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Effect of different land configuration on soil moisture, growth and yield of foxtail millet (*Setaria italica*) under rainfed alfisols

Kathirvelan, P.

Tapioca and Castor Research Station, Tamil Nadu Agricultural University, Yethapur, Salem- 636 119, Tamil Nadu, India.
Corresponding Author's E-mail: kathirvelan76@yahoo.co.in

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ABSTRACT

Experiment was conducted to study the effect of different moisture conservation practices on soil moisture, growth and yield of foxtail millet under rainfed alfisol during 2014-15. The experiment consisted of seven treatments viz., T1 Broad Bed and Furrow, T2 Compartmental Bunding, T3 Ridges and Furrows, T4 Tied Ridges, T5 Basin Listing, T6 Vertical Mulching and T7 Flat Bed. The soil moisture content ranges from 0.4 per cent to 17.2 per cent and the highest soil moisture of 17.2 per cent was recorded during the flowering stage of the crop growth under tied ridges followed by ridges and furrows (15.5 per cent). The results on yield attributing characters and yield revealed that crop grown under tied ridges followed by ridges and furrows attained fifty per cent flowering stage at 45 DAS and physiologically matured 10 days earlier as compared to other moisture conservation practices. Significantly higher productive tillers plant-1 (16.4), ear head length (22.2 cm) and test weight (3.06 g) were registered with tied ridges treatment and the next best treatment was ridges and furrows. Similarly, grain was significantly higher in tied ridges though it was at par with ridges and furrows and compartmental bunding. Whereas, green fodder yield was significantly higher in tied ridges (6654 kg ha-1) and the next best treatments were ridges and furrows and compartmental bunding. Higher gross returns (Rs 84465 ha-1), returns above variable cost (Rs. 60965 ha-1) with a benefit-cost ratio of 3.6 were recorded with tied ridges.

Key words: Soil moisture, drought, *in situ*, grain and green fodder yield

Recurrently, rainfall becomes an important constraint for crop production in Semi-arid regions of India, this region has low rainfall, high evaporation and low water use efficiency. In order to reduce evaporation, conserving soil moisture and ensuring the crop productivity moisture conservation practices has been used as means of conserving soil and water resources for productivity enhancement of dry land crops. However, the effectiveness of conservation tillage depends on soil type, climate, and land slope (Lampurlanes *et al.*, 2002). Foxtail millet (*Setaria italica*) is one of the main antiquity crop mainly grown in semi-arid region by disadvantaged groups including small and marginal holders for their livelihood security. It has the ability to withstand severe drought, matures earlier, requires very minimum external inputs, free from biotic and abiotic stresses and produces the reasonable yield even under marginal resources. It is highly resilient in adapting to different agro-ecological situations and ideal crop for climate change and contingency planting. Its grain has unique nutritional properties viz., high fibre, protein, minerals, vitamins and also possesses special health benefitting properties desired by people who suffering from life-style diseases like obesity and diabetes.

However, the productivity in semi-arid region is often limited by either early or terminal drought (Pan et al., 2012). The major reason for low productivity in foxtail millet is that it is being cultivated in marginal soils under scarcity conditions and non-adoption of improved management practices. Foxtail millet responds well to improved agronomic practices consisting of land configuration, timely sowing with optimum density and weeding and thus crop management strategies should be prioritized to identify the location specific crop production techniques. Hence, the present investigation was carried out to find out most efficient in-situ soil

moisture conservation practices for maximizing the productivity of foxtail millet under rainfed condition.

MATERIALS AND METHODS

Field experiment was conducted at Dry land Agricultural Research Station Experimental Farm, Chettinad during *Kharif* 2014 season to find out the effect of different in-situ moisture conservation techniques for enhancing the productivity of foxtail millet under rainfed condition. The experiment consisted of the following treatments such as T_1 Broad Bed and Furrow, T_2 Compartmental Bunding, T_3 Ridges and Furrows, T_4 Tied Ridges, T_5 Basin Listing, T_6 Vertical Mulching and T_7 Flat Bed. The trial was laid out in Randomized block design with four replications. The different soil moisture conservation practices such as broad bed and furrow (105 cm width and 50 cm furrow depth), compartmental bunding (8x5m), ridges and furrows (25x15cm), tied ridges (25x15 cm) at 60 cm intervals, basin listing (25x15 cm), vertical mulching (25x30cm) were formed on 26.08.2014 with residual soil moisture and these treatments were compared with flat bed. The soils of experimental field represent the red sandy loam type. The available nutrient status of the field was low in N (165 kg ha^{-1}), medium in phosphorus (22 kg ha^{-1}) and medium in potash (197 kg ha^{-1}).

