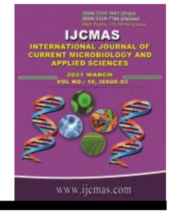
Int.J.Curr.Microbiol.App.Sci (2021) *10*(03): 1378-1384

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 10 Number 03 (2021)**
Journal homepage: http://www.ijcmas.com



Original Research Article https://doi.org/10.20546/ijcmas.2021.1003.168

Relative Impact of *in situ* Moisture Conservation Practices on Sorghum Cultivars under Rainfed Condition

A. K. Katiyar, Sumit Raj* and P. K. Rajput

Department of Soil Conservation and Water Management, C.S. Azad University of Agriculture and Technology, Kanpur, India

**Corresponding author*

Keywords

Canopy development, Splash loss, Soil moisture, Consumptive use, Total water use, Net return, B:C ratio, Yield, Economics, Rainfed

Article Info

Accepted:
10 February 2021
Available Online:
10 March 2021

A B S T R A C T

Four cultivars of sorghum were tested under three *in situ* moisture conservation practices during *kharif* seasons of 2015 and 2016 at Kanpur. Results revealed that the organic residue mulch @ 4 t ha^{-1} on soil surface in between the crop rows after 25 days of sowing brought out significant improvement in crop canopy development and yields over ridging and furrowing in between the crop rows at 25 DAS and farmer's practice (control). Total water use and splash loss were higher under farmer's practice over other moisture conservation practices. The trend was reverse for WUE and splash loss. Mulching treatment also exhibited higher net return as compared to other treatments. However, this treatment was failed to exhibit superiority in B:C ratio over ridging and furrowing plot due to additional cost of mulch application. Among cultivars, Ratna-40 considered to be the most promising in terms of yield and net return.

Introduction

Sorghum (*Sorghum bicolor* L. Moench) is grown under dryland and rainfed conditions, which may suffer due to deficiency of water at critical stage of growth and development. 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 sorghum crop. Therefore, the present experiment was conducted.

Materials and Methods

A field experiment was conducted during two consecutive *kharif* seasons of 2015 and 2016 at Soil Conservation and Water Management Farm of the C.S. Azad University of Agriculture and Technology, Kanpur. The soil of the experimental field was deep, well drained, sandy loam and Calcareous in nature having 0.31% organic carbon, 0.029% total-N, 168.5 kg ha^{-1} available-N, 15.8 kg ha^{-1} available P_2O_5 and 193.0 kg ha^{-1} available

K_2O. The soil pH was 7.8 and EC (1:2.5) was 0.26 d Sm^{-1}. The values of field capacity, wilting point, water holding capacity, bulk density, particle density and porosity of the surface soil were 18.3%, 6.0%, 28.3%, 1.38 Mg m^{-3}, 2.60 Mg m^{-3} and 46.9%, respectively. The treatments consisted of 3 moisture conservation practices i.e. farmer's practice (control), ridging and furrowing in between the crop rows at 25 DAS with the help of spade, organic residue mulch @ 4 t ha^{-1} on soil surface in between the crop rows at 25 DAS and 4 cultivars i.e. Suraj, Virat, Hi-tech-3201, Ratna-40 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 x 2.70 m. Sorghum crop was sown spaced at 45 cm apart with recommended seed rate of 15 kg ha^{-1} on July 16 and 22 during 2015 and 2016, 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 time 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 followed. The crop was harvested on November 20 and 23 during first and second year, respectively. At sowing time, available soil moisture up to 100 cm soil profile was measured which was 231.8 and 202.0 mm during 2015 and 2016, respectively. Total rainfall during crop period was 318.2 and 397.3 mm during first and second year, respectively.

