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Nutrient Uptake and Economics of Finger Millet [*Eleusine coracana* (L.) Gaertn.] Under Guni Method of Planting in Eastern Dry Zone of Karnataka

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ABSTRACT

The field experiment was taken at Zonal Agricultural Research Station, UAS, GKVK, Bengaluru, during kharif season of 2014 for "Nutrient uptake and economics of finger millet [Eleusine coracana (L.) Gaertn.] under guni method of planting in Eastern Dry Zone of Karnataka" on sandy loam soil. The experiment consisted of eight treatments laid in randomized complete block design with three replications. Treatments composed of two spacings (45 X 45 cm and 60 X 60 cm) with three levels of NPK (50, 75 and 100 % RDF) composed with farmer"s method of guni planting (60 X 60 cm with only FYM) and UAS package of practice. Significantly higher NPK uptake was recorded in spacing of 60 X 60 cm with 100 % recommended dose of fertilizers (152.10, 24.42 and 94.37 kg NPK ha^{-1}, respectively) and found superior over other treatments, followed by spacing of 60 X 60 cm with 75 % recommended dose of fertilizers. Increased available nitrogen, phosphorus and potassium (248.40, 49.07, and 249.90 kg NPK ha^{-1}, respectively) was recorded in spacing of 60 X 60 cm with 100 % recommended dose of fertilizers and found superior over other treatments, followed by spacing of 60 X 60 cm with 75 % recommended dose of fertilizers. Further, higher net returns of Rs. 44,789 and B: C ratio of 2.20 was recorded in spacing of 60 X 60 cm with 75 % recommended dose of fertilizers under guni method of planting owing to its higher grain yield (41.66 t ha^{-1}) and straw yield (60.86 t ha^{-1}).

Key words: *Finger millet, Guni method of planting, Nutrient uptake, Economics.*

INTRODUCTION

Millet is a group of small-grained cereal grown around the world for food and fodder. Millets is known to be „crops of the future" as it well adapted and cultivated under harsh environment of arid and semi-arid region Resmisa[18]. Finger millet [*Eleusine coracana* (L.) Gaertn.] commonly known as ragi, is one of the important millet crops grown for grain and fodder purpose under varied agro-climatic conditions. It occupies the highest area under cultivation among the small millets.

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In India, it is grown in an area of 13.07 million hectares with the production of 19.29 million tonnes and the productivity is1641 kg ha^{-1}. The state of Karnataka is the largest producer of finger millet in India. Other major finger millet growing states in India are Tamil Nadu, Andra Pradesh, Orissa, Jharkhand, Maharashtra and Uttaranchal. In Karnataka, finger millet is grown in an area of 7.88 lakh ha, with an annual production of 12.72 lakh tonnes and productivity of 1871 kg ha^{-1}. It ranks third in area and production after rice and sorghum accounting for 58 per cent area and 44.9 per cent production in the state Anon[2].

Significant information generated by long-term studies related to the ability of bulky organic manures to neutralize the rapid yield fall with the continuous use of chemical fertilizers. It is a storehouse of several nutrients. Its regular application prevented the occurrence of zinc and sulphur deficiencies. More importantly FYM is known to improve the soil physical environment. Polysaccharides produced by microbes which are involved in decomposition of organic manure are important in binding soil particles together and for creating a stable soil structure. With regular use of FYM, soil erosion is minimized and water retention characteristics are improved. Its limited availability, however, restricts its wide scale use. In guni method, land preparation is as usual for crop production and then they create a grid similar to that with SRI method of paddy cultivation. At intersection points a small pit (guni) or scoop is formed at a spacing of 2 x 2 feet and approximately 0.75 kg of FYM is applied to the guni and mixed with a top soil. Then young seedlings of 20days old (never more than30 days old), are planted two in each guni. A ox-drawn wooden implement - called a *Koradu* is dragged over the seedlings at 30-35 DAT in different directions during which the stems are bent over the ground. When other growing conditions are favorable and dragging a *koradu* stimulates profuse tillers and adventitious root system enables the panicles to be larger and better grains filling and improve the size of and quality of the ear heads due to better availability of nutrients and moisture and farmers are harvested yield of 18 to 20 quintals per acre. Besides these, other advantages are reduction in seed rate, easy inter cultivation, better weed management and drip irrigation can also be adopted by providing wider spacing (60 x 60 cm) than the conventional method of planting (30 x 10 cm. Therefore guni method of planting is being practiced by good number of farmers in Kolar and Haveri districts of Karnataka. Hence, scientific validation of the method was essential for its further spreading of the technology among the farming community.

