Madras Agric. J., 105 (7-9): 257-261, September 2018

Enhancement of Finger Millet Productivity through Land Configuration and Nitrogen Management under Sodic Soil

G. Nagarajan, T. Ramesh,* P. Janaki and S. Rathika
Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute,
Tamil Nadu Agricultural University, Tiruchirappalli-620 027, Tamil Nadu, India

A field experiment was conducted at Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirapalli, during *Kharif,* 2017 to study the effect of land configuration and nitrogen management on the productivity of finger millet (TRY 1) under sodic soil. The experiment was laid out in split plot design and replicated thrice. The main plot treatments consisted of land configurations *viz.,* flat bed (M_1), ridges and furrows (M_2) and broad bed furrows (M_3) and the sub plot consisted of N levels *viz.,* 100 per cent Recommended Dose of Nitrogen (RDN) (60 kg ha^{-1}) (S_1), 125 per cent RDN (75 kg ha^{-1}) (S_2) and 150 per cent RDN (90 kg ha^{-1}) (S_3). The entire dose of recommended phosphorus (30 kg ha^{-1}) and potassium (30 kg ha^{-1}) were applied as basal and nitrogen was applied in two equal splits during basal and 30 days after transplanting. The results revealed that ridges and furrows registered higher soil moisture content at 0-10 cm and 10-20 cm depth during all the stages of observations than broad bed furrows and flat bed. Significantly higher growth parameters *viz.,* plant height, number of tillers and DMP and LAI and yield attributes *viz*., productive tillers, length of finger, number of grains per earhead, earhead weight and N uptake were registered under ridges and furrows than flat bed. Grain and straw yields (3428 and 6589 kg ha^{-1}) were recorded significantly higher under ridges and furrows over broad bed furrows and flat bed. In nitrogen management, application of 150 per cent RDN registered significantly higher growth, yield attributes and grain yield (3604 kg ha^{-1}) over 125 and 100 per cent N application. Thus, land configuration through ridges and furrows and application of 150 per cent RDN (90 kg ha^{-1}) could be recommended for higher productivity of finger millet under sodic soil condition.

Key words: Broad bed furrows, Finger millet, Grain yield, Growth parameters, Ridges and furrows

Finger millet (*Eleusine coracana* L.) is a staple food crop grown by poor farmers in the semi-arid tropics of South Asia and Africa. Among the millets, it is ranked fourth globally in importance, after sorghum, pearl millet and foxtail millet. Most of the soils in the semi-arid tropics, where finger millet is grown, are deficient in major and micronutrients, mainly due to lower use of inorganic fertilizers, poor recycling of crop residues and low rates of organic matter application which can limit yield potential. The distribution of saline sodic and sodic soils is more than half a billion hectare worldwide, warranting attention for their efficient, economical and environmentally acceptable management practices. In India, 3.79 m ha and 0.35 m ha in Tamil Nadu have been affected by sodicity which affects the productivity of land directly.

Land configuration techniques such as ridges and furrows and broad bed furrows can play a vital role to overcome soil related problems in sodic soil by providing easy and uniform germination as well as good growth and development of plants. It is particularly useful in areas having problem soils and saline irrigation water because it helps to avoid salt injury and increases water use efficiency and also increases availability of nutrients to crops (Chiroma *et al.,*2008).The recommended land configuration for finger millet is flat bed which produces lesser yield mainly because of poor soil hydro regimes under sodic soil condition. It is highly essential to investigate the benefits of improved land configuration techniques like ridges and furrows and broad bed furrows on the productivity of finger millet under sodic soil with saline water.

Sodic soils are characterized by higher levels of Na^+ in soil solution and on the cation exchange sites and high soil pH, thereby adversely affecting the transformation and availability of several plant nutrients particularly nitrogen. Further, these soils are generally characterized by poor physical condition, low organic matter and total and available nitrogen. Crop yields in sodic soils are adversely affected unless additional nitrogen is applied to compensate for losses due to denitrification, volatilization, etc. Application of 25 per cent extra N over the recommended dose of 150 kg N ha^{-1} is recommended for higher productivity of paddy under sodic soil in Tamil Nadu (CPG, 2012). With this background, the present study has been proposed to study the effect of land configurations and increased level of nitrogen on productivity for finger millet under sodic soil.

