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Growth and productivity of pearl millet as influenced by moisture conservation practices in dry land conditions

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ABSTRACT

Experiment was conducted at Research Farm, College of Agriculture, Fatehpur - Shekhawati, Sikar during *kharif*, 2024 to study the influence of moisture conservation practices on growth and yield of pearl millet [*Pennisetum glaucum* (L.) R. Br.] in dry land conditions. The experiment was laid out in split plot design with Four moisture conservation practices at sowing (M_1 - control, M_2 - Compartmental bunding, M_3 - Running wheel after sowing and M_4 - Application of Pusa hydrogel @ 10 kg/ha at sowing) allocated to main plots and four moisture conservation practices in standing crop (S_1 - Soil mulch at 30 DAS, S_2 - Straw mulch @ 5 t/ha at 30 DAS, S_3 - Running hand plough at 30 DAS and S_4 - Kaolin spray @ 5% at dry spell) allotted to sub plots with three replications. The pearl millet variety 'HHB 299' was grown by following complete package of practices recommended for agro climatic zone II. The findings revealed that practice of running wheel after sowing significantly improved the plant height and dry matter accumulation at 40, 60 DAS and at harvest, periodic CGR and RGR, effective tillers/plant, ear head length and grain, stover and biological yields over the control. The running wheel after sowing had ultimately achieved 46.5, 31.3 and 35.2 per cent higher grain, straw and biological yields, respectively in comparison to control. Results further indicated that plant height and dry matter accumulation at 40, 60 DAS and at harvest, effective tillers/plant, ear head length, grain, stover and biological yield significantly increased with application of straw mulch @ 5 t/ha at 30 DAS. The combination of running wheel after sowing and running hand plough at 30 DAS gave the 134.3% higher grain yield (2,415 kg/ha) in comparison to the combination of control with soil mulch at 30 DAS (1030 kg/ha).

Keywords: Pusa hydrogel, Moisture conservation, Mulches, Pearl millet, Running hand plough, Running wheel, Yield

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is a widely grown drought-tolerant, warm-season *kharif* cereal, serving as a staple food in dry regions and as fodder and feed for livestock in dryland areas of Rajasthan. Its flour, traditionally used for *roti* and flatbreads, is now, getting popularity after celebrating millet year, and being also utilized in products like biscuits, cakes, muffins, kurkure and pasta. Nutritionally, it is superior to many cereals, as 100 g grain provides 361 kcal energy, 12.1 g protein, 67.5 g carbohydrates, 5 g fat and essential minerals, vitamins and amino acids (Satyavathi *et al.*, 2018). In India, pearl millet was grown in 7.38 million ha with production of 10.72 million tonnes and a productivity of 1,453 kg/ha (Anonymous, 2023). The major pearl millet growing states are Rajasthan, Maharashtra, Uttar Pradesh, Gujarat and Haryana, contributing to 90% of the total production in the country. Rajasthan contributes nearly 45% followed by Uttar Pradesh (18%), Gujarat (11.3%), Haryana (11%), Madhya Pradesh (8%) and Maharashtra (4%)

(Anonymous 2023). In Rajasthan, pearl millet was grown in 4.25 million ha with 4.38 million tonnes production and a productivity of 1030 kg/ha. Major pearl millet-growing districts are Barmer (0.978 million ha), Jodhpur (0.443 million ha), Alwar (0.308 million ha), Jalore (0.305 million ha), Nagaur (0.280 million ha) and Jaipur (0.275 million ha) (Anonymous, 2023-24).

Indian agriculture is highly dependent on monsoons and crop failure due to erratic rainfall is common in dryland areas. Moisture management is therefore crucial for improving pearl millet productivity, as inadequate soil moisture limits the efficient use of other resources (Mishra *et al.*, 2015). Sustainable management of natural resources is crucial for achieving long-term agricultural productivity while minimizing environmental degradation. Integrated and conservation-oriented approaches are increasingly emphasized to address emerging challenges in Indian agriculture (Bhardwaj *et al.*, 2011). Since ancient times, several practices have been adopted to conserve soil moisture (Upadhyaya, 2020). Moisture conservation practices at sowing help in reducing evaporation losses, enhancing soil moisture retention, and ensuring better seed-soil contact for uniform germination. By conserving available soil water during the critical early growth stages, they support vigorous seedling emergence, improve nutrient uptake, and promote healthy root development (Rahman *et al.*, 2020; Jalgaonkar *et al.*, 2020). Practices such as compartmental bunding, running wheel after sowing, and the application of Pusa hydrogel not only increase the efficiency of rainfall utilization but also create favourable soil conditions that sustain plant growth during moisture stress periods (Prasad *et al.*, 2020). Ultimately, these methods lead to better crop growth, higher yield stability and improved resilience against erratic rainfall.

