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RESPONSE OF PEARLMILLET CULTIVARS TO DIFFERENT MOISTURE CONSERVATION PRACTICES UNDER RAINFED CONDITION ON LIGHT TEXTURED SOIL OF CENTRAL UTTAR PRADESH, INDIA

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ABSTRACT

A field experiment was conducted during *kharif* seasons of 2018 and 2019 at Soil Conservation and Water Management Farm of C.S. Azad University of Agriculture and Technology, Kanpur, to study the performance of pearlmillet cultivars under varying moisture conservation practices in terms of production, total water use, water use efficiency and root development under rainfed condition. Results revealed that among cultivars, 'Krishna-834' considered to be the most promising in terms of yield, WUE, root development, net return and B:C ratio. One weeding and hoeing + organic residue mulch @ 4 t ha^{-1} on soil surface at 25 DAS brought out significantly higher production as compared to ridging and furrowing as well as one weeding and hoeing practices. The roots $plant^{-1}$, dry weight of roots $plant^{-1}$, soil moisture status, WUE and net return were also the highest, where mulching practice was taken as moisture conservation practice.
***Keywords*:** Soil moisture status, consumptive use, water use efficiency, root development, B:C ratio.

Introduction

The economy of India has a close and vital link with rainfall during the south-west monsoon season. The onset and advancement of south-west monsoon over the country play a crucial role during the sowing of *kharif* crops. The timely onset of south-west monsoon over Kerala and its northward progress across the country is of vital importance to the agriculture operations all over India as well as for water replenishment and management. A late onset or advancement of monsoon may have devastating effects on agriculture, even if the mean annual rainfall is normal (Tyagi *et al.,* 2011). However, these rational distribution of rainfall which affected crop growth and development, in turn reduced the pearlmillet productivity. This indicates the role of soil moisture even at the time of planting. Suitable *in situ* moisture conservation practice and choice of a good cultivar consistent with available moisture at the critical stage of crop growth offer a good scope to enhance the production potential of pearlmillet crop. Therefore, the present experiment was conducted.

Materials and Methods

A field experiment was conducted during *kharif* seasons of 2018 and 2019 at Soil Conservation and Water Management Farm of the C.S. Azad University of Agriculture and Technology, Kanpur. The experiment site had a slope of 1.7% with the top soil washed out by water erosion. However, the area was made cultivable by bunding. The soil of experimental field was moderately deep, well drained, sandy loam in nature having 0.33% organic carbon, 0.031% total-N, 166.2 kg ha^{-1} available-N, 17.8 kg ha^{-1} available P_2O_5 and 131.3 kg ha^{-1} available K_2O. The soil pH was 7.9 and EC (1:2.5) was 0.36 dSm^{-1}. The values of field capacity, wilting point, water holding capacity, bulk density, particle density and porosity of the surface soil 18.6%, 6.1%, 28.6%, 1.35 Mg m^{-3}, 2.60 Mg m^{-3} and 48.1%, respectively. The treatments consisted of 3 cultivars i.e. Krishna-4311, Anand, Krishna-834 and 3 moisture conservation practices i.e. one weeding and hoeing by *khurpi* at 25 DAS, ridging and furrowing with the help of spade in between the crop rows at 25 DAS and one weeding and hoeing by *khurpi* + organic residue mulch @ 4 t ha^{-1} on soil surface at 25 DAS were tested in the experiment. The treatments were replicated thrice in a factorial randomized block design. The gross plot size was 5.0 m x 3.60 m but the net plot size was 4.0 m x 2.70 m. Pearlmillet crop was sown spaced at 45 cm apart with recommended seed rate of 5 kg ha^{-1} on July 27 and 28 during 2018 and 2019, respectively. An uniform dose of 40 kg N + 40 kg P_2O_5 + 40 kg K_2O ha^{-1} was applied as basal at sowing through funnel attached with country plough. Additional 40 kg N ha^{-1} through Urea top dressed in standing crop at optimum soil moisture condition. Recommended package of cultural operations was applied. The crop was harvested on November 7 and 5 during first and second year, respectively. At sowing time, available soil moisture up to 100 cm soil profile was measured which was 156.7 and 165.8 mm during 2018 and 2019, respectively. Total rainfall during crop period was 420.6 and 592.0 mm during first and second year, respectively.

The soil moisture was determined thermogravimetrically using the samples collected from 0-25, 25-50, 50-75 and 75-100 cm depths at different growth stages. The moisture use by the crop was computed by summing up the values to soil moisture depletion from the profile during the entire crop period. Water use efficiency of the crop was calculated by the formula (WUE = Y/ET) as expressed by Viets (1962). Root studies were made at harvest by selecting 2 plants at random from each plot. The roots were freed with a fine jet of water spray so that the delicate rootlets were not broken. Studies on water use and root development were made in one replication only where the plant stand was most uniform.

