Research Journal of Agricultural Sciences
An International Journal

Res. Jr. of Agril. Sci. 12(1): 86–89

P- ISSN: 0976-1675 | E- ISSN: 2229-4538

www.rjas.org

Research Paper

Application of Nutrients through Soil and Foliar Methods on Growth and Yield of Foxtail millet (*Seteria italic.* L)

P. Ashoka*[1] and P. Priya[2]

Received: 06 Oct 2020 | Revised accepted: 17 Dec 2020

ABSTRACT

The study was conducted during *kharif* 2018 and *kharif* 2019 at ICAR- Krishi Vigyan Kendra, Haveri to evaluate the response of foxtail millet (*Seteria italic* L) to soil application of micronutrients and foliar application of NPK along with RDF. The experiment was laid out in RCBD comprising of nine treatments replicated thrice. Studies revealed that the growth parameters, yield attributes and grain yield of foxtail millet differed significantly due to foliar application of NPK along with RDF and soil application of micronutrients along with RDF. The results indicated that significantly higher grain yield (18.49 q ha^{-1}) and straw yield (36.14 q ha^{-1}) of foxtail millet were recorded in treatment applied with RDF + foliar spray of 19:19:19 @ 1% at flower initiation stage (pooled data of 2 years) followed by soil application of micronutrients along with RDF. The treatment RDF + foliar spray of 19:19:19 @ 1% at flower initiation stage recorded significantly higher plant height (92.50 cm), panicle length (22.27 cm) and grain weight per panicle (2.80 g). The biological yield and nutrient uptake (NPK, Zn and Fe) are also significantly higher with the same treatment. The gross returns, net returns and BC ratio were also higher with the same treatments (Rs.48284, Rs.32036 and 2.97, respectively) as compared to all other treatments and absolute control.

***Key words*:** Foxtail millet, Iron, Zinc, Foliar NPK, Nutrient uptake, Growth, Yield

Foxtail millet (*Setaria italica* L. Beauv) is an important minor millet crop belonging to the family Poaceae. In India, the cultivation of foxtail millet is confined to Karnataka, Andhra Pradesh, and Tamil Nadu. Foxtail millet comes under drought tolerant crop and it can be grown as a short-term catch crop. It is grown mainly in dry lands. Its grain used for human consumption and a feed for poultry and cage birds. It is used in several food preparations, like, chapati, fermented bread, biscuits, malts, etc. the stalks are used as fodder and for thatching. It is rich in micronutrients and good for diabetic patients. It protects against cancer and related heart diseases [1]. Foxtail millet is getting popular, because of its low requirement of inputs, wider adaptability and nutritional superiority over other cereals [2].

Soil fertility is one of the main limiting factors that influence production of crops. Introduction of high yielding varieties in many crops, increased use of high analysis chemical fertilizers without adequate application of organics and micronutrients have resulted in wide spread deficiency of micronutrients and nutrient imbalance which adversely affected the long-term yields [3].

Zinc is an essential micronutrient for the growth and development of plants, humans and animals. Zinc deficiency in soil is affecting human health. The growth and immune system of humans can be impaired by Zn deficiency. Zinc deficiency in soils may reduce yield and quality of the crop. Agronomic and genetic bio-fortification has been suggested as strategies to increase the dietary Zn through edible crops [4]. Although cereals and millets are generally less sensitive to nutrient deficiency than pulses, still it affects the cereals by a deficiency in several parts of the world. In Karnataka, in few districts, millets are the main components of regional cropping system [5]. Integration of organic and inorganic sources of nutrients play a pivotal role in enhancing crop productivity, sustaining soil health and reducing environmental hazard. Considering these, attempts were made to study the crop nutrition through foliar application of chemical fertilizers at flower initiation stage (45 DAS) on foxtail millet crop.

MATERIALS AND METHODS

The experiment was carried out at Hanumanamatti ICAR-KVK of UAS, Dharwad (Karnataka) during *Kharif* season, 2018-19 and 2019-20, which is located at 25° 40' 94" N latitude and 81° 85' 35" E longitude of 980 meter above mean sea level (MSL). The field of experiment conducted is red sandy loam. The soil pH is 6.56, organic C is 0.42 percent, available N, P, K are 220, 16.25 and 162.5 kg ha^{-1}, respectively. The field experiment with Foxtail millet variety DHFt-109 having duration of 90-110 days was conducted in randomized block design with nine treatments (T_1- Control, T_2- RDF, T_3- RDF + foliar spray of urea @ 2% at flower initiation stage, T_4- RDF + foliar spray of 19:19:19 @1% at flower initiation stage, T_5- Foliar spray of urea @ 2% flower