The soil moisture was determined thermo-gravimetrically using the samples collected from 0-25, 25-50, 50-75 and 75-100 cm depths at different growth stages. The amount of moisture use by the crop under different treatments was computed by summing up the value of soil moisture depletion from the profile during the entire crop season. Water use efficiency of the crop was calculated by the method described by Viets (1962). The crop canopy was measured with the help of a quadrate (2'x 2' 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 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:

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

where, ss = splashed soil (g)

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

Results and Discussion

Crop canopy development

The crop canopy development was recorded significantly higher under organic residue mulching treatment followed by ridging and furrowing and lowest in farmer's practice plot at 30, 60, 90 DAS and maturity stage during both the years (Table 1). It may be associated with increased availability of soil moisture in root zone of crop under mulching treatment. Thus, plants in this treatment utilized more moisture which improved their growth in form of height, stem girth and broad and more number of leaves. These results are in agreement to the findings of Katiyar (2001). Among cultivars, Ratna-40 and Hi-tech-3201 being at par recorded significantly higher values of canopy development than Virat and Suraj cultivars during both the years. It might be associated with genetic make-up of different cultivars. Besides, better root development of Ratna-40 and Hi-tech-3201 might has been helpful in utilizing comparatively more moisture during vegetative crop phase and development of various growth and yield attributes of sorghum.

Splash loss

Among moisture conservation practices, higher splash loss of soil observed under farmer's practice (control) during both the years (Table 1) due to minimum vegetative canopy. The minimum splash loss showed under organic residue mulching treatment during both the seasons due to maximum leaf coverage. These results are in conformity with the findings of Katiyar (2001). Cultivar 'Suraj' showed higher splash loss of soil as compared to other cultivars during both the years. The soil loss was found to be directly governed by crop canopy development. Since, maximum canopy was found in cultivar 'Ratna-40', the soil loss was less in 'Ratna-40'. Cultivar 'Suraj' which had the lowest canopy showed maximum soil loss.

Table.1 Crop canopy development and splash loss of sorghum as influenced by moisture conservation practices and cultivars

Treatment	Crop canopy development (%)								Splash loss (t ha^{-1})	
	2015				2016					
	30 DAS	60 DAS	90 DAS	At maturity	30 DAS	60 DAS	90 DAS	At maturity	2015	2016
Moisture cons. practices										
Farmer's practice	30.5	55.3	70.5	44.1	31.2	56.5	71.7	43.5	4.98	5.18
Ridging and furrowing	33.3	59.8	76.2	51.0	34.3	60.5	77.8	50.2	4.34	4.51
Organic residue mulch @ 4 t ha^{-1}	34.9	62.4	80.1	52.3	36.5	62.7	81.9	52.2	3.10	3.24
SE(d)	0.7	0.9	1.3	0.8	0.9	1.0	1.4	0.8	-	-
CD (P=0.05)	1.4	1.9	2.6	1.7	1.8	2.0	2.8	1.6	-	-
Cultivars										
Suraj	30.8	56.0	71.0	45.6	31.6	56.7	72.7	45.9	4.55	4.70
Virat	32.2	57.9	73.7	47.4	33.2	58.8	75.5	47.5	4.44	4.64
Hi-tech-3201	33.9	60.7	77.5	50.9	35.6	61.3	79.2	49.8	3.97	4.15
Ratna-40	34.7	62.2	80.1	52.5	36.7	62.8	81.0	51.2	3.60	3.75
SE (d)	0.8	1.1	1.4	1.0	1.0	1.1	1.5	0.9	-	-
CD (P = 0.05)	1.6	2.2	3.0	2.0	2.1	2.3	3.2	1.8	-	-

Table.2 Soil moisture content up to one metre depth (mm) at different intervals of sorghum as influenced by moisture conservation practices and cultivars

Treatment	2015					2016				
	Sowing time	30 DAS	60 DAS	90 DAS	At harvest	Sowing time	30 DAS	60 DAS	90 DAS	At harvest
Moisture cons. practices										
Farmer's practice	231.8	231.6	180.9	101.7	65.6	202.0	212.7	196.2	150.3	99.6
Ridging and furrowing	231.8	232.0	194.2	131.4	93.5	202.0	213.2	199.6	156.3	102.7
Organic residue mulch @ 4 t ha^{-1}	231.8	232.4	202.7	147.7	110.9	202.0	213.8	201.3	158.4	104.5
Cultivars										
Suraj	231.8	231.8	196.4	135.2	98.4	202.0	213.1	205.9	169.8	118.0
Virat	231.8	232.0	197.3	136.7	99.9	202.0	213.1	201.6	161.1	108.6
Hi-tech-3201	231.8	232.1	190.4	122.2	85.3	202.0	213.3	200.4	156.8	103.9
Ratna-40	231.8	232.1	186.3	113.6	76.4	202.0	213.4	188.1	132.3	78.9