Rahman[16] reported that application of 100 % N, P and K + FYM (10 t ha^{-1}) recorded 42.0, 2.42 and 9.12 kg ha^{-1} in case of grain and 34.0, 2.88 and 12.8 kg ha^{-1} of N, P and K uptake by straw of finger millet, respectively at Bengaluru. Reddy *et al.*[17] reported that N content of grain and straw of finger millet increased significantly up to 40 kg N ha^{-1}. Higher uptake of N (51.56 kg ha^{-1}) was recorded with 80 kg ha^{-1} addition of N had significantly effect on P concentration. Higher concentration of P in grain (0.642 per cent) and straw (0.30 per cent) was recorded at 60 kg ha^{-1}. However, 80 kg N ha^{-1} resulted in maximum uptake of P (22.05 kg ha^{-1}).

Basavaraj and Rao[3] recorded that higher net income (Rs. 7,642 ha^{-1}) and B:C ratio (3.17) from finger millet with the application of 50 per cent N through FYM and 50 per cent NPK as compared to net income of Rs 6,931 and B:C ratio of 3.03 in case of recommended NPK through fertilizers. Shivakumar[20] revealed that higher net returns (Rs. 21,260) and B:C ratio (2.90) from finger millet with application of 50 per cent N, P and K + 50 N, P and K through bio-agrorich in *alfisols* of Bengaluru. Singh[13] reported that returns per rupee investments in FYM application to finger millet @ 0, 5, 7.5 and 10 tones ha^{-1} were 0.97, 1.07, 1.15 and 1.17 rupees, respectively. The in the dose of FYM beyond 7.5 tones ha^{-1} was not significant due to increased cost incurred on FYM application. Anil Kumar *et al.*[1] reported that application of 7.5 tons of compost ha^{-1}in conjunction with

recommended level of fertilizer recorded higher gross profits (Rs. 28,460 ha^{-1}), net returns (Rs. 20,400 ha^{-1}) and B: C ratio (2.76) in finger millet under Bengaluru conditions. Govindappa[7] reported that application of 100 per cent RDF recorded higher B: C ratio (2.89) followed by 100 per cent N and K (2.66) and poultry manure (2.16). While, lower B: C ratio was recorded in city waste compost (0.4) and bio gas slurry (0.73).

Poor soil fertility and erratic rains are the most important constraints to crop production in eastern dry zone of Karnataka. Soil fertility management i.e nutrient management particularly nitrogen plays a major role in increasing production and productivity of finger millet. Nitrogen (N) is an essential nutrient and key limiting factor in crop production of different agro-ecosystems. Nitrogen is the major nutrient required by finger millet under guni method of planting system, which positively increases the growth attributes, productive tillers, length and width of ear head, test weight, number of fingers ear $head^{-1}$, grin yield $plant^{-1}$ and finally improve the yield Prasad *et al.*[13] Keeping the importance of finger millet under eastern dry zone and importance of fertilizer and spacing, an experiment was conducted to assess the nutrient uptake, yield and economics of finger millet with NPK levels and spacing under guni method of planting at eastern dry zone of Karnataka.

MATERIAL AND METHODS

The experiment was conducted during rainy (*kharif)* season of 2014, at the Zonal Agriculture Research Station, UAS, GKVK, Bengaluru. Situated in eastern dry zone (Zone-5) of Karnataka at a latitude of 12^{0} 58' North, longitude of 75^{0} 35' East and at an altitude of 930 meters above mean sea level (MSL) India. The climate is typically semi-arid with temperature ranges from 28.5 to 19.1ºC and rainfall during crop period was 648.6 mm. The soil samples were analyzed for physicochemical properties *viz.* texture Black[4] available N Subbiah and Asija[21] available P Olsen *et al.*[11] and available K Jackson[8] The soil was sandy loam in texture and slightly acidic in reaction (6.97) with medium in available nitrogen, phosphorus and potassium (284.75, 46.97 and 236.60 kg ha^{-1}, respectively). The organic carbon content was medium (0.57 %). GPU-28 finger millet seedlings of 20 old were used for transplanting and two seedlings per guni were planted in all the plots on 4th August-2014with a spacing of 45 cm X 45 cm and 60 X 60 cm. Experiment included eight treatments consisting of T_1:Spacing of 45 X 45 cm + 50 % RDF T_2: Spacing of 45 X 45 cm + 75 % RDF, T_3: Spacing of 45 X 45 cm + 100 % RDF, T_4: Spacing of 60 X 60 cm + 50 % RDF, T_5: Spacing of 60 X 60 cm + 75 % RDF, T_6 : Spacing of 60 X 60 cm + 100 % RDF, T_7: Spacing of 60 X 60 cm + 0.75 kg FYM $guni^{-1}$ (Farmers practice) and T_8:Spacing of 30 X 10 cm + RDF : 50 :40 :25 kg NPK ha^{-1} (UAS package of practices) laid out in Randomized Complete Block Design (RCBD) with three replications. FYM @ 7.5 t ha^{-1} was applied 15 days prior to sowing and recommended fertilizer (50: 45: 25 NPK ha^{-1}) adopted in the study.