*Corresponding author's email: agronramesh@gmail.com

Material and Methods

A field experiment was conducted at Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirapalli during *Kharif*, 2017 to study the effect of land configuration and nitrogen levels on the productivity of finger millet under sodic soil. The experimental site located at 10° 45' N latitude and 78° 36'E longitude with an altitude of 85 m above MSL. The experiment was laid out in split plot design and replicated thrice. The main plot treatments consisted of land configurations *viz.,* flat bed (M_1), ridges and furrows (M_2) and broad bed furrows (M_3) and the sub plot consisted of N levels *viz.,* 100 per cent RDN (60 kg ha^{-1}) (S_1), 125 percent RDN (75 kg ha^{-1}) (S_2) and 150 per cent RDN (90 kg ha^{-1}) (S_3). The entire dose of recommended phosphorus (30 kg ha^{-1}) and potassium (30 kg ha^{-1}) were applied as basal and nitrogen was applied in two equal splits during basal and 30 days after transplanting. TRY 1 finger millet variety was used for the study. The soil of the experimental field was sandy clay loam in texture, moderately drained and classified as *Vetric Ustropept.* The initial soil status was low in available nitrogen, medium in available phosphorus and high in available potassium. The irrigation water was neutral in pH (7.6) with slightly saline (EC= 2.07 dSm^{-1}) in nature.

After thorough land preparation, flat beds were formed manually in the size of 40 m^2. Ridges and furrows were formed using tractor drown ridger with spacing of 60 cm between ridges. Broad bed former with spacing of 120 cm bed width and 15 cm furrow width and depth was used to form broad bed furrows. Thirty days old seedlings were transplanted in the main field by adopting a spacing 30 cm x 10 cm with one seedling per hill. Soil moisture content was estimated at 0-10 cm and 10-20 cm soil depths at 10 days interval after transplanting. Observations on growth characters *viz.,* plant height, number of tillers, dry matter production and yield parameters *viz.,* productive tillers, length of finger, number of grains per earhead, earhead weight, test weight and grain and straw yields were recorded. Nitrogen uptake was computed from nitrogen concentration and dry matter production and expressed as kg ha^{-1}.

Results and Discussion

Soil moisture content

Soil moisture content at root zone depth varied with land configuration techniques. Among the land configurations, ridges and furrows retained higher soil moisture content at the root zone depth (0-10 and 10-20 cm) at all the stages of crop growth over broad bed furrows and flat bed (Fig 1). The mean increment in soil moisture under ridges and furrows was to the tune of 12.4 and 13.2 per cent at 0-10 and 10-20 cm soil depths respectively over flat bed. The increase in soil moisture in the ridges and furrows was mainly due to better infiltration of water in the furrows. The results were in accordance with findings of Arul *et al.* (2008) and Mahitha *et al.* (2014). Broad bed furrows registered 8.8 per cent higher mean soil moisture content than flat bed at flowering stage. The results were in conformity with Kuotsu *et al.* (2014). The lowest soil moisture content was registered under flat bed due to more evaporation and surface runoff.

Table 1. Effect of land configuration and nitrogen levels on growth parameters of finger millet

Treatments	Flowering stage		Harvest stage		
	Leaf area index	SPAD reading	Plant height (cm)	Number of tillers (m^{-2})	Dry matter production (kg ha^{-1})
Land configuration					
M1- Flat Bed	4.09	36.4	91.2	193	8044
M2 - Ridges and Furrows	4.75	39.8	98.2	210	9932
M3 - Broad Bed Furrows	4.29	39.0	95.7	196	9026
S.Ed	0.16	0.20	0.87	4	265
C.D (P=0.05)	0.45	0.54	2.41	11	735
Nitrogen levels					
S1 – 100 % RDN	3.99	35.0	89.9	190	7875
S2 – 125 % RDN	4.36	38.7	95.7	201	8956
S3 – 150 % RDN	4.78	41.4	100.5	211	10172
S.Ed	0.14	0.73	2.37	4	226
C.D (P=0.05)	0.30	1.59	4.65	8	494