Table.3 Consumptive use m^{-1} soil depth at different intervals, total water use and water use efficiency of sorghum 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	60DAS to 90 DAS	90 DAS to at harvest	Sowing to 30 DAS	30 DAS to 60 DAS	60DAS to 90 DAS	90 DAS to at harvest				
	2015				2016				2015	2016	2015	2016
Moisture cons. practices												
Farmer's practice	100.1	113.8	119.2	55.4	97.5	110.8	114.6	50.7	388.5	373.6	5.17	5.56
Ridging and furrowing	99.7	100.9	102.8	57.2	97.0	107.9	112.0	53.6	360.6	370.5	6.54	6.57
Organic residue mulch @ 4 t ha^{-1}	99.3	92.8	95.0	56.1	96.4	106.8	111.6	53.9	343.2	368.7	7.60	7.42
Cultivars												
Suraj	99.9	98.5	101.2	56.1	97.1	101.5	104.8	51.8	355.7	355.2	6.01	6.10
Virat	99.7	97.8	100.6	56.1	97.1	105.8	109.2	52.5	354.2	364.6	6.07	6.13
Hi-tech-3201	99.6	104.8	108.2	56.2	96.9	107.2	112.3	52.9	368.8	369.3	6.74	6.90
Ratna-40	99.6	108.9	112.7	56.5	96.8	119.6	124.5	53.4	377.7	394.3	6.69	6.88

Table.4 Grain yield, stover yield, net return and benefit: cost ratio of sorghum as influenced by moisture conservation practices and cultivars

Treatment	Grain yield (q ha^{-1})		Stover yield (q ha^{-1})		Net return (Rs ha^{-1})		B : C ratio	
	2015	2016	2015	2016	2015	2016	2015	2016
Moisture cons. practices								
Farmer's practice	20.09	20.79	66.42	68.07	13876	18047	1.47	1.63
Ridging and furrowing	23.59	24.35	78.02	77.70	22531	25790	1.79	2.13
Organic residue mulch @ 4 t ha^{-1}	26.07	27.34	86.21	86.37	23489	32451	1.71	1.90
SE(d)	0.72	1.07	1.75	1.86	-	-	-	-
CD (P=0.05)	1.49	2.22	3.64	3.85	-	-	-	-
Cultivars								
Suraj	21.36	21.67	70.63	72.10	15882	16235	1.52	1.57
Virat	21.49	22.35	71.06	72.95	16163	20182	1.53	1.70
Hi-tech-3201	24.87	25.48	82.24	80.12	23468	25511	1.78	1.89
Ratna-40	25.28	27.13	83.59	84.33	24348	39786	1.80	2.39
SE (d)	0.83	1.36	2.02	2.10	-	-	-	-
CD (P = 0.05)	1.72	2.82	4.20	4.35	-	-	-	-

Soil moisture status

The highest soil profile moisture up to one metre depth was observed under mulching treatment followed by ridging and furrowing at almost all the growth stages during both the years (Table 2), 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 organic residue mulching treatment. These results are in accordance with the views advocated by Katiyar (2001). Cultivar 'Suraj' was observed to have higher soil moisture up to one metre depth at almost all the stages of plant growth as compared to other cultivars during both the years. It might be associated with genetic make-up of different cultivars.

Periodic consumptive use (PCU)

PCU of sorghum crop was found remarkably influenced by various *in-situ* moisture conservation practices over farmer's practice during both the years (Table 3). The minimum moisture use was observed under the organic residue mulch plot and the maximum under farmer's practice at almost all the growth stages during both the years. Mulch is the material applied over the soil surface to check evaporation and weed emergence under the thick cover of mulch, and thus saved water due to reduced PCU of water under mulching plot. These results are supported by the findings of Katiyar (2001). Cultivar 'Ratna-40' resulted more PCU over the other cultivars during both the years, which is attributed to more transpiration by the plants and higher water requirement cultivar.