*Ashoka P.
ashokapuas@gmail.com

[1]ICAR- Krishi Vigyan Kendra, Hanumanamatti - 581 115, Ranebennur (Tq), Haveri (Dist), Karnataka, India

[2]Department of Agronomy, College of. Agriculture, Hanumanamatti, Ranebennur, Haveri - 581 115, Karnataka

initiation stage, T_6- Only foliar spray of 19:19:19 @ 1% at flower initiation stage, T_7- RDF + $ZnSO_4$10 kg /ha, T_8- RPP + $FeSO_4$ 10 kg/ha and T_9- RDF + $ZnSO_4$ 10 kg/ha + $FeSo_4$ 10 kg/ha.

Five plants from each plot were selected at random to record the observations. Plant height was measured at 30 and 60 days after sowing and at harvest, from the ground level to the base of the node on which the first fully opened leaf from the top and expressed in centimeter. The length of panicle was measured from the same sample of five randomly selected plants from each plot. It was measured from the neck to the tip of the ear heads and the average was computed. Grains from the harvested panicles of each plot of five plants were separated by threshing and weight was measured. The average weight of grains per panicle was computed.

The net plots (leaving two borders on each side of the plot, 0.5 meters from each side of the plot) were harvested and sun dried for 3 days in the field and then the total biomass yield was recorded. After threshing, cleaning and drying, the grain yield was recorded and reported at 12 per cent moisture content. The straw yield was obtained by subtracting grain yield from the total biomass yield and yield was expressed in q ha^{-1}.

RESULTS AND DISCUSSION

Application of RDF alone to most crops is not sufficient to meet their demand. Soils deficient in micronutrients need external application and foliar application of NPK is also sometimes essential (Table 1). The data given in (Table 2-3) indicated the importance of the study on integrated use of different sources of nutrients. It was found to influence significantly the plant height, panicle length, grain per panicle, grain yield and straw yield of foxtail millet [6]. There was a significant increase in plant height of foxtail millet (field observation at different intervals of crop growth) due to the application of different sources of integrated use of fertilizers along with recommended dose of fertilizers (RDF). Pooled data indicated that (2018 and 2019) application of RDF + $ZnSO_4$ 10 kg/ha + $ZnSO_4$ 10 kg/ha significantly registered the highest plant height (92.50 cm) and on par with RDF + foliar spray of 19:19:19 @ 1% at flower initiation stage (88.93 cm) over the rest of the treatments [7]. The plant height is the indicative of the vigour and growth of plant. Among the different treatments, integrated treatment recorded highest plant height, which was superior over all other treatments. This may be due to balanced and increased availability of nutrients to the crop due to fertilizer and foliar application.

Table 1 Initial soil properties of experimental plot at ICAR-KVK, Hanumanamatti

Parameters	Value	Status
pH (1:2.5)	6.56	Neutral
EC (dS/m)	0.40	Normal
OC (%)	0.42	Low
Available N (kg ha^{-1})	220	Low
Available P_2O_5 (kg ha^{-1})	16.25	Low
Available P (kg ha^{-1})	7.40	Low
Available K_2O (kg ha^{-1})	162.0	Medium
Available Zn (ppm)	0.45	Deficient
Available Fe (ppm)	2.15	Deficient

The highest plant height might be due to the better nutrition, which plays a vital role in cell division and growth of the plant [8]. Foliar application of macro and micro nutrients at critical stages of the crop were effectively absorbed and translocated to the developing panicle thereby producing more length (22.27 cm) and better filling [9].

Table 2 Response of Foxtail millet to nutrient management

Treatments	Plant height (cm)			Panicle length (cm)		
	2018	2019	Mean	2018	2019	Mean
T_1- Control	46.65	58.3	52.47	8.74	11.23	9.98
T_2- RPP (30:15:15 NPK kg ha^{-1} with FYM @ 6 t ha)	60.66	82.87	71.76	12.69	16.52	14.60
T_3- RDF + foliar spray of Urea @ 2% at flower initiation stage	65.05	79.73	72.39	14.64	18.45	16.54
T_4- RDF+foliar spray of 19:19:19 @ 1% at flower initiation stage	92.56	92.44	92.50	19.89	24.66	22.27
T_5- Foliar spray of Urea @ 2% flower initiation stage	54.65	79.16	66.90	11.26	14.26	12.76
T_6- Foliar spray of 19:19:19 @ 1% at flower initiation stage	60.57	77.66	69.11	11.69	13.15	12.42
T_7- RDF+10 kg /ha $ZnSO_4$	69.56	86.21	77.88	15.67	18.65	17.16
T_8- RDF+10 kg/ha $FeSO_4$	60.79	85.44	73.11	13.74	17.37	15.55
T_9- RDF+ 10 kg/ha $ZnSO_4$ + 10 kg/ha $FeSO_4$	92.15	85.7	88.93	17.7	21.13	19.41
S.Em±	1.11	2.6	1.82	0.72	0.85	0.78
CD (P=0.05)	3.33	7.79	5.45	2.16	2.56	2.99

