Gaertn.) is the staple food for people in the dry areas and is cultivated by farmers on marginal lands with limited resources. Since the crop is primarily cultivated and consumed by the small to marginal households, it is often referred to as 'poor man's crop or as 'famine food'.

It is estimated that in India it is grown in an area of 1.01 m ha with production of 1.67 million tons and productivity of 1747 kg ha^{-1} (Directorate of Economics and Statistics, Govt. of India 2021-22). Finger millet responds well to fertilizer application especially to Nitrogen and Potassium. The optimal doses of major nutrients, *viz.* nitrogen, potassium, and phosphorus, ensure attaining the desired yield goal as well as maintaining soil productivity for the long-run (Pramanick *et al.*, 2020).

Application of potassium along with nitrogen improves N use efficiency and favours an increase in grain protein and amino acid contents. It plays a major role in providing resistance to plant and maintaining quality. Foliar application of nutrients in addition to soil application has a number of advantages in meeting the nutritional needs of crops such as rapid and efficient response by crop, less requirement of the product and independent of soil conditions.

Foliar nutrition is intended to avoid problems like fixation and immobilization of nutrients. Hence, feeding of crop foliage has emerged as an important practice of fertilization in modern agriculture.

Among various nutrients, nitrogen is inevitable and becoming increasingly important for assessing economic and environmental validity of a cropping system and establishment of its precise requirement is highly imperative for reaping higher yields in North Coastal Andhra Pradesh.

MATERIAL AND METHODS

A field experiment was conducted at Agriculture College Farm, Naira of Acharya N. G. Ranga Agricultural University, Andhra Pradesh during *Rabi*, 2020-21. The experiment was laid out in a Randomized Block design, replicated thrice with eleven treatments *viz.*, T_1: N0 & K0, T_2: N60 & K0, T_3: N90& K0, T_4: N120 & K0, T_5: N60 & K30 , T_6: N90 & K45, T_7: N120 & K60, T_8: N60 & K0 + Foliar application of 2% MOP twice at active tillering

& PI stages, T_9: N60 & K0 + Foliar application of 1% KNO_3 twice at Active tillering & PI stages, T_{10}: N90& K0 + Foliar application of 2% MOP twice at Active tillering & PI stages, T_{11}: N90 & K0 + Foliar application of 1% KNO_3 twice at Active tillering & PI stages.

The soil was sandy loam having pH 7.4, EC 0.15 dSm^{-1}, organic carbon 0.35 %, low in available N (187.3 kg ha^{-1}), high in available P_2O_5 (28.0 kg ha^{-1}) and medium in available K_2O (260.5 kg ha^{-1}). The mean maximum temperature during the experimental period ranged from 29.2^{0}C to 38.5^{0}C. One rainy day was recorded with 38.0 mm rainfall during the crop growth period. The cultivar used for the experiment was VR-847 (Srichaitanya). The crop was transplanted on 07th January, 2021 and harvested on 30th March, 2021. Field operations such as weeding, irrigation and plant protection measures were taken as per requirement.

The recommended dose of fertilizer is 60:30:30 kg NPK ha^{-1}. Half of the nitrogen, potassium and total phosphorus ware applied as basal at the time of transplanting and remaining doses of nitrogen and potassium ware applied as second dose. The data on plant height, dry matter production, days to 50% earhead emergence snd maturity, yield attributes, grain yield, straw yield and harvest index were recorded as per standard procedures. Data was analyzed using ANOVA and the significance was tested by Fisher's least significance difference (p=0.05).

RESULTS AND DISCUSSION

Effect of N and K growth parameters Plant height

A gradual and progressive increase in plant height due to incremental dose of nitrogen and potassium up to the highest level supplied (120 kg N & 60 kg K ha^{-1}) was noticed at all growth stages. At harvest, higher stature (123.9 cm) of finger millet was recorded with 120 kg N & 60 kg K ha^{-1}, which was significant over all other levels of fertilization (Table 1).

With regards to foliar application of nutrients, plant height (102.6 cm) was significantly higher with N90 & K0 + Foliar application of 1% KNO_3 twice at active tillering & PI stages (T_{11}) which was however, found in parity (98.9cm) with N90 & K0 + Foliar application of 2% MOP twice at active tillering & PI stages (T_{10}). This could be attributed to the fact that higher levels of nitrogen might have accelerated the synthesis of more chlorophyll and amino acids and stimulated cellular activity which is useful for the process of cell division, coupled with cell enlargement resulting in vertical increase in the culm length. These findings are in agreement with those reported by Dharmendra and Umesha (2022) and Sanju Choudhary *et al*. (2021) in finger millet.