Total water use (TWU) and water use efficiency (WUE)

Organic residue mulching treatment recorded lower TWU and higher WUE as compared to other moisture conservation practices during both the years (Table 3). Farmer's practice plot reflected higher TWU due to partial control of weeds as well as open space, which caused higher ET loss but lower moisture utilization by the crop under organic residues mulch may be ascribed to almost all weeds got depressed due to covered space, which are jointly responsible to minimise moisture loss. WUE was higher in mulched plot than other moisture conservation practices as a result of increased yield and lowest TWU in the mulched plot. Beneficial effect of mulch has also been reported by Singh *et al.,* (2012). In case of cultivars, TWU was maximum in Ratna-40 but WUE was highest in Hi-tech-3201 during both the years. Higher TWU in Ratna-40 cultivar might be attributed to their better root development as compared to other cultivars. Higher grain yield of Ratna-40 and Hi-tech-3201 might has increased WUE over other cultivars. These findings of other research workers like Chand and Bhan (2002) support the results of present experiment very well.

Yield

Grain and stover yields of sorghum were produced significantly highest under organic residue mulching followed by ridging and furrowing practice and lowest in farmer's practice during both the years (Table 4). 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 Singh *et al.,* (2013) and Gabir *et al.,* (2014). Among cultivars, Ratna-40 and Hi-tech-3201 being at par produced significantly higher grain and stover yields than other two cultivars during both the years. Grain yield was found associated with various yield attributes, while stover yield might be attributed to growth characters. These results confirm the findings of Mishra *et al.,* (2015).

Economics

Organic residue mulching treatment exhibited higher net return as compared to ridging and furrowing as well as farmer's practice during both the years (Table 4). However, this treatment was failed to exhibit superiority in B:C ratio over ridging and furrowing plot due to additional cost of mulch application. Among cultivars, Ratna-40 earned highest net return and B :C ratio closely followed by Hi-tech-3201. It might be attributed mainly to higher gross return values but total cost of cultivation was similar in all tested cultivars.

References

Chand, M. and Bhan, S. (2002). Root development, water use and water use efficiency of sorghum (*Sorghum bicolor*) as influenced by vegetative barriers in alley cropping system under rainfed condition. *Indian Journal of Agronomy*, 47(3): 333-339.

Gabir, S.I.M.N.; Khanna, M.; Singh, M.; Parihar, S.S.; Mani, I. and Das, T.K. (2014). Effect of conservation practices and fertilizer on sorghum (*Sorghum bicolor*) yield under rainfed conditions of Northern India. *Indian Journal of Agronomy*, 59(2): 301-305.

Katiyar, S.C. (2001). Soil loss, moisture, yield and root growth of sorghum as influenced by conservation practices. *Indian Journal of Soil Conservation*, 29(2): 179-181.

Mishra, J.S.; Thakur, N.S.; Singh, P.; Kubsad, V.S.; Kalpana, R.; Alse, U.N. and Sujathamma, P. (2015). Productivity, nutrient use efficiency and economics of rainy season grain sorghum (*Sorghum bicolor*) as influenced by fertility levels and cultivars. *Indian Journal of Agronomy*, 60(1): 76-81.

Singh, P.; Sumariya, H.K. and Kaushik, M.K. (2013). Effect of *in-situ* soil moisture conservation practices and its interaction with nutrients on yield, quality and economics of sorghum (*Sorghum bicolor*). *Advance Research Journal of Crop Improvement*, 4(2): 88-

92.

Singh, R.P.; Yadav, P.N.; Uttam, S.K.; Katiyar, S.C. and Tripathi, A. K. (2012). Effect of moisture conservation and nutrient management on growth, yield and water use of sorghum. *Current Advances in Agricultural Sciences*, 4(1): 37-40.

Viets, F.G. (1962). Fertilizers and the efficient use of water. *Advances in Agronomy*, 14: 223-261.

How to cite this article:

Katiyar, A. K., Sumit Raj and Rajput, P. K. 2021. Relative Impact of *in situ* Moisture Conservation Practices on Sorghum Cultivars under Rainfed Condition. *Int.J.Curr.Microbiol.App.Sci.* 10(03): 1378-1384.
doi: https://doi.org/10.20546/ijcmas.2021.1003.168