E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(11): 39-43
Received: 09-09-2024
Accepted: 20-10-2024

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Response of finger millet (*Eleusine coracana* L.) to soil and foliar application of fertilizers under rainfed conditions

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i11Sa.1928

Abstract
The field experiment was conducted at Experimental Farm, Department of Agronomy, College of Agriculture, Latur during *kharif*, 2023 on clayey soil to study response of finger millet (*Eleusine coracana* L.) to soil and foliar application of fertilizers under rainfed conditions. The experiment was laid out in Randomized Block Design. The eight treatments were replicated thrice. The treatments were T_1: Control, T_2: 100% RDN, T_3: 75% RDN + 2% Urea, T_4: 75% RDN + 2% KNO_3, T_5: 75% RDN + 2% DAP, T_6: 100% RDN + 2% Urea, T_7: 100% RDN + 2% KNO_3 and T_8: 100% RDN + 2% DAP. The results indicated that growth and yield of finger millet were influenced significantly due to various treatments. The application of 100% RDN + 2% Urea (T_6) recorded higher plant height plant^{-1} (110.24 cm), no. of tillers plant^{-1} (3.67), no. of functional leaves plant^{-1} (50.10), leaf area plant^{-1} (6.94 dm^2), LAI (3.08) and dry matter accumulation plant^{-1} (55.55 g) which was at par with 100% RDN + 2% DAP (T_8) and 100% RDF + 2% KNO_3 (T_7) and found significantly superior over rest of the treatments. Highest grain yield (2523 kg ha^{-1}) was observed with the application of 100% RDN + 2% Urea (T_6) which was at par with 100% RDN + 2% DAP (T_8) and found significantly superior over rest of the treatments. Highest harvest index was observed with the application of 100% RDN + 2% Urea (T_6).

Keywords: Finger millet, RDN, Urea, DAP, KNO_3

Introduction
Millets are a group of small-grained cereal, round in shape and can be white, grey, yellow to red hardy and grow well around the world for food and fodder. It is known to be "crops of the future" as it is well adapted and cultivated under harsh environment of semi-arid region. India is the largest producer of various kinds of millets. They are grown on an area of 15.48 million hectares in India, yielding 120 lakh tonnes at an average of 1208 kg ha^{-1} productivity. Among states Rajasthan has the highest area under millets cultivation (29.67%) followed by Maharashtra (20.67%), Karnataka (13.46%), Uttar Pradesh (8.06%), Madhya Pradesh (6.11%), Gujarat (3.94%) and Tamil Nadu (3.74%) (Anonymous, 2023) [1].
Among various millets, finger millet (*Eleusine coracana* L.) is an important small millet crop grown in India and has the pride of place characterized by highest productivity among millets. Small-seeded grains belonging to different variety of annual grasses that are cultivated primarily as grain crops on marginal lands in dry areas in temperate, subtropical and tropical regions are collectively referred as millets. Its name is derived from the seed head, which has shape of human fingers. It has different names in local languages. In india finger millet is commonly called by various names like ragi (in Kannada, Telugu and Hindi), also Mandua/Mangal in Hindi, mandia (Oriya), Taidalu (in Telangana region), Kezhvaragu (in Tamil). It is also known as African millet and bird's foot millet. In India area under finger millet was 1159 million ha with production of 1998 million tonnes and productivity of 1724 kg ha^{-1} in 2021-22 and in Maharashtra finger millet is cultivated on an area of 81.26 milllion ha with production of about 93.92 million tonnes with productivity of 1264 kg ha^{-1}. Nutritional potential of millets in terms of protein, carbohydrate and energy values are comparable to the popular cereals like rice,

wheat, barley or bajra. Finger millet contains about 5–8% protein, 1–2% ether extractives, 65–75% carbohydrates, 15–20% dietary fiber, 2.5–3.5% minerals (Chethan and Malleshi, 2007) [2]. It has the highest calcium content among all cereals (344 mg/100 g) and potassium (408 mg/100 g). The cereal has low fat content (1.3) and contains mainly unsaturated fat.

Soil application of essential nutrients is the common practice but nutrients undergo several changes and vulnerable to losses through leaching and volatilization. In order to avoid or minimize severity of such losses and to facilitate efficient absorption and usage by the crop plants, foliar application of nutrients is imperative. Foliar spray of nutrients is the fastest way to boost up crop growth because nutrients are available to plants quickly in initial and critical stages of crop and nutrients will reach site of food synthesis directly leading to no wastage and quickly supply of food, thereby reduce the requirement of fertilizers. Keeping these points in view, a field experiment entitled "Response of finger millet (*Eleusine coracana* L.) to soil and foliar application of fertilizers under rainfed conditions" was carried out.