Due to small size of the experimental plots Hodtha operation cannot be done. However, the ragi seedlings were trampled manually between 30 to 35 DAT to bent over the stems to ground to stimulate propused tillering. Whereas, the farmers do it by using a wooden implement known as *Koradu*. It was passed thrice at weekly interval on the transplanted seddlings during tillering stage under favourable soil conditions. This enhances tillering in finger millet and results in higher yield. The observations were subjected to for statistical analysis as per procedure of Gomez and Gomez[6] *viz.*, F-test and t-test as per 5 per cent level. The „t" value was calculated ever where „F" test was found significant.

Uptake of nutrients

The uptake of nitrogen, phosphorus and potassium was computed using the formula.

$$\text{Nutrient uptake by grain or straw (kg ha}^{-1}\text{)} = \frac{\text{Nutrient per cent in grain or straw}}{} \times \text{Dry weight of grain or 100 straw (kg ha}^{-1}\text{)}$$

Gross return= [Grain yield x market price of grain]+ [straw yield x market price of straw]
Net returns = Gross returns – total cost of cultivations
B:C ratio = (Gross returns Rs. ha $^{-1}$)
(total cost of cultivation Rs. ha

RESULTS AND DISCUSSION

The various observations made crop namely Spad reading, nutrient up take, yield and yield parameters and economics of finger millet as influenced by various treatments are presented and discussed here under.

SPAD reading

Different spacing and levels of NPK differed significantly with respect to the SPAD readings at 30, 60, 90 DAT and at harvest. Wider spacing of 60 x 60 cm with 100 % RDF recorded significantly higher SPAD readings (26.57, 99.10, 76.32 and 43.83, respectively) than all the treatments. Whereas, recommended UAS package of practices (15.31, 56.63, 54.02 and 23.87, respectively) were recorded significantly lower SPAD readings. (Table 1).

Effect of spacing and levels of NPK on nutrient uptake by finger millet

Significantly higher total uptake nitrogen (152.10 kg ha^{-1}), phosphorus (24.42 kg ha^{-1}) and potassium (94.37 kg ha^{-1}) was recorded at spacing of 60 x 60 cm + 100 % RDF and was statically on par with spacing of 60 x 60 cm + 100 % RDF (146.43, 21.43 and 91.07 kg ha^{-1} nitrogen, phosphorus and potassium, respectively) (Table 2). Significantly lower total uptake by finger millet crop was recorded by UAS package of practices (100.67, 12.43 and 73.77 kg ha^{-1} nitrogen, phosphorus and potassium respectively). The higher uptake in grain and straw was due to increased growth parameters like plant height, number of leaves plant^{-1}, number of tillers hill^{-1}dry matter production and yield parameters like number of productive tillers hill^{-1}, number of finger hill, finger length, grain yield plant^{-1}, ear head weight net plot^{-1} and 1000 grain weight in widely spaced plants which was due to favorable environment and less competition among plants provided by wider spacing and increased fertilizer levels made sufficient quantity available in the rhizoshepre helped the plants to uptake more nutrients. The present findings are in similar line with Thimma Reddy[22] Muthuswamy[10] Satyanarayana *et al.*[19] Reddy *et al.*[17] Chatra *et al.*[5] and Verma *et al*.[23]