*Interaction absent *RDN-Recommended Dose of Nitrogen

Effect on growth parameters of finger millet

Growth parameters of finger millet were significantly influenced by different land configurations and N levels (Table 1). Among the land configurations, ridges and furrows registered significantly taller plants (98.2 cm), more number of tillers (210 m^{-2}), dry matter production (9932 kg ha^{-1}) at harvest stage and higher leaf area index (4.75) and SPAD reading (39.8) at flowering stage than flat bed. This could be attributed to the fact that higher moisture and nutrients availability under ridges and furrows improved the higher plant height and number of leaves per plant and higher LAI which resulted in more photosynthetic rate and finally higher dry matter production of finger millet. This was followed by broad bed furrows, which recorded higher plant height (95.7 cm), number of tillers (196 m^{-2}), dry matter production (9026 kg ha^{-1}) and leaf area index (4.29) than flat bed. The lowest plant height (91.2 cm), number of tillers (193 m^{-2}), dry matter production (8044 kg ha^{-1}) and leaf area index (4.09) observed under flat bed.

Table 2.Effect of land configuration and nitrogen levels on yield parameters of finger millet

Treatments	Yield parameters				
	No. of productive tillers (m^2)	Finger length (cm)	No. of grains ($earhead^{-1}$)	Earhead weight (g)	Test weight (g)
Land configurations					
M_1- Flat Bed	172	5.7	1621	5.7	3.2
M_2 - Ridges and Furrows	196	6.1	1789	6.4	3.3
M_3 - Broad Bed Furrows	184	5.9	1684	6.1	3.2
S.Ed	4.0	0.08	39.0	0.19	0.03
C.D (P=0.05)	9.1	0.21	84.9	0.40	NS
Nitrogen levels					
S_1– 100 % RDN	164	5.5	1640	5.6	3.1
S_2– 125 % RDN	177	5.8	1725	6.0	3.2
S_3– 150 % RDN	194	6.4	1806	6.6	3.7
S.Ed	3.6	0.20	34.1	0.15	0.9
C.D (P=0.05)	7.9	0.44	77.6	0.29	0.19

*Interaction absent *RDN-Recommended Dose of Nitrogen

With regard to N levels, significantly higher plant height (100.5 cm), number of tillers (211 m^{-2}), dry matter production (10172 kg ha^{-1}) at harvest stage and leaf area index (4.78) and SPAD reading (41.4) at flowering stage were recorded under application of 150 per cent recommended dose of nitrogen (RDN).

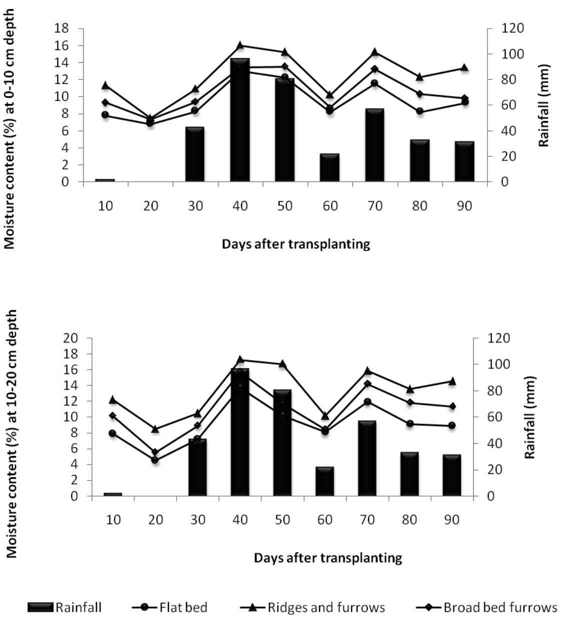

Fig. 1. Effect of land configurations on available soil moisture content (%) at 0-10 and 10-20 cm depth

This was followed by application of 125 per cent RDN, which recorded the plant height of 95.7 cm, number of tillers of 201 m^{-2} , leaf area index of 4.36 and dry matter production of 8956 kg ha^{-1} Higher nitrogen levels increased plant height, tillers production and leaf area index improved the photosynthetic efficiency of plant resulted in more DMP (Idikut *et al.,* 2009). Application of 100 per cent RDN registered the lower plant height (89.9 cm), number of tillers (190 m^{-2}), dry matter production (7875kg ha^{-1}) and leaf area index (3.99).