Materials and Methods

The field experiment was conducted to study the response of finger millet (*Eleusine coracana* L.) to soil and foliar application of fertilizers under rainfed conditions at Experimental Farm of Agronomy Section, College of Agriculture, Latur (MS) during *kharif* 2023. Geographically Latur district of Maharashtra state is located at 18° 05' to 18° 75' North latitude and 77° 25' to 77° 36' East latitude with the total geographical area is 7.37 million ha. Latur area comes under semi-arid region of Maharashtra. The average annual rainfall of the Latur district is 689.72 mm. The soil of experimental plot was clayey in texture, low in available nitrogen (228.0 kg ha^{-1}), medium in available phosphorous (16.82 kg ha^{-1}) and very high in available potassium (432.0 kg ha^{-1}). The soil was neutral in reaction having pH 7.04. It was well drained which was favourable for optimum growth. The experiment was laid out in Randomized Complete Block Design. The eight treatments were replicated thricely. The treatments were T_1: Control, T_2: 100% RDN, T_3: 75% RDN + 2% Urea, T_4: 75% RDN + 2% KNO_3, T_5: 75% RDN + 2% DAP, T_6: 100% RDN + 2% Urea, T_7: 100% RDN + 2% KNO_3, T_8: 100% RDN + 2% DAP. The gross and net plot size of each experimental unit was 5.40 m x 4.50 m and 4.95 m x 3.9 m, respectively. Sowing was done on 8th July, 2023 by dibbling method using seed rate 10 kg ha^{-1}. The recommended dose of fertilizer for finger millet crop was 60: 30: 30 NPK kg ha^{-1}. The finger millet variety Phule Nachani was tested for this experiment along with these treatments. The recommended cultural practices and plant protection measures were undertaken. The statistical technique for the analysis of variance was employed to analyse the recorded data (Panse and Sukhatme, 1967) [4].

Methodology

Plant height (cm)

The average height of five randomly selected and labeled plants in each plot was measured from the soil surface to the base of fully opened top most leaf.

Number of tillers $plant^{-1}$ (cm)

The number of tillers per plant was recorded by counting tillers of five observation plants at the time of harvesting and then the average was worked out.

Number of functional leaves $plant^{-1}$

The number of functional leaves per plant was recorded by counting functional leaves of five selected plants and then average was worked out for each stage respectively. Leaves which dried more than half of its area were excluded while counting functional leaves.

Leaf area $plant^{-1}$ (dm^2)

Leaf area was calculated with randomly selected five plant samples. The leaves of samples were grouped as small, medium and large. The leaf area $plant^{-1}$ (dm^2) was measured by taking length and breadth of each leaf and multiplied it with the leaf factor and number of leaves. Then averaging and converted on plant basis.

Leaf area (LA) = L x B x N x K

where,
LA = Leaf area (dm^2)
L = Maximum length of leaf (cm)
B = Maximum breadth of leaf (cm)
N = Number of leaves under particular group
K = Leaf area constant (0.786)

Leaf area index (LAI)

Since, the crop yield is to be assessed per unit of ground area instead of per plant, the leaf area existing on one plant was considered as the leaf area produced on unit ground area was proposed by Watson (1952) [15]. The measure is known as leaf area index. It is calculated by the formula,

$$LAI = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Ground area per plant (cm}^2\text{)}}$$

Dry matter accumulation $plant^{-1}$ (kg ha^{-1})

The individual plant from the respective net plot was removed at harvest by cutting at the base. The samples were initially dried in shade, then cut into pieces and transferred to labelled brown paper bags and later dried in a hot air oven at 65°C. The weight of oven dried plant samples was recorded using an electronic balance and mean value was recorded as dry matter accumulation and expressed in g $plant^{-1}$ of particular observation.

Grain yield (kg ha^{-1})

The harvested earheads from net area were thoroughly sun dried and threshed. After threshing, grains were separated cleaned and weighed after drying the produce. The grain yield from tagged plants was included in respect of net plot before expressing yield in kg $ha^{-1.}$

Straw yield (kg ha^{-1})

The straw obtained from net plot area including straw of sampled plants was weighed after thorough sun drying to a constant weight and expressed as kg ha^{-1}.

Biological yield (kg ha^{-1})

It was recorded by formula:

Biological yield = Seed yield + straw yield.