Effect on yield

The yield of finger millet crop differed significantly among different treatments. Wider spacing of 60 x 60 cm + 100 % RDF recorded significantly ear head weight net plot^{-1}, 1000 grain weight, higher grain yield (4166 kg ha^{-1}) and straw yield (6086 kg ha^{-1}) and was statistically on par with 60 x 60 cm + 75 % RDF (24.17 kg, 3.64 g,4092 kg ha^{-1} and 5696 kg ha^{-1} seed and straw yield, respectively). The least ear head weight net plot^{-1} (10.50 kg), 1000 grain weight (2.32 g), grain (1948 kg ha^{-1}) and straw yield (4502 kg ha^{-1}) was obtained with UAS package of practices (Table 3). Increased yield at wider spacing with 100 % RDF was mainly due to higher growth parameters like higher plant, higher number of leaves plant^{-1}, number of tillers hill^{-1} and dry matter accumulation in leaf, stem and total plant^{-1}. These growth parameters helped to assimilate and utilize the solar radiation, water and nutrients more efficiently to produce more photosysnthates. The increased dry matter accumulation helped the plant to get more number of yield attributing parameters like number of fingers hill^{-1}, finger length, grain yield plant^{-1}, ear head weight net plot^{-1} and 1000 grain weight. These yield attributing parameters finally helped to get significantly higher yield at wider spacing with higher fertilizer levels. These results are in accordance with the findings of Puttaswamy[14] Puttaswamy and Krishnamurthy[15] and Pandushastry[12] indicated that synthesis, accumulation and translocation of photosynthates depend upon efficient photosynthetic structure, extent of translocation into sink (grains) and also plant growth and development during early stages of crop growth. The production and translocation of synthesized photosynthates depends upon mineral nutrition supplied.

Economics of finger millet as influenced by spacing and levels of NPK

Higher gross returns and net returns was registered in a spacing of 60 x 60 cm + 100 % RDF (Rs. 83,320 ha^{-1} and Rs. 45,219 ha^{-1}, respectively) followed by spacing of 60 x 60 cm + 75 % RDF (Rs. 81,840 ha^{-1} and Rs. 44,789 ha^{-1}, respectively) (Table 4). The increased net returns in these treatments was mainly due to higher grain and straw yield as a result of increased growth and yield parameters helped to achieve higher grain and straw yield which finally resulted in higher net returns compared to other treatments. The lower net returns were observed in UAS package of practices (Rs. 12,644 ha^{-1}) due to lower grain and straw yield. Similarly, higher B:C ratio was recorded in spacing of 60 x 60 cm + 75 % RDF (2.20) followed by spacing of 60 x 60 cm + 100 % RDF (2.18) due to higher grain and straw yield. Lower B: C ratio was recorded in recommended UAS package of practices (1.48) was due to lower grain and straw yield. Similar results were reported by Basavaraj and Rao[3], Shivakumar[20] and Anil Kumar *et al*.[1]

Table 1: SPAD readings of finger millet at different growth stages as influenced by spacing and levels of NPK

Treatments	30 DAT	60 DAT	90 DAT	At harvest
T_1:Spacing of 45 X 45 cm + 50 % RDF	16.65	74.21	60.39	32.93
T_2: Spacing of 45 X 45 cm + 75 % RDF	17.53	77.30	61.69	33.89
T_3: Spacing of 45 X 45 cm +100 % RDF	17.90	85.39	62.03	36.26
T_4: Spacing of 60 X 60 cm + 50 % RDF	19.78	89.61	63.60	37.03
T_5: Spacing of 60 X 60 cm + 75 % RDF	20.03	96.63	66.07	38.10
T_6: Spacing of 60 X 60 cm + 100 % RDF	26.57	99.10	76.32	43.83
T_7: Spacing of 60 X 60 cm + 0.75 kg FYM $guni^{-1}$ Farmer"s practice)	19.11	86.75	66.46	32.13
T_8: Spacing of 30 X 10 cm + RDF : 50 :40 : 25 kg NPK ha^{-1} (UAS package of practice)	15.31	56.63	54.02	23.87
S. Em±	0.93	3.96	1.59	1.42
CD (*p=0.05*)	2.81	12.00	4.83	4.32
C.V	8.40	8.23	5.32	7.09

Note: FYM @ 7.5 t ha^{-1} is common for all treatments except T_7.
DAT - Days After Transplanting.