Effect on yield parameters of finger millet

The data on yield attributes of finger millet *viz.,* number of productive tillers m^{-2}, finger length (cm), number of grains per earhead (g), earhead weight (g) and test weight (g) were significantly influenced by land configuration and nitrogen management (Table 2). Ridges and furrows produced significantly more number of productive tillers (196 m^{-2}), length of finger (6.1 cm), number of grains per earhead (1789) and earhead weight (6.4 g) as compared to broad bed furrows and flat bed. The increment in yield attributes was mainly due to increased moisture and nutrient availability and lesser salt accumulation at the root zone under ridges and furrows would have improved the growth parameters that ultimately supplied more photosynthates for development of sink. Broad bed furrows which registered higher number of productive tillers (184 m^{-2}), length of finger (5.9 cm), number of grains per earhead (1684), earhead weight (6.1 g) than flat bed. The lower yield parameters were recorded with flat bed was mainly due to low soil moisture content, insufficient nutrient availability and more salt accumulation in root zone would have reduced the crop growth and ultimately lesser yield parameters. Similar findings were reported by (Allolli *et al.,* 2008). The test weight of finger millet not varied significantly due to land configurations.

Among the levels of N, application of 150 per cent RDN registered significantly more number of productive tillers (194 m^{-2}), length of finger (6.4 cm), number of grains per earhead (1806), earhead weight (6.6) and test weight (3.7 g) over lower doses. Adequate supply of nitrogen under higher N levels increased the N uptake, translocation along with other nutrients might have improved the source-sink relation and ultimately more yield attributes. Lesser number of productive tillers (164 m^{-2}), length of finger (5.5 cm), number of grains per earhead (1640), earhead weight (5.6 g) and test weight (3.1 g) was obtained with application of 100 per cent RDN.

Effect on grain and straw yields of finger millet

Different land configuration and N levels had significant influence on grain and straw yields of finger millet. Significantly higher grain and straw yields (3428 and 6589 kg ha^{-1}) were registered under ridges and furrows over broad bed furrows and flat bed (Table 3). This was mainly due to increased availability of soil moisture content in the root zone under ridges and furrows would have increased the nutrients availability resulted in improved growth parameters *viz.,* plant height, dry matter production, leaf area index, tillers, root growth parameters and yield parameters such as productive tillers, earhead weight, finger length and test weight which ultimately the grain yield. Further, ridges and furrows land configuration reduced the soil compaction, salt accumulation at the root zone and increased the root activity and microbial population in the rhizosphere of sodic soil ecosystem. The broad bed furrows registered grain and straw yields of 3210 and 6357 kg ha^{-1}, which was comparable with flat bed. These findings are in accordance with the finding of Augustina *et al*. (2017). The lowest grain and straw yields were recorded under flat bed. This might be due to lower moisture content coupled with more evaporation resulted in accumulation of salts in the root zone and surface hardening of sodic soils. These conditions reduced the root activity and nutrient availability which resulted in reduced crop growth parameters and ultimately lesser grain yield.

In nitrogen management, significantly higher grain and straw yields (3604 and 6740 kg ha^{-1}) were recorded under application of 150 per cent RDN than lower doses of nitrogen. This was followed by 125 per cent RDN (3215 and 6231 kg ha^{-1}). Application of 150 per cent RDN recorded 26.2 and 19.1 per cent higher grain and straw yields than 100 per cent RDN. Increased availability of nitrogen under sodic soil due to higher level of nitrogen application would have improved the plant height, number of tillers and leaf chlorophyll content which resulted in more photosynthates accumulation and more yield attributes and ultimately higher grain and straw yields. Since, sodic soil has various means of N losses, excess N application required to compensate the N losses and adequate N availability to crops (Gupta *et al.,* 2011). Inadequate nitrogen supply under 100 per cent RDN resulted in lesser crop growth and yield.

