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Evaluation of pearlmillet genotypes under moisture conservation practices in eroded soil under rainfed condition

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Abstract
Three varieties of pearlmillet were tested under three moisture conservation practices during *kharif* 2018 and 2019 at Soil Conservation and Water Management Farm, Kanpur. Variety 'Krishna-834' provided the highest yield with substantial benefit over 'Anand' and 'Krishna-4311' varieties. One weeding and hoeing + organic residue mulch @ 4 t ha-1 on soil surface at 25 DAS gave the highest growth, yield attributes, grain yield and net return but lowest splash loss as compared to ridging and furrowing as well as one weeding and hoeing practices. Interaction between varieties and moisture conservation practices was found to be non-significant.

Keywords: tillers, canopy development, splash loss, yield, net return

Introduction
Rainfed agriculture plays an important role in contributing to world food security. In India, area under rainfed agriculture is about 85 m ha representing 60% of net cultivated area and support 40% population of the country. Apart from erratic rainfall, soils are highly degraded physically, chemically and biologically (Sharma *et al.*, 2005) [7] and Maruthi Sankar *et al.*, 2010) [5]. A single practice is insufficient to increase the productivity and strategy needs modification with integrated approach of soil and water conservation, crop, variety, land, nutrient management and alternate land use for stabilizing productivity. The challenge of improving productivity in rainfed areas can be addressed by a suitable crop variety and soil moisture management by efficiently utilizing natural resources. The present study was conducted to identify efficient variety and moisture conservation management for attaining sustainable yield, net returns and splash loss from pearlmillet under rainfed condition.

Materials and Methods
A field experiment was conducted during two consecutive *kharif* seasons of 2018 and 2019 at Soil Conservation and Water Management Farm of C. S. Azad University of Agriculture and Technology, Kanpur. The treatments consisted of 3 varieties i.e. (i) Krishna-4311 (ii) Anand (iii) Krishna-834 and 3 moisture conservation practices i.e. (i) One weeding and hoeing by *khurpi* at 25 DAS (ii) Ridging and furrowing with the help of spade in between the crop rows at 25 DAS (iii) 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 3.6 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 *deshi* 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. The soil of the experimental field was 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 d S m^{-1}. The values of field capacity, wilting point, WHC, bulk density and particle density of the surface soil were 18.6%, 6.1%, 28.6%, 1.35 Mg m^{-3} and 2.60 Mg m^{-3}, respectively. Total rainfed during crop period was 420.6 and 592.0 mm during first and second year, respectively.
The crop canopy was measured with the help of a quadrate (2'x2' size) having 2304 small squares. The quadrate was help over the rows of plants and the number of squares covered by plant canopy was counted and the canopy percentage was calculated.

It was recorded at 2 randomly places in each plot after 30, 60, 90 DAS and at maturity stage. For estimation of soil loss by splash erosion, one cylindrical splash cup (10 cm x 20 cm) was fixed in each plot in one replication in such a way that their edges were about 4 cm above the soil surface. After every rain storm the soil splash collected in splash cup was taken into plastic bottles. The plastic bottles were carried to the laboratory and the splash material was filtered through filter paper and the soil along with filter paper was kept in the Oven for drying. The weight of dry soil along with filter paper was determined by means of physical balance. The weight of dry soil obtained on filter paper was determined by deducting the weight of filter paper from the dry weight of soil. The dry weight of soil (g) obtained from each splash cup was calculated in t ha^{-1} by the following formula:

$$\text{Splash loss (t ha}^{-1}) = \frac{3\,(10 \times SS)}{7.956}$$

where, ss = splashed soil (g)

Study on splash loss was made in one replication only where the plant stand was uniform. Net profit and B:C ratio were worked out on the basis of prevailing market rates.