Table 2: Effect of spacing and levels of NPK on nutrient uptake (kg ha^{-1}) and nutrient status of soil after harvest of the finger millet

Treatments	Nitrogen		Phosphorus		Potassium	
	Uptake (kg ha^{-1})	Available (kg ha^{-1})	Uptake (kg ha^{-1})	Available (kg ha^{-1})	Uptake (kg ha^{-1})	Available (kg ha^{-1})
T_1:Spacing of 45 X 45 cm +50 % RDF	110.40	221.86	11.00	44.40	60.33	236.13
T_2: Spacing of 45 X 45 cm +75 % RDF	110.77	223.13	12.87	44.43	68.53	237.60
T_3: Spacing of 45 X 45 cm +100 % RDF	126.93	224.75	14.23	46.43	76.50	239.20
T_4: Spacing of 60 X 60 cm + 50 % RDF	137.47	237.04	17.17	46.97	85.77	241.00
T_5: Spacing of 60 X 60 cm + 75 % RDF	146.43	245.70	21.43	48.17	91.07	246.47
T_6: Spacing of 60 X 60 cm + 100 % RDF	152.10	248.40	24.42	49.07	94.37	249.90
T_7: Spacing of 60 X 60 cm + 0.75 kg FYM guni^{-1} Farmer"s practice)	129.53	223.45	15.70	44.90	80.70	236.87
T_8: Spacing of 30 X 10 cm + RDF : 50 : 40 : 25 kg NPK ha^{-1} (UASpackage of practice)	100.67	173.73	12.43	35.43	73.77	156.33
S. Em±	5.33	3.93	0.64	1.01	2.55	1.56
CD (*p=0.05*)	16.17	11.91	1.95	3.07	7.75	4.72
C.V	6.75	6.03	6.89	6.89	7.10	7.63

Note: FYM @ 7.5 t ha-1 is common for all treatments except T7**. NS:** non-significant.
DAT-DaysAfter Transplanting

Table 3: Effect of spacing and levels of NPK on yield parameters of finger millet

Treatments	Ear head weight per net plot (kg)	1000 grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1:Spacing of 45 X 45 cm +50 % RDF	19.57	3.02	3172	5287
T_2: Spacing of 45 X 45 cm +75 % RDF	19.83	3.18	3200	5457
T_3: Spacing of 45 X 45 cm +100 % RDF	21.17	3.20	3355	5503
T_4: Spacing of 60 X 60 cm + 50 % RDF	20.50	3.34	3848	5629
T_5: Spacing of 60 X 60 cm + 75 % RDF	24.00	3.48	4092	5696
T_6: Spacing of 60 X 60 cm + 100 % RDF	24.17	3.64	4166	6086
T_7: Spacing of 60 X 60 cm + 0.75 kg FYM guni^{-1} Farmer"s practice)	19.67	2.85	3606	5867
T_8: Spacing of 30 X 10 cm + RDF : 50 : 40 : 25 kg NPK ha^{-1} (UAS package of practice)	10.50	2.32	1948	4502
S. Em±	0.60	0.10	69.91	114.69
CD (*p=0.05*)	1.83	0.31	212.04	438.86
C.V	5.26	5.72	6.54	7.55

Note: FYM @ 7.5 t ha^{-1} is common for all treatments except T_7**.** DAT - Days After Transplanting.

Table 4: Economics of finger millet as influenced by spacing and level of NPK in finger millet

Treatments	Cost of Cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B : C ratio
T_1:Spacing of 45 X 45 cm +50% RDF	37164	63440	26276	1.70
T_2: Spacing of 45 X 45 cm +75% RDF	37421	64000	26579	1.71
T_3: Spacing of 45 X 45 cm +100% RDF	39259	67100	27841	1.70
T_4: Spacing of 60 X 60 cm + 50% RDF	35675	76960	41285	2.16
T_5: Spacing of 60 X 60 cm + 75% RDF	37051	81840	44789	2.20
T_6: Spacing of 60 X 60 cm + 100% RDF	38101	83320	45219	2.18
T_7: Spacing of 60 X 60 cm + 0.75 kg FYM guni^{-1} Farmer"s practice)	33893	72120	38227	2.13
T_8: Spacing of 30 X 10 cm + RDF : 50 : 40 : 25 kg NPK ha^{-1} (UAS package of practice)	26316	38960	12644	1.48

Note: FYM @ 7.5 t ha^{-1} is common for all treatments except T_7. **NS:** non-significant.

CONCLUSION

Among different treatments spacing of 60 X 60 cm + 100 % RDF recorded higher nutrient uptake leads to higher net returns and B: C ratio followed by spacing of 60 X 60 cm + 75 % RDF. Whereas, UAS package of practices recorded significantly lower nutrient upatake, net returns and B: C ratio. But considering the current trend of planting method, Guni method of finger millet planting with spacing of 60 x 60 cm + 75 % RDF along with 7.5 tons of FYM ha^{-1} found to give higher yield, nutrient uptake and economic returns.

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