Yield components of finger millet as influenced by the different treatments

The integrated use of fertilizers was significantly influenced grain weight per panicle, grain yield and straw yield of foxtail millet. Appreciable increase in the grain yield of foxtail millet could be observed due to combination of organic and inorganic sources along with foliar nutrients. The grain and straw yields of finger millet as influenced by different treatments are presented in (Table 3, Fig 1). Soil application and foliar spray of fertilizers has resulted in significant yield differences among the treatments [10].

The significantly higher grain weight per panicle (2.80 g), highest grain (18.49 q ha^{-1}) and straw yield (36.14 q ha^{-1}) in T_4 treatment were recorded where application of RDF + foliar spray of 19:19:19 @ 1% at flower initiation stage was done and it is at par with RDF + 10 kg/ha $ZnSO_4$ + 10 kg/ha $FeSo_4$ (16.67 q ha^{-1}, 34.39 q ha^{-1} grain and straw yield, respectively) [11]. The lower yield (8.82 q ha^{-1}, 20 q ha^{-1} grain and straw yield, respectively) was recorded in absolute control (T_1).

Soil and foliar application of macro and micro nutrients at critical stages of the crop were effectively absorbed and did translocation to the developing panicle thereby producing more panicle filling in foxtail millet. It could be attributed to the fact that higher availability of NPK during crop growth period might have improved the plant growth characters like plant height and weight of the grains which eventually led to higher yield [12]. Zinc and Iron are essential for several enzyme systems that regulate various metabolic activities in plants and also as essential component responsible for assimilation of nitrogen and also helps in formation of chlorophyll and played an important role in nitrogen metabolism [13]. This might be due to the fact that zinc may serve as source of energy for synthesis of auxin which helps in elongation of stem [14].

The grain weight per panicle showed similar trend as growth characters. The significantly highest grain weight per panicle (2.80) was recorded with RDF + foliar spray of 19:19:19 @ 1% at flower initiation stage. However, it was at par with RDF + 10 kg/ha $ZnSO_4$ + 10 kg/ha $FeSo_4$ (Table 3). This might be due to translocation of synthesized food materials from source to sink. This could be possible due to non-limiting supplies of nutrient like N, P K, Zn and Fe from the soil and fertilizers owing to their absorption [15].

Table 3 Yield parameters of foxtail millet as influenced by nutrient management

Treatments	Grain weight per panicle (g)			Grain yield (q/ha)			Straw yield (q/ha)		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
T_1	1.05	1.82	1.43	8.33	9.30	8.82	19.80	20.20	20.00
T_2	1.80	2.36	2.08	15.30	13.30	14.30	28.76	26.50	27.63
T_3	1.51	2.65	2.08	15.94	13.94	14.94	29.20	28.00	28.60
T_4	2.61	3.00	2.80	18.27	18.70	18.49	36.78	35.50	36.14
T_5	2.30	1.10	1.70	9.52	12.10	10.81	20.74	24.00	22.37
T_6	1.32	2.41	1.86	10.68	12.60	11.64	20.52	24.90	22.71
T_7	1.90	2.99	2.44	16.40	16.60	16.50	32.22	31.20	31.71
T_8	1.20	2.82	2.01	15.22	13.30	14.26	33.56	26.50	30.03
T_9	2.35	2.46	2.41	17.33	16.60	16.97	35.79	33.00	34.39
S.Em±	0.40	0.54	0.13	0.50	3.48	0.59	1.25	5.46	1.25
CD (P=0.05)	0.13	0.18	0.42	1.51	1.16	1.77	3.75	1.82	3.74

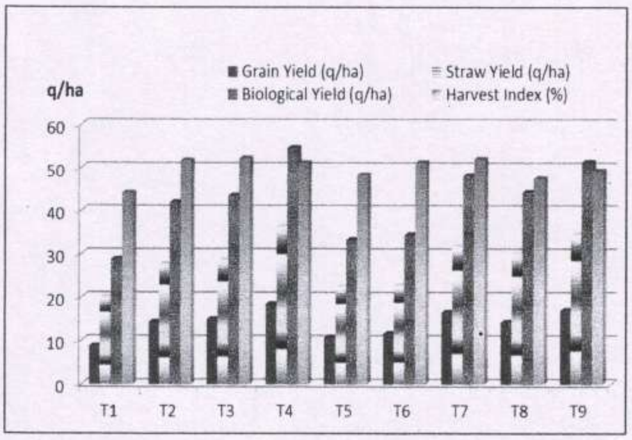

Fig 1 Yield parameters of Foxtail millet as influenced by soil and foliar application of nutrients