Results and Discussion

Soil moisture content

Cultivar 'Krishna-4311' was observed to have higher soil moisture up to one meter soil depth at all the stages of plant growth as compared to 'Anand' and 'Krishna-834' cultivars during both the years (Table-1). It might be associated with genetic make-up of different cultivars. The highest soil profile moisture was observed under one weeding and hoeing + mulching treatment followed by ridging and furrowing at all the growth stages, which might be attributed firstly to arresting the runoff at the site of occurrence, thus providing more opportunity for the rain-water to inter into the soil, and secondly to reduction of surface evaporation and weeds particularly in case of one weeding and hoeing + mulching treatment. These results are in accordance with the views advocated by Kumar *et al.* (2013) and Katiyar *et al.* (2017).

Periodic consumptive use (PCU)

Cultivar 'Krishna-834' resulted higher PCU over 'Anand' and 'Krishna-4311' cultivars (Table-2), which is attributed to more transpiration by the plants and higher water requirement cultivar. The minimum PCU was observed under one weeding and hoeing + mulching plot and maximum under one weeding and hoeing practice at all the growth stages. Mulch is the material applied over the soil surface to check evaporation and weed emergence under the thick cover resulting saved water for long period. These results are supported by the findings of Verma *et al.* (2017).

Total water use and water use efficiency

In case of cultivars, TWU and WUE were maximum in 'Krishna-834' during both the years (Table-2). Higher TWU in this cultivar might be attributed to their better root growth (Table-3) and crop canopy as well as comparatively longer crop duration as compared to other cultivars. Higher grain yield of 'Krishna-834' might has increased the WUE over other cultivars. One weeding and hoeing + mulching treatment recorded lower TWU and higher WUE than other moisture conservation practices during both the years. Higher WUE recorded by the crop grown under one weeding and hoeing + mulching practice might has been due to control of weeds and reduce evaporation loss as a result sufficient conserved water in the soil, which in turn made it possible to utilize moisture by the crop more efficiently over other moisture conservation practices. Similar were the findings of Singh *et al.* (1997), Tejawal *et al.* (2006) and Kumar *et al.* (2013).

Root development

Cultivar Krishna-834' proved better root development i.e. root depth, number of roots plant^{-1} and dry weight of roots plant^{-1} than other cultivars during both the years (Table-3). The varietal differences in root development may be attributed to hereditary characteristics of cultivars. Higher root depth was found to be connected with one weeding and hoeing practice due to lack of available moisture in soil, where crop tended to develop deeper roots in search of available moisture and nutrients. On the other hand, higher number of roots plant^{-1} and dry weight of roots plant^{-1} appeared to be associated with one weeding and hoeing + mulching, where crop appeared to develop lateral roots due to considerable amount of moisture conserved in the surface layer. These results are in accordance with that of Verma *et al.* (2017).

Yield

Pearlmillet cultivars differed significantly in grain and stover yields during both the years (Table-3). Krishna-834 gave significantly higher grain and stover yields over other two cultivars during both the years. Higher yields recorded with 'Krishna-834' might be on account of an overall improvement in yield attributes, compared to 'Anand' and 'Krishna-4311' cultivars. Grain and stover yields were produced significantly highest under one weeding and hoeing + mulching treatment followed by ridging and furrowing and lowest in one weeding and hoeing practice during both the years. Grain yield might be attributed to various yield attributes, while stover yield is the combined effect of growth characters and yield attributes. Similar results have also been reported by Kaushik and Gautam (2012), Kumar *et al.* (2013), Sekhawat *et al.* (2016), Verma *et al.* (2017), and Katiyar *et al* (2017).

Economics

'Krishna-834' cultivar adjudged to be the best and gave highest net return and B:C ratio than 'Anand' and 'Krishna-4311' cultivars during both the years (Table-3). One weeding and hoeing + mulching recorded the highest net return. However, this treatment was failed to exhibit superiority in respect of B:C ratio over ridging and furrowing due to additional cost of cultivation. Treatment of ridging and furrowing exhibited the highest B:C ratio during both the years.