Results and Discussion

Plant growth

Among varieties, 'Anand' produced tallest plants at harvest but number of tillers $plant^{-1}$ was recorded highest in variety 'Krishna-834' during both the years (Table-1). 'Krishna-834' significantly delayed flowering and maturity of pearlmillet crop as compared to 'Anand' and 'Krishna-4311' varieties during both the seasons. It might be due to genetical characters of different varieties and their moisture utilization ability in improving plant growth. Plant height and number of tillers $plant^{-1}$ both recorded highest under one weeding and hoeing + organic residue mulching followed by ridging and furrowing while the lowest in one weeding and hoeing practice during both the years. It may be associated with increased availability of soil moisture in root zone of crop under moisture conservation practice of one weeding and hoeing + mulching. One weeding and hoeing + mulching practice also significantly delayed flowering and maturity than ridging and furrowing as well as one weeding and hoeing practices during both the years. Such delay might be due to increased soil moisture in this treatment which was utilized by plants and prolonged the vegetative growth period. These results are in agreement to the findings of Chaudhary *et al.* (2002) [1] and Rajput and Bhadouriya (2019) [6].

Canopy development and splash loss

Variety 'Krishna-4311' showed higher splash loss of soil as compared to other varieties during both the years (Table-2). The soil loss was found to be directly governed by the crop canopy development. Since, maximum canopy was found in variety 'Krishna-834', the soil loss was less in 'Krishna-834'. Variety 'Krishna-4311' which had the lowest canopy showed maximum soil loss. Among moisture conservation practices, higher splash loss of soil observed under one weeding and hoeing practice during both the years due to minimum vegetative canopy. The minimum splash loss showed under one weeding and hoeing + mulching treatment during both the seasons due to maximum leaf coverage. These results are in conformity with the findings of Jodaugiene *et al.* (2006) [2].

Yield attributes and yield

Pearlmillet varieties differed significantly in grain and stover yields during both the years (Table-4). Krishna-834 gave significantly higher grain and stover yields over other two varieties during both the years. The yield parameters i.e. length of ear, girth of ear, number of ears $plant^{-1}$, weight of ear and 1000 grain weight followed almost similar pattern as in yields (Table-3). Thus, higher yields recorded with 'Krishna-834' might be on account of an overall improvement in yield parameters, compared to 'Anand' and 'Krishna-4311' varieties. 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) [3], Kumar *et al.* (2013) [9] and Verma *et al.* (2017). Harvest index was not influenced by varieties and moisture conservation practices during both the years (Table-4).

Economics

'Krishna-834' variety adjudged to be the best and gave highest net return and B:C ratio over other varieties during both the years (Table-4). As a practice of moisture conservation, 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.

Table 1: Effect of moisture conservation practices on growth of pearlmillet varieties

Treatment	Plant height (cm)		No. of tillers $plant^{-1}$		Days to flowering		Days to maturity	
	2018	2019	2018	2019	2018	2019	2018	2019
Varieties								
Krishna-4311	179.4	181-2	3.3	3.5	58.6	59.7	92.1	93.3
Anand	194.4	197.8	3.8	3.9	60.2	61.5	93.8	94.7
Krishna-834	186.9	189.4	4.3	4.4	61.6	63.2	95.7	97.0
SE(d)	3.4	3.7	0.1	0.1	0.6	0.5	0.7	0.6
CD (P=0.05)	7.2	7.9	0.3	0.3	1.2	1.1	1.5	1.3
Moisture cons. practices								
One weeding & hoeing	176.0	178.7	2.2	2.4	58.0	59.0	91.5	92.4
Ridging & furrowing in between crop rows	186.6	190.8	4.3	4.5	60.4	61.8	94.2	95.2
One weeding & hoeing + organic residue mulch @ 4 t ha^{-1} on soil surface	196.1	198.9	4.9	4.9	61.9	63.6	95.9	97.4
SE(d)	3.4	3.7	0.1	0.1	0.6	0.5	0.7	0.6
CD (P=0.05)	7.2	7.9	0.3	0.3	1.2	1.1	1.5	1.3

Table 2: Effect of moisture conservation practices on crop canopy development and splash loss of pearlmillet varieties