Table 3. Effect of land configurations and nitrogen levels on grain and straw yields and nitrogen uptake of finger millet

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Nitrogen uptake (kg ha^{-1})
Land configurations			
M_1- Flat Bed	3035	6120	100.8
M_2 - Ridges and Furrows	3428	6589	131.7
M_3 - Broad Bed Furrows	3210	6357	116.6
S.Ed	88	178	4.75
C.D (P=0.05)	200	396	10.33
Nitrogen levels			
S_1 – 100 % RDN	2855	5657	95.6
S_2 – 125 % RDN	3215	6231	115.6
S_3 – 150 % RDN	3604	6740	137.9
S.Ed	80	201	5.98
C.D (P=0.05)	174	439	11.56

Effect on nitrogen uptake of finger millet

Nitrogen uptake (131.7 kg ha^{-1}) at harvest was significantly higher under ridges and furrows over broad bed furrows and flat bed (Table 3). This was due to that ridges and furrows favoured higher soil moisture content, increased root growth and nitrogen availability, which ultimately increased the N uptake. Increased uptake of N under ridges and furrows could be attributed to higher dry matter production and grain yield (Mudalagiriyappa *et al*. 2015). The lowest N uptake of 100.8 kg ha^{-1} was noticed with flat bed. Application of 150 per cent RDN registered 44.2 per cent higher nitrogen uptake over recommended dose of nitrogen. The lower N uptake was noticed under application of 100 per cent RDN.

From the above study, it could be concluded that growing of finger millet under ridges and furrows and application of 150 per cent RDN (90 kg ha^{-1}) found to increase the productivity of finger millet under sodic soil ecosystem.

References

Augustina, S., Shirshendu, S., and V.M. Bhale. 2017. Effect of land configuration and nutrient management on growth and yield of organic guar gum. *Environment and Ecology*, **35(2)**: 799–801.

Allolli, T. B., Hulihalli, U. K. and S. I. Athani, 2008. Influence of in situ Moisture Conservation Practices on the Performance of Dryland Cluster Bean. *Karnataka Journal of Agricultural Science,* **21(2)**:250-252.

Arul, K. P., Shinde, V. S., Solunke, P. S., Kubde, K. J. and V. D. Kadam. 2008. Influence of *in-situ* soil moisture conservation techniques on moisture use efficiency, yield and economics of maize under rainfed condition. *Annals of Plant Physiology*, **22(2)**: 202–204.

Chiroma, A. M., Alhassan, A. B. and B. Khan,. 2008. Yield and water use efficiency of millet as affected by land configuration treatments.*Journal of Sustainable Agriculture*, **32(2)**:321–333.

CPG. 2012.Crop Production Guide.Department of Agriculture, Govt. of Tamil Nadu, Chennai and Tamil Nadu Agricultural University, Coimbatore.

Gupta, R. K. M., Verma, K., Singh, K. P., and M. Singh. 2011. Influence of bio-chemical fertilizers on growth and yield of finger millet (*Eleusine coracana L.*). *Pantnagar Journal of Research*, **9(1)**: 96–102.

Idikut, L., Tiryaki, I., Tosun, S., and H. Celep. 2009. Nitrogen rate and previous crop effects on some agronomic traits of two corn (*Zea mays L.*) cultivars Maverik and Bora. *African J. Biotech.,* **8(19)**: 4958–4963.

Kuotsu, K., Das, A., Lal, R., Munda, G. C., Ghosh, P. K., and Ngachan, S. V. 2014. Land forming and tillage effects on soil properties and productivity of rainfed groundnut (*Arachis hypogaea* L.) – rapeseed (*Brassica campestris* L.) cropping system in Northeastern India. *Soil Tillage Res.,142*, 15–24.

Mahitha, B., Ramulu, V., Kumar, K. A., and M.U.M.A. Devi. 2014. Effect of land configurations and mulches on soil moisture conservation , growth and yield of maize (*Zea mays L.*) Under rainfed conditions.*The Journal of Research*, **42(3)**: 87–91.

Mudalagiriyappa, B., Raghavendra, G., Ramachandrappa, B.K. and H.V. Nanjappa. 2015. Influence of customized fertilizers on growth and yield of finger millet (*Eleusine coracana (L.) Gaertn.*) in *Alfisols* of Southern India. *J. Dryland Agric. Res. and Dev.,* **30(1)**: 50-54.

Received : February 20, 2018; Revised : March 10, 2018; Accepted : March 25, 2018