Harvest index

$$\text{Harvest index} = \frac{\text{Economic yield}}{\text{Biological Yield}} \times 100$$

Results and Discussion

Growth attributes

Growth attributing characters of finger millet *i.e.*, plant height plant^{-1} (cm), number of tillers, number of functional leaves plant^{-1}, leaf area (dm^2), dry matter acumulation plant^{-1} (g) and LAI were affected significantly (Table 1) due to difference treatments. The application of 100% RDN + 2% Urea at (T_6) recorded significantly highest plant height (110.24 cm) finger millet, which was at par with application of 100% RDN + 2% DAP (T_8), 100% RDN + 2% KNO_3 (T_7), 75% RDN + 2% Urea T_3 and 75% RDN + 2% DAP (T_5) and found significantly superior over rest of the treatments. Number of tillers, number of functional leaves plant^{-1}, leaf area (dm^2), dry matter acumulation plant^{-1} (g) and LAI were highest with the application of 100% RDN + 2% Urea at (T_6), which were at par with application of 100% RDN + 2% DAP (T_8) and 100% RDN + 2% KNO_3 (T_7) and found significantly superior over rest of the treatments. The increase in growth characters were attributed due to increased availability of nutrients leading to better nutrition of crop which enhanced uptake and translocation of nutrients resulting in better growth and development. Similar results were reported by Senthilkumar and Gokul (2019) [11], Roy *et al.*, (2002) [9], Udapudi *et al.*, (2024) [14], Sneha *et al.*, (2016) [12], Senthamil & Tamilmounika (2023) [10] and Reddy *et al.*, (2018) [8]

Yield

Data shown in Table 2 revealed that grain yield (Kg ha^{-1}), straw yield (Kg ha^{-1}), biological yield (Kg ha^{-1}) and harvest index of finger millet were affected significantly due to different treatments.

The higher seed yield (2523 kg ha^{-1}) of finger millet was observed with the application of 100% RDN + 2% Urea (T_6) which was at par with application 100% RDN + 2% DAP (T_8) and found significantly superior over rest of the treatments. Highest straw yield (7581 kg ha^{-1}) and biological yield (10104 kg ha^{-1}) were recorded with the application of 100% RDN + 2% Urea (T_6) which was at par with application of 100% RDN + 2% DAP (T_8), 100% RDN + 2% KNO_3 (T_7), 75% RDN + 2% Urea (T_3) and 75% RDN + 2% DAP (T_5) and found superior over rest of the treatments. Whereas highest harvest index was observed with the application of 100% RDN + 2% Urea (T_6) which was significantly superior over Control (T_1) and 100% RDN (T_2) and found at par rest of the treatments. It might be due to higher growth attributing character with higher fertilizer levels which enhanced photosynthetic efficiency and higher supply of photosynthates to developing earheads for proper grain filling and thus contributing to higher yield. The results of the present investigation are in accordance with Reddy *et al.*, (2018) [8], Roy *et al.*, (2002) [9], Patil *et al.*, (2015) [5], Maitra *et al*, (2020) [3], Sundaresh and Basavraja (2017) [13], Radha *et al.*, (2019) [6], Yadav *et al.*, (2010) [16] and Ramachandrappa *et al.*, (2020) [7].

Table 1: Plant height plant^{-1} (cm), number of tillers plant^{-1}, number of functional leaves plant^{-1}, leaf area plant^{-1} (dm^2), dry matter plant^{-1} (g) and LAI of finger millet as influenced by different treatments.

Treatments	Plant height (cm)	No. of tillers plant^{-1}	No. of functional leaves plant^{-1}	Leaf area plant^{-1} (dm^2)	Dry matter accumulation plant^{-1}	Leaf area index
T_1: Absolute control	87.64	2.23	32.93	4.69	41.71	2.08
T_2: RDN	93.32	2.78	38.28	5.03	44.72	2.23
T_3: 75% RDN + 2% Urea	102.47	3.14	43.61	5.61	49.30	2.49
T_4: 75% RDN + 2% KNO_3	97.39	2.90	40.02	5.25	46.14	2.33
T_5: 75% RDN + 2% DAP	99.51	3.06	41.98	5.38	47.48	2.39
T_6: 100% RDN + 2% Urea	110.24	3.67	50.10	6.94	55.55	3.08
T_7: 100% RDN + 2% KNO_3	105.76	3.35	45.81	5.95	51.39	2.64
T_8: 100% RDN + 2% DAP	107.02	3.43	47.39	6.13	53.05	2.73
S.Em ±	3.64	0.16	2.11	0.34	2.07	0.15
CD at 5%	10.91	0.47	6.37	1.01	6.21	0.45

Table 1: Grain yield (kg ha^{-1}), straw yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index of finger millet as influenced by different treatments.