No. of tillers hill^{-1}

At 30 DAT, application of the highest dose of nitrogen and potassium *i.e.*, 120 kg N & 60 kg K ha^{-1} respectively (T_7) resulted into maximum number of tillers $hill^{-1}$ (3.0) followed by (2.7) application of 120 kg N ha^{-1} (T_4). At 60 DAT, significantly higher number of tillers $hill^{-1}$ (4.0) was found due to application of 120 kg N & 60 kg K ha^{-1} (T_7) followed by (3.7) application of 120 kg N ha^{-1} (T_4). The lowest tiller production (2.1) was observed with absolute control (T_1). With regards to foliar application of nutrients, no. of tillers $hill^{-1}$ (3.2) was significantly higher with N90 & K0 + Foliar application of 1% KNO_3 twice at active tillering & PI stages (T_{11}) which was however, found in parity with N90 & K0 + Foliar application of 2% MOP twice at active tillering & PI stages (3.0) (T_{10}) at 60 DAT. Significantly higher tiller count with the highest dose of nitrogen and potassium (120, 60 kg ha^{-1} respectively) could be ascribed to the fact that higher levels of nitrogen might have increased higher uptake by the crop which might have accelerated the growth and development of auxiliary buds from which tillers are emerged. The present findings are in conformity with those reported by Sagar Maitra *et al*. (2020) in finger millet and Dharmendra & Umesha (2022) in finger millet.

Dry matter production

Perusal of the data (Table 2.) showed that levels of nitrogen and potassium application as well as foliar sprays altered the dry matter production to a statistically measurable magnitude throughout the crop growth.

With regards to nitrogen and potassium levels, statistically measurable differences were observed at 30, 60 DAT and at maturity. At harvest, the highest dry matter production (6011 kg ha^{-1}) was noticed with application of 120 kg N & 60 kg K ha^{-1} (T_7) followed (5347 kg ha^{-1}) by 120 kg N ha^{-1} (T_4). The lowest dry matter production (2469 kg ha^{-1}) was recorded with absolute control (T_1).

Table 1. Plant height (cm) & no. of tillers m^{-2} of finger millet at 30, 60 DAT and at maturity as influenced by nitrogen and potassium levels.

TREATMENTS	Plant height (cm)			No. of tillers hill^{-}	
	30 DAT	60 DAT	Harvest	30 DAT	60 DAT
T_1: N0 & K0	28.7	49.8	67.5	1.6	2.1
T_2: N60 & K0	35.5	58.5	81.9	1.9	2.5
T_3: N90& K0	39.8	72.2	96	2.2	2.9
T_4: N120 & K0	47.4	96.1	117.7	2.7	3.7
T_5: N60 & K30	36.7	61.2	83.7	2	2.7
T_6: N90 & K45	44.5	88.3	109.7	2.5	3.4
T_7: N120 & K60	52	101.5	123.9	3	4
T_8: N60 & K0 + Foliar application of 2% MOP twice at Active tillering & PI stages	37.9	63.2	89	2	2.7
T_9: N60 & K0 + Foliar application of 1% KNO_3 twice at Active tillering & PI stages	38.8	67.9	93.2	2.1	2.7
T_{10}: N90& K0 + Foliar application of 2% MOP twice at Active tillering & PI stages	41.2	77.5	98.9	2.2	3
T_{11}: N90 & K0 + Foliar application of 1% KNO_3 twice at Active tillering & PI stages	42.1	82.4	102.6	2.3	3.2
SEm±	0.8	1.6	1.7	0.053	0.074
CD (P=0.05)	2.3	4.7	5	0.16	0.22
CV (%)	5.9	6.4	5.2	7.2	7.4

With regards to foliar application of nutrients, dry matter production (5097 kg ha^{-1}) was significantly higher with N90 & K0 + Foliar application of 1% KNO_3 twice at active tillering & PI stages (T_{11}) which was however, found in parity (5018 kg ha^{-1}) with N90 & K0 + Foliar application of 2% MOP twice at active tillering & PI (T_{10}).

Significantly higher dry matter production registered with the highest dose (120 kg and 60 Kg ha^{-1}) of nitrogen and potassium supplied might be due to liberal supply of nitrogen to accelerate the synthesis of more chlorophyll, amino acids and stimulated cellular activity, meristematic growth coupled with cell enlargement resulting in production of large number of tillers and more leaf area which ultimately leads to enhanced dry matter accrual. These findings are in agreement with the findings of Vamsi Krishna *et al*. (2019) in finger millet and Ramyasri *et al*. (2019) in foxtail millet.