Treatment	Crop canopy development (%)								Splash loss (t ha^{-1})	
	30 DAS	60 DAS	90 DAS	At maturity	30 DAS	60 DAS	90 DAS	At maturity		
	2018				2019				2018	2019
Varieties										
Krishna-4311	28.6	56.0	68.4	36.2	30.4	58.2	69.9	38.0	4.38	4.45
Anand	31.2	58.8	72.1	39.1	33.2	61.2	73.8	41.0	4.29	4.38
Krishna-834	34.0	61.3	76.0	41.8	36.2	63.8	78.1	43.9	4.18	4.29
SE(d)	1.0	1.1	1.7	1.2	1.2	1.1	1.7	1.3	-	-
CD (P=0.05)	2.1	2.4	3.6	2.6	2.6	2.3	3.7	2.8	-	-
Moisture cons. practices										
One weeding & hoeing	27.8	55.9	68.0	35.0	29.2	57.1	69.9	36.9	5.48	5.56
Ridging & furrowing in between crop rows	31.8	58.7	72.3	39.6	34.0	61.1	74.0	41.5	4.33	4.39
One weeding & hoeing + organic residue mulch @ 4 t ha^{-1} on soil surface	34.2	61.5	76.4	42.4	36.7	65.0	77.9	44.7	3.04	3.16
SE(d)	1.0	1.1	1.7	1.2	1.2	1.1	1.7	1.3	-	-
CD (P=0.05)	2.1	2.4	3.6	2.6	2.6	2.3	3.7	2.8	-	-

Table 3: Effect of moisture conservation practices on yield attributes of pearlmillet varieties

Treatment	Length of ear (cm)		Girth of ear (cm)		No. of ears plant^{-1}		Weight of ear (g)		1000-grain weight (g)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Varieties										
Krishna-4311	21.0	21.6	7.0	7.2	2.3	2.1	17.2	18.8	6.82	6.89
Anand	21.9	22.7	7.5	7.6	2.5	2.4	18.0	19.4	8.62	8.97
Krishna-834	23.1	24.0	8.3	8.2	2.7	2.8	19.1	20.3	9.23	9.89
SE(d)	0.4	0.5	0.2	0.1	0.05	0.1	0.3	0.2	0.08	0.06
CD (P=0.05)	0.8	1.0	0.4	0.3	0.1	0.2	0.6	0.4	0.18	0.12
Moisture cons. practices										
One weeding & hoeing	19.6	19.6	6.7	6.5	1.7	1.9	16.7	17.9	7.04	7.25
Ridging & furrowing in between crop rows	22.2	23.2	7.6	7.6	2.6	2.5	18.0	19.7	8.16	8.53
One weeding & hoeing + organic residue mulch @ 4 t ha^{-1} on soil surface	24.2	25.5	8.5	8.9	3.2	2.9	19.6	20.9	9.47	9.96
SE(d)	0.4	0.5	0.2	0.1	0.05	0.1	0.3	0.2	0.08	0.06
CD (P=0.05)	0.8	1.0	0.4	0.3	0.1	0.2	0.6	0.4	0.18	0.12

Table 4: Effect of moisture conservation practices on yield and economics of pearlmillet varieties

Treatment	Grain yield (q ha^{-1})		Stover yield (q ha^{-1})		Harvest index (%)		Net return (Rs ha^{-1})		Benefit : cost ratio	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Varieties										
Krishna-4311	14.04	15.34	49.15	53.67	22.22	22.23	16747	17863	1.29	1.59
Anand	15.88	16.67	52.78	57.19	23.13	22.57	17974	20024	1.32	1.62
Krishna-834	17.59	18.67	56.32	59.45	23.80	23.90	21619	22684	1.55	1.68
SE(d)	0.71	0.60	1.20	1.00	0.91	0.96	-	-	-	-
CD (P=0.05)	1.51	1.27	2.54	2.12	NS	NS	-	-	-	-
Moisture cons. practices										
One weeding & hoeing	14.29	14.89	50.17	52.27	22.17	22.17	16083	16083	1.31	1.54
Ridging & furrowing in between crop rows	15.83	17.00	52.74	57.38	23.08	22.85	19234	21389	1.46	1.68
One weeding & hoeing + organic residue mulch @ 4 t ha^{-1} on soil surface	17.41	18.78	55.34	60.67	23.93	23.64	21024	23099	1.40	1.67
SE(d)	0.71	0.60	1.20	1.00	0.91	0.96	-	-	-	-
CD (P=0.05)	1.51	1.27	2.54	2.12	NS	NS	-	-	-	-

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