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Table 1 : Soil moisture content up to one meter depth (mm) at different intervals of pearlmillet as influenced by moisture

conservation practices and cultivars

Treatment	2018					2019				
	Sowing time	30 DAS	60 DAS	90 DAS	At harvest	Sowing time	30 DAS	60 DAS	90 DAS	At harvest
Cultivars										
Krishna-4311	156.7	173.4	219.4	127.8	103.1	165.8	179.2	199.1	119.2	102.5
Anand	156.7	173.1	216.7	122.0	95.9	165.8	179.0	195.9	113.6	95.7
Krishna-834	156.7	172.9	215.1	118.0	90.8	165.8	178.7	193.9	109.6	90.8
Moisture cons. practices										
One weeding & hoeing	156.7	172.8	214.4	118.0	90.0	165.8	178.0	192.1	106.7	90.1
Ridging & furrowing in between crop rows	156.7	173.2	218.0	124.0	97.7	165.8	179.3	196.3	114.6	96.9
One weeding & hoeing + organic residue mulch @ 4 t ha^{-1} on soil surface	156.7	173.4	218.8	125.8	102.2	165.8	179.6	200.5	121.1	102.0

DAS = days after sowing

Table 2 : Periodic consumptive use m^{-1} soil depth at different intervals, total water use and water use efficiency of pearlmillet as influenced by moisture conservation practices and cultivars

Treatment	Consumptive use (mm) m^{-1} soil depth								Total water use (mm)		Water use efficiency (kg grain ha^{-1} mm^{-1} of water)	
	Sowing to 30 DAS	30 DAS to 60 DAS	60 DAS to 90 DAS	90 DAS to at harvest	Sowing to 30 DAS	30 DAS to 60 DAS	60 DAS to 90 DAS	90 DAS to at harvest				
	2018				2019				2018	2019	2018	2019
Cultivars												
Krishna-4311	106.2	95.8	100.2	24.7	103.4	101.2	98.3	16.7	326.9	319.6	4.30	4.80
Anand	106.5	98.2	103.3	26.1	103.6	104.2	100.7	17.9	334.1	326.4	4.75	5.11
Krishna-834	106.7	99.6	105.7	27.2	103.9	105.9	102.7	18.8	339.2	331.3	5.19	5.63
Moisture cons. practices												
One weeding & hoeing	106.9	100.2	105.0	28.0	104.6	107.0	103.8	16.6	340.1	332.0	4.20	4.48
Ridging & furrowing in between crop rows	106.4	97.0	102.6	26.3	103.3	104.1	100.1	17.7	332.3	325.2	4.76	5.23
One weeding & hoeing + organic residue mulch @ 4 t ha^{-1} on soil surface	106.2	96.4	101.6	23.6	103.0	100.2	97.8	19.1	327.8	320.1	5.31	5.87

DAS = days after sowing

Table 3 : Root development, yield and economics of pearlmillet as influenced by moisture conservation practices and cultivars

Treatment	Root development								Grain yield (q ha^{-1})		Stover yield (q ha^{-1})		Net return (Rs ha^{-1})		B:C ratio	
	Root depth (cm)	No. of roots plant^{-1}		Dry weight of roots plant^{-1} (g)	Root depth (cm)	No. of roots plant^{-1}		Dry weight of roots plant^{-1} (g)								
		Primary	Secondary			Primary	Secondary									
	2018				2019				2018	2019	2018	2019	2018	2019	2018	2019
Cultivars																
Krishna-4311	21.1	18.1	60.4	19.3	20.2	19.9	64.2	19.4	14.08	15.34	49.15	53.67	16747	17863	1.29	1.59
Anand	22.5	20.4	65.6	21.4	21.7	22.4	68.9	22.2	15.88	16.67	52.78	57.19	17974	20024	1.32	1.62
Krishna-834	24.8	23.0	70.3	23.1	23.8	25.4	72.4	24.3	17.59	18.67	16.32	59.45	21619	22684	1.55	1.68
SE(d)	-	-	-	-	-	-	-	-	0.71	0.60	1.20	1.00	-	-	-	-
CD (P=0.05)	-	-	-	-	-	-	-	-	1.51	1.27	2.54	2.12	-	-	-	-
Moisture cons. practices																
One weeding & hoeing	26.5	17.0	59.7	18.8	25.4	18.6	62.4	19.2	14.29	14.89	50.17	52.27	16083	16083	1.31	1.54
Ridging & furrowing in between crop rows	22.6	20.5	65.0	21.5	21.8	23.0	69.0	22.3	15.83	17.00	52.74	57.38	19234	21389	1.46	1.68
One weeding & hoeing + organic residue mulch @ 4 t ha^{-1} on soil surface	19.3	23.3	71.5	23.5	18.5	26.2	74.1	24.4	17.41	18.78	55.34	60.67	21024	23099	1.40	1.67
SE(d)	-	-	-	-	-	-	-	-	0.71	0.60	1.20	1.00	-	-	-	-
CD (P=0.05)	-	-	-	-	-	-	-	-	1.51	1.27	2.54	2.12	-	-	-	-

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