Table 1. Physico-chemical properties of the experimental field

Particulars	Value
p^H	6.5
EC (dS m^{-1})	4.0
Organic carbon (%)	0.38
Nitrogen (kg ha^{-1})	165 kg ha^{-1}
Phosphorus (kg ha^{-1})	22 kg ha^{-1}
Potassium (kg ha^{-1})	197 kg ha^{-1}
Textural class	Red sandy loam
Bulk density (g CC-1)	1.49

The seeds of short duration variety CO 7 were sown by manual pre monsoon seeding with a spacing of 22.5x10 cm. Required plant population was maintained by thinning at 15 days after sowing (DAS). Soil moisture was measured using soil moisture pulse meter (Model MPM-160 B) at fortnightly interval. The recommended doses of organic manure as FYM @ 12.5.0 t ha^{-1} including inorganic fertilizers (44:22 kg NP ha^{-1}) were applied along the planting rows as urea and diammonuim phosphate and covered with soil. Nitrogen was applied in two splits at 20 and 40 DAS and whole amount of phosphorus was applied as basal. All other plant protection measures were adopted as per the technical programme. The total number of productive tillers, ear head length and test weight from five plants were counted and mean arrived. Grains from each treatment were thrashed separately. The harvested grains from the net plot were sun dried, cleaned and then grain yield was recorded for the individual treatment after drying to 12 per cent seed moisture and expressed in kg ha^{-1}.

RESULTS AND DISCUSSION

Rainfall and its distribution:

The rainfall received during the cropping period (*Kharif* 2014 season) is presented in Fig 1. The amount of rainfall received during *Kharif* 2014 season was 579 mm in 25 rainy days and the average maximum and minimum temperature were 30.3 and 22.8°C, respectively. The highest rainfall of 112.5 mm was received during 41st standard week while the lowest rainfall of 4.0 mm was received during 44 th standard week. A continuous dry spell of 8 days was noticed during 35th standard week at which crop was coincided with vegetative stage.

Effect of moisture conservation practices on soil moisture retention capacity:

The results on soil moisture recorded during the critical period of crop growth (Table 2) revealed that the highest soil moisture was observed at 45 DAS week followed by 60 DAS and the lowest values were observed at 30 DAS. With respect to different management practices on in-situ soil moisture conservation techniques, invariably at all the stages of crop growth, the highest soil moisture retention capacity was recorded in tied ridges treatment followed by ridges and furrows. The soil moisture content ranges from 0.4 per cent to 17.2 per cent and the highest soil moisture of 17.2 per cent was recorded during the flowering stage of the crop growth under tied ridges followed by ridges and furrows which recorded the soil moisture content of 15.5 per cent. The lowest soil moisture content of 0.4 and 0.5 per cent, respectively was noticed under Broad Bed and Furrow and Flat bed.

The highest soil moisture retention capacity recorded throughout the cropping period from 15 DAS to 75 DAS under tied ridges treatment as envisaged in the study was evidently due to the

reduction in runoff and soil erosion during the monsoonal period which resulted in high infiltration rate of the soil and greater availability of water in the root zone.

Effect of moisture conservation practices on productivity of foxtail millet:

Moisture conservation practices had significant influence on days to fifty per cent flowering and days to maturity as evidenced by the results of the experiment which revealed that crop grown under tied ridges followed by ridges and furrows attained fifty per cent flowering stage at 45 DAS and physiologically matured 10 days earlier as compared to other moisture conservation practices. With reference to number of productive tillers plant^{-1}, significant difference was noticed among the moisture conservation practices and the highest productive tillers plant^{-1} of 16.4 was registered with tied ridges treatment. The next best treatment was ridges and furrows which were observed to be on par with compartmental bunding. The lowest value of this parameter was noticed under broad bed and furrow treatment followed by flat bed. Among the different moisture conservation practices evaluated, tied ridges had the highest ear head length of 22.2 cm followed by ridges and furrows (20.2 cm) however, it was at par with compartmental bunding (19.8 cm) and vertical mulching treatments (19.6 cm). Moisture conservation practices had exhibited significant variation on test weight and highest values of these parameters were registered with tied ridges though (3.06 g) it was observed to be at par with other insitu moisture conservation practices except flat bed and broad bed and furrow system. The better growth, yield attributing characters in tied ridges treatment was apparently due to favorable physical environment for the increased mineralization and mobility of applied fertilizers by reducing the runoff and enhancing the infiltration rate of the soil which resulted in higher moisture retention capacity as compared to other treatments (Singh *et al*., 2013). Similarly, grain was significantly higher in tied ridges though it was at par with ridges and furrows and compartmental bunding. Whereas, green fodder yield was significantly higher in tied ridges (6654 kg ha^{-1}) and the next best treatments were ridges and furrows and compartmental bunding. This was mainly due to increased water holding capacity with increased availability of the applied nutrient in the soil which in turn increased the nutrient uptake and photosynthetic efficiency, thus leading to early flowering, higher productive tillers plant^{-1}, ear head length and test weight, resulted in higher grain and green fodder yield as envisaged in the investigation (Khurshid *et al*., 2006 and Yadav, 2010).