Days to 50% earhead emergence and Days to maturity

The highest number of days to 50% earhead emergence (73.3) was recorded with the application of the highest dose *i.e.,* 120 kg N & 60 kg K ha^{-1} (T_7) followed by (72.0) application of 90 kg N & 45 kg K ha^{-1} (T_6). Regards to foliar application of nutrients, Days to 50% earhead emergence (70.7) was found to be the highest with N90 & K0 + Foliar application of 1% KNO_3 twice at Active tillering & PI stages (T_{11}) and was found to be at par (69.0) with N90 & K0 + Foliar application of 2% MOP twice at active tillering & PI stages (T_{10}). However, days to maturity did not alter significantly with incremental doses of nitrogen, potassium and foliar application of nutrients.

Table 2. Dry matter production (kg ha^{-1}), Days to 50% earhead emergence and days to maturity of finger millet as influenced by nitrogen and potassium levels.

TREATMENTS	Dry matter production (kg ha^{-1})			Days to 50% earhead emergence	Days to maturity
	30 DAT	60 DAT	Harvest		
T_1: N0 & K0	469	1132	2469	64	101.7
T_2: N60 & K0	1069	2867	4072	64.3	103
T_3: N90& K0	1227	3171	5102	68	106
T_4: N120 & K0	1565	3581	5347	70	107
T_5: N60 & K30	1093	3050	4572	65	104
T_6: N90 & K45	1412	3422	5338	72	108
T_7: N120 & K60	1724	3742	6011	73.3	108
T_8: N60 & K0 + Foliar application of 2% MOP twice at Active tillering & PI stages	1113	3086	4419	65.3	104
T_9: N60 & K0 + Foliar application of 1% KNO_3 twice at Active tillering & PI stages	1145	3114	4519	67	104
T_{10}: N90& K0 + Foliar application of 2% MOP twice at Active tillering & PI stages	1290	3313	5018	69	106
T_{11}: N90 & K0 + Foliar application of 1% KNO_3 twice at Active tillering & PI stages	1351	3368	5097	70.7	108
SEm+	20.8	53	96.8	1.08	1.12
CD (P=0.05)	61.3	156	285.5	3.2	3.3
CV (%)	5.1	5.2	6.1	4.8	3.2

Effect on yield attributes and yield:

Data on yield attributes (Table 3.) of finger millet *viz.*, number of earheads m^{-2}, number of fingers earhead^{-1}, test weight (1000- grain weight) revealed that, there was a progressive increase in yield parameters with increase in fertilizer levels. No. of earheads m^{-2} (106.3) and no. of fingers earhead^{-1} (6.93) was found to be maximum with application of 120 kg N and 60 kg K ha^{-1} (T_7) followed by application of 90 kg N & 45 kg K ha^{-1} (T_6). As regards foliar application of nutrients, no. of earheads m^{-2} (95.7) was significantly higher with N90 & K0 + Foliar application of 1% KNO_3 twice at Active tillering & PI stages (T_{11}) followed (90.0) by N90 & K0 + Foliar application of 2% MOP twice at active tillering & PI stages (T_{10}).

No. of fingers earhead^{-1} (5.93) was significantly higher with N90 & K0 + Foliar application of 1% KNO_3 twice at active tillering & PI stages (T_{11}) which was however, found in parity (5.50) with N90 & K0 + Foliar application of 2% MOP twice at active tillering & PI stages (T_{10}). No. of fingers earhead^{-1} was noticed to be the lowest (3.73) with absolute control (T_1).

Test weight was found to be the highest (3.80) with application of higher dose of N and K *i.e.*, 120 & 60 kg ha^{-1} respectively (T_7) followed by (3.59) application of 90 kg N & 60 kg K ha^{-1} (T_6). The test weight was significantly lower with absolute control (T_1).

Maximum values for yield attributes were associated with the highest level of nitrogen and

potassium @ 120 kg & 60 kg ha^{-1} (T_7) tried and these values decreased with decrease in N and K levels. Higher accumulation of photosynthates during the reproductive phase results in increased translocation of these resources from source to sink resulting in enhanced yield parameters. Dharmendra and Umesha (2022), Vamsi Krishna *et al.* (2019) and Poorna Teja *et al*. (2016) in finger millet also made similar observations.

Grain yield

There was a gradual and progressive increase in grain yield of finger millet with increase in levels of nitrogen and potassium from 0 to 120 kg ha^{-1} & 0 to 60 kg ha^{-1} respectively. Application of nitrogen and potassium @ 120 kg & 60 kg ha^{-1} (T_7) recorded the highest grain yield (2397 kg ha^{-1}) followed by (2193 kg ha^{-1}) application of 90 kg N & 45 kg K ha^{-1} (T_6) and both the treatments were significantly superior to other nitrogen and potassium levels. Absolute control (T_1) recorded significantly lower grain yield (652 kg ha^{-1}) among all the treatments.