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	HI (%)
T_1: Absolute control	1504	6010	7514	20.01
T_2: RDN	1765	6514	8278	21.31
T_3: 75% RDN + 2% Urea	2016	7035	9052	22.27
T_4: 75% RDN + 2% KNO_3	1835	6625	8459	21.68
T_5: 75% RDN + 2% DAP	1956	6893	8849	22.10
T_6: 100% RDN + 2% Urea	2523	7581	10104	24.97
T_7: 100% RDN + 2% KNO_3	2117	7238	9356	22.63
T_8: 100% RDN + 2% DAP	2320	7356	9675	23.98
S.Em ±	109	293	371	1.14
CD at 5%	325	877	1111	3.42

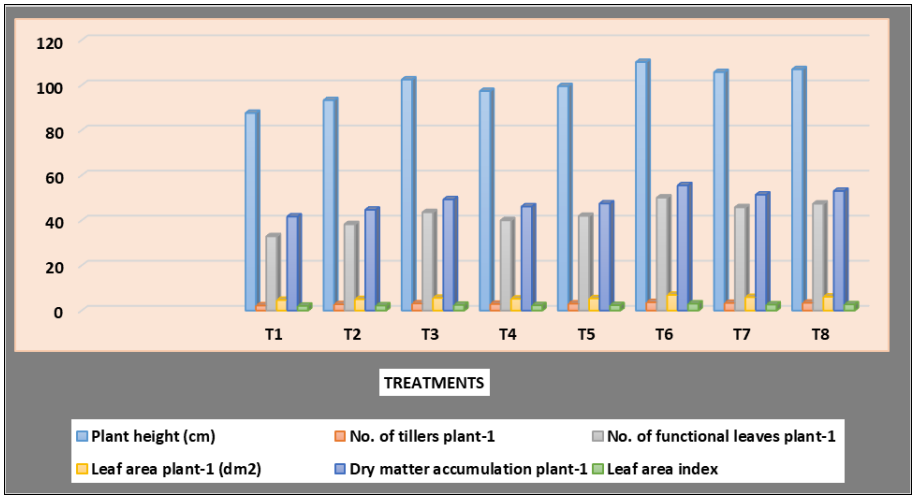

Fig-1: Plant height plant^{-1} (cm), number of tillers plant^{-1}, number of functional leaves plant^{-1}, leaf area plant^{-1} (dm^2), dry matter plant^{-1} (g) and LAI of finger millet as influenced by different treatments

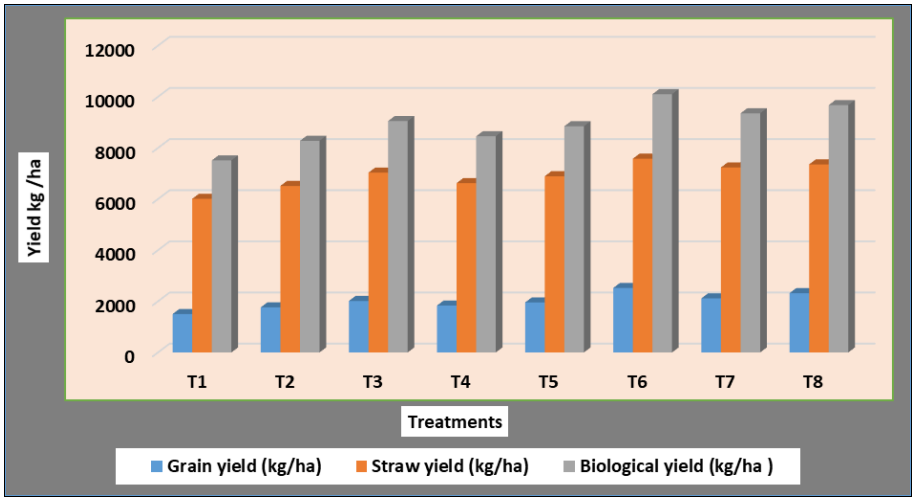

Fig-2: Grain yield (kg ha^{-1}), straw yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index of finger millet as influenced by different treatments

Plate 1: Drone View of Experimental Plot

Conclusion

Application of 100% RDN + 2% Urea (T_6) proved to be significantly effective for getting higher growth attributes *viz.* plant height (110.24 cm), highest number of leaves plant^{-1} (56.40), mean leaf area (7.34 dm^2), total dry accumulation plant^{-1} (55.55 g), number of tillers plant^{-1} (3.67) which was at par with application of 100% RDN + 2% DAP (T_8) and 100% RDN + 2% KNO_3 (T_7).

Application of 100% RDN + 2% Urea (T_6) proved to be significantly effective for getting the higher seed yield (2523 kg ha^{-1}), straw yield (7581 kg ha^{-1}), biological yield (10104 kg ha^{-1}), harvest index (24.97%) which was at par with application of

100% RDN + 2% DAP (T_8) and 100% RDN + 2% KNO_3 (T_7).

Acknowledgement
The authors are grateful to College of Agriculture, Latur (VNMKV), Maharashtra for providing the facilities for smooth conduct of the experiment.

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