Effect of moisture conservation practices on profitability of foxtail millet:

Cost of cultivation, gross returns, net returns and benefit cost ratio varied among the different moisture conservation practices (Table 4) and the results revealed that the lowest cost of cultivation of Rs. 23500 ha^{-1}, higher gross returns (Rs 84465 ha^{-1}), returns above variable cost (Rs. 60965 ha^{-1}) with a benefit cost ratio of 3.6 were recorded with tied ridges. The next best treatment was ridges and furrows which recorded cost of cultivation of Rs. 23000 ha^{-1}, gross returns of Rs 78570 ha^{-1}, net returns of Rs. 55570 ha^{-1} with a benefit cost ratio of 3.4. Lowest values of these parameters were noticed under broad bed and furrow and flat be system.

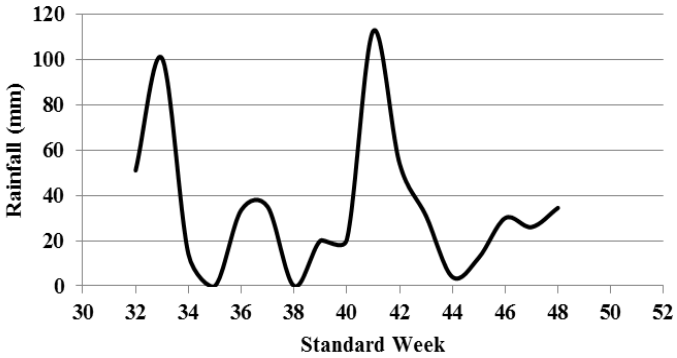

Fig 1. Rainfall recorded during the cropping period

Table 2. Soil moisture (%) recorded during the cropping period (*Kharif* 2014).

Treatment	15 DAS	30 DAS	45 DAS	60 DAS	75DAS
Broad Bed and Furrow	3.8	0.4	14.6	10.6	5.1
Compartmental Bunding	4.4	1.8	15.0	12.9	5.1
Ridges and Furrows	5.2	3.0	15.5	13.1	7.5
Tied Ridges	7.2	3.5	17.2	14.9	7.6
Basin Listing	3.6	1.5	12.3	9.1	5.2
Vertical Mulching	3.8	1.1	13.0	10.5	5.4
Flat Bed	3.1	0.5	12.1	9.1	4.8

Table 3. Effect of different insitu soil moisture conservation techniques on growth and yield attributing characters of foxtail millet variety CO 7 under rainfed condition.

Treatment	Days to 50% flowering	Days to maturity	Productive tillers plant^{-1}	Ear head length (cm)	Test weight (g)
Broad Bed and Furrow	54	91	8.4	17.2	2.57
Compartmental Bunding	49	91	14.4	19.8	2.95
Ridges and Furrows	45	80	14.8	20.2	2.99
Tied Ridges	45	80	16.4	22.2	3.06
Basin Listing	54	91	10.8	18.4	2.75
Vertical Mulching	52	91	11.3	19.6	2.85
Flat Bed	52	91	10.1	17.6	2.65
S.Em±	1.22	1.83	0.37	0.49	0.17
CD (P=0.05)	2.56	3.85	0.81	1.07	0.38

Table 4. Effect of different insitu soil moisture conservation techniques on yield and economics of foxtail millet variety CO 7 under rainfed condition.

Treatment	Grain yield (kg ha^{-1})	Fodder yield (kg ha^{-1})	Cost of Cultivation (Rs ha^{-1})	Gross Income (Rs ha^{-1})	Net Income (Rs ha^{-1})	BCR (Rs ha^{-1})
Broad Bed and Furrow	799	4412	23500	35955	12455	1.5
Compartmental Bunding	1737	5772	22750	78165	55415	3.4
Ridges and Furrows	1746	5982	23000	78570	55570	3.4
Tied Ridges	1877	6654	23500	84465	60965	3.6
Basin Listing	1426	4851	23000	64170	41170	2.8
Vertical Mulching	1447	4912	24500	65115	40615	2.7
Flat Bed	1140	4456	22750	51300	28550	2.3
S.Em±	86.8	200.9	-	-	-	-
CD (P=0.05)	189.2	437.8	-	-	-	-

CONCLUSION

From this study, it could be concluded that soil moisture conservation practices such as tied ridges and ridges and furrows proved to be the best agronomic management practices for higher productivity an economic returns besides conserving soil moisture.

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