With regards to foliar application of nutrients, grain yield (2042 kg ha^{-1}) was significantly higher with N90 & K0 + Foliar application of 1% KNO_3 twice at active tillering & PI stages (T_{11}) which was however, found in parity (1991 kg ha^{-1}) with N90 & K0 + Foliar application of 2% MOP twice at active tillering & PI stages (T_{10}). There was an appreciable increase in the grain yield to the tune of 9.3% over 90 kg N & 45 kg K ha^{-1}, 37.1% over recommended dose of fertilizers (60:30:30 kg NPK ha^{-1}) and 267.6% over absolute control due to application of the highest dose of nitrogen and potassium *i.e.,* 120 kg & 60 kg ha^{-1} respectively.

Increment in nitrogen and potassium levels increase grain yield of finger millet which clearly indicates the crop response to the highest level of nitrogen and potassium *i.e.,* 120 kg N & 60 kg K ha^{-1}, which indicates the linear response of nitrogen and potassium with grain yield. This could be attributed mainly to the augmented growth and yield structure leading to increase in grain yield. These findings are in corroborations with those reported by Dharmendra & Umesha (2022), Sanju Choudhary *et al*. (2021) in finger millet.

Straw yield

There was a steady and progressive increase in straw yield of finger millet with increase in levels of nitrogen and potassium Application of 120 kg N & 60 kg K ha^{-1} (T_7) registered the highest straw yield (3564 kg ha^{-1}) followed by (3294 kg ha^{-1}) application of 120 kg N ha^{-1} (T_4) which was however found to be at par (3280 kg ha^{-1}) with 90 kg N ha^{-1} (T_3). While, straw yield was the lowest (1794 kg ha^{-1}) with absolute control (T_1).

With regards to foliar application of nutrients, straw yield (3022 kg ha^{-1}) was significantly higher with N90 & K0+ Foliar application of 1% KNO_3 twice at active tillering & PI stages (T_{11}) which however, was found in parity (2994 kg ha^{-1}) with N90 & K0 + Foliar application of 2% MOP twice at active tillering & PI stages (T_{10}).

Increase in straw yield of finger millet could be attributed mainly to the augmented growth stature and yield structure associated with this treatment in enhancing straw yield, underlining the prominence of nitrogen in both source and sink development. These findings are in corroborations with those reported by Dharmendra & Umesha (2022), Sanju Choudhary *et al*. (2021) in finger millet.

Harvest index (%)

The highest harvest index (41.3) was observed with the application of 90 kg N and 45 kg K ha^{-1} (T_6). Higher harvest index associated with application of 90 kg N & 45 kg K ha^{-1} might be due to incremental dose of nitrogen and potassium helped in better availability and uptake of nitrogen, phosphorus and potassium to enable efficient metabolism to translate into higher grain and straw yield and in turn harvest index. Among foliar nutrition, the highest harvest index (40.3) was noticed with N90& K0 + Foliar application of 1% KNO_3 twice at Active tillering & PI stages (T_{11}) followed (40.2) by N60 & K0 + Foliar application of 1% KNO_3 twice at Active tillering & PI stages (T_9).

Table 3. Yied attributes and Yield (kg ha^{-1}) of finger millet as influenced by nitrogen and potassium levels.

TREATMENTS	No. of earheads m^{-2}	No. of fingers earhead^{-1}	1000 grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index
T_1: N0 & K0	65	3.73	2.31	652	1794	26.6
T_2: N60 & K0	78.7	4.77	2.68	1364	2675	33.7
T_3: N90& K0	89	5.3	2.97	1805	3280	35.4
T_4: N120 & K0	92	5.67	3.19	2019	3294	38.1
T_5: N60 & K30	84	5.07	2.79	1745	2794	38.5
T_6: N90 & K45	101	6.47	3.59	2193	3112	41.3
T_7: N120 & K60	106.3	6.93	3.8	2397	3564	40.2
T_8: N60 & K0 + Foliar application of 2% MOP twice at Active tillering & PI stages	82	4.87	2.73	1730	2649	39.5
T_9: N60 & K0 + Foliar application of 1% KNO_3 twice at Active tillering & PI stages	87	5.13	2.88	1794	2702	40.2
T_{10}: N90& K0 + Foliar application of 2% MOP twice at Active tillering & PI stages	90	5.5	3.07	1991	2994	40
T_{11}: N90 & K0 + Foliar application of 1% KNO_3 twice at Active tillering & PI stages	95.7	5.93	3.26	2042	3022	40.3
SEm±	1.6	0.15	0.05	31.2	52.5	-
CD (P=0.05)	4.7	0.43	0.16	92	154.8	
CV (%)	5.5	8.06	5.25	5.2	5.4	

CONCLUSION

Based on the above results and discussion, it can be concluded that application of nitrogen and potassium @ 120 kg & 60 kg ha^{-1} respectively to finger millet resulted in higher growth parameters, yield attributes, grain and straw yield contributing to higher productivity and profitability of finger millet in North Coastal Andhra Pradesh.

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