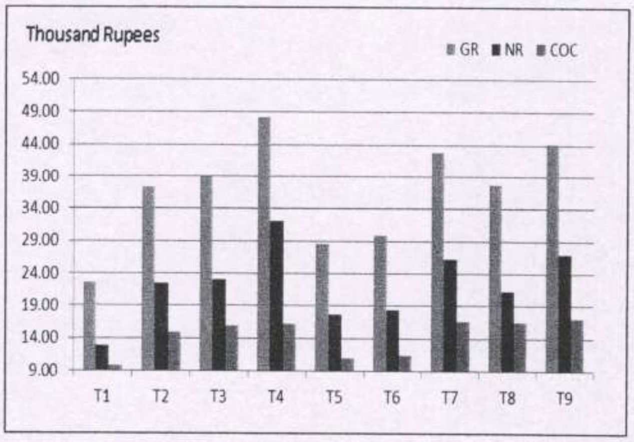

Fig 2 Gross returns (GR), net returns (NR) and cost of cultivation (COC) as influenced by soil and foliar application of nutrients

Table 4 Biological yield and harvest index of foxtail millet as influenced by nutrient management

Treatments	Biological yield (q/ha)			Harvest index (%)		
	2018	2019	Mean	2018	2019	Mean
T_1- Control	28.13	29.50	28.82	42.07	46.04	44.10
T_2- RPP (30:15:15 NPK kg ha^{-1} with FYM @ 6 t ha)	44.06	39.80	41.93	53.20	50.19	51.76
T_3- RDF + foliar spray of Urea @ 2% at flower initiation stage	45.14	41.94	43.54	54.59	49.79	52.24
T_4- RDF+foliar spray of 19:19:19 @ 1% at flower initiation stage	55.05	54.20	54.63	49.67	52.68	51.16
T_5- Foliar spray of Urea @ 2% flower initiation stage	30.26	36.10	33.18	45.90	50.42	48.32
T_6- Foliar spray of 19:19:19 @ 1% at flower initiation stage	31.20	37.50	34.35	52.05	50.60	51.25
T_7- RDF+10 kg /ha $ZnSO_4$	48.62	47.80	48.21	50.90	53.21	52.03
T_8- RDF+10 kg/ha $FeSO_4$	48.78	39.80	44.29	45.35	50.19	47.49
T_9- RDF+ 10 kg/ha $ZnSO_4$ + 10 kg/ha $FeSO_4$	53.12	49.60	51.36	48.42	50.30	49.35
S.Em±	1.11	2.6	1.82	0.72	0.85	0.785
CD (P=0.05)	3.33	7.79	5.45	2.16	2.56	2.36

Biological yield and harvest index

The biological yield and harvest index are also in similar trend as growth characters. The significantly highest indices (54.63 kg/ha and 51.16, respectively) were recorded with RDF + foliar spray of 19:19:19 @ 1% at flower initiation stage [16]. However, it was at par with RDF + 10 kg/ha $ZnSO_4$ + 10 kg/ha $FeSo_4$ (Fig 1, Table 4).

Economics of finger millet as influenced by different treatments

Higher gross returns (Rs. 48,284 0 ha^{-1}), net returns (Rs. 32,036 ha^{-1}) and B:C ratio (2.97) with the cost of cultivation of Rs.16,250 ha^{-1} was recorded with RDF + foliar spray of 19:19:19 @ 1% at flower initiation stage followed by RDF + soil application of $ZnSO_4$ @ 10 kg ha^{-1} + $FeSo_4$ @10 kg ha^{-1} (Fig 3, Table 4). These were superior over other treatments and control [17].

CONCLUSIONS

The present findings clearly indicated that soil and foliar application of nutrients increase the growth and yield of foxtail millet. It has the potential to improve the productivity of the crop grown in low fertile soils where fertilization is a constraint under conditions of low rainfall area. The growth and yield components were significantly higher with soil application of recommended dose of fertilizers along with foliar application of 19:19:19 @ 1% at flower initiation stage. Treatments receiving recommended package of practice with soil application of zinc and ferrous sulphate @ 10 kg/ha were at par with each other but significantly superior over other treatments and control.

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