Moisture conservation in standing crops is crucial for sustaining growth and yield in rainfed and dryland farming. Practices like soil and straw mulching, use of anti transpirants, intercultural operations (like running hand plough) and making ridge–furrow reduce evaporation and runoff, improve infiltration and maintain soil structure. These measures conserve rainwater, regulate soil temperature, suppress weeds and enhance root activity, resulting in better moisture availability, improved photosynthesis, higher dry matter accumulation and stable yields under moisture stress. The present study aims to find out the best moisture conservation practices at sowing or in standing crop or combination of these to improve the performance of pearl millet under dryland conditions.

MATERIALS AND METHODS

The experiment was conducted during *kharif* 2024 at Research farm, College of Agriculture, Fatehpur - Shekhawati, Sikar Rajasthan which is located at 27.98°N latitude and 74.95°E longitude with an altitude of 324 meters above mean sea level. The area falls under agro-climatic zone II - A (Transitional Plains of Inland Drainage) of Rajasthan within the NARP (National Agricultural Research Project) framework. The total rainfall received during crop growing period was 325.6 mm in 24 rainy days. The soil of the experimental field was loamy sand with slightly alkaline in reaction (pH 8.6). It was moderately fertile, being low in organic carbon (0.14%) and available nitrogen (103.4 kg/ha) and medium in available phosphorus (15.5 kg/ha) and potassium (275.2 kg/ha).

The experiment was laid out in split plot design comprising four moisture conservation practices at sowing (M_1 - control, M_2 - Compartmental bunding, M_3 - Running wheel after sowing and M_4 - Application of Pusa hydrogel @ 10 kg/ha at sowing) in main plots and four moisture conservation practices in standing crop (S_1 - Soil mulch at 30 days after sowing (DAS), S_2 - Straw mulch @ 5 t/ha at 30 DAS, S_3 - Running hand plough at 30 DAS and S_4 - Kaolin spray @ 5% at dry spell) were allotted to sub plots replicated thrice. The crop was grown with the recommended package of practices. With the onset of rains, sowing was done on 14 July 2024 using the seed of variety - 'HHB 299' with the help of a seed drill in the rows spaced 45 cm apart using a seed rate of 4 kg/ha. The recommended dose of nitrogen (40 kg/ha) and phosphorus (20 kg/ha) was applied in field. The treatment wise moisture conservation practices were done at sowing in earmarked plots i.e. compartmental bunding was accomplished by using a grape hoe and rack around the respective plots (M_2), running wheel (approximately 4.5 kg rubber wheel) was run above the rows/furrows just after sowing (M_3) and Pusa hydrogel was applied in respective plots @ 10 kg/ha at sowing (M_4). The treatments of moisture conservation practices in standing crops were practiced by creating soil mulch by hoeing between the rows at 30 DAS by "*Kassi* up to a depth of about 4-5 cm (S_1), mustard straw @ 5 t/

ha (sun-dried) received from the threshing of mustard was spread in the ear-marked plots over the soil surface uniformly in between rows at 30 DAS (S_2), hand ploughing was done between two rows of the crop at 30 days after sowing (S_3) and kaolin was sprayed @ 5% (S_4) on 27th August after observing almost 10 day rain free dry spell in respective plots.

During the experimental period (July to October, 2024), a total of 325.6 mm rainfall in 24 rainy days was received with maximum and minimum temperature ranged between 30.3 to 40.3°C and 18.8 to 28.4°C, respectively. Relative humidity varied from 41 to 94% and the duration of bright sunshine hours (BSSH) ranged between 0.7 to 9.0 hours.

Data on growth attributes viz., plant height and dry matter accumulation were recorded precisely from randomly selected 5 plants from each plot at 20, 40, 60 DAS and at harvest and CGR and RGR were calculated using standard formula as given below:

$$\overline{\text{CGR}}\ (\text{g m}^{-2}\ \text{day}^{-1}) = \frac{W_2 - W_1}{(t_2 - t_1) \times A}$$

$$\overline{\text{RGR}}\ (\text{mg g}^{-1}\text{day}^{-1}) = \frac{(\text{Log}_n W_2 - \text{Log}_n W_1)}{t_2 - t_1} \times 1000$$

Where A = Area of sampling, W_1= Dry matter of crop at time t_1, W_2= Dry matter of crop at time t_2, t_1= Time of first observation and t_2=Time of last observation

Data on yield attributes viz., effective tillers/plant, ear head length, ear head diameter and test weight and grain yield, stover yield and biological yield were recorded at harvest. The numbers of grain bearing tillers was counted from the previously tagged 5 plants at the time of harvesting and the average was taken and expressed as number of effective tillers/plant. The length and diameter of five randomly selected ear heads was measured and the average was worked. After shade drying the produce from each net plot area was weighed and expressed as biological yield/plot. Grains from the corresponding net plot area were then threshed, weighed and expressed as grain yield/plot. After separating the grains, stover yield was worked out by subtracting the grain yield from biological yield and expressed as stover yield/plot. Thousands seeds were drawn randomly from each plot grain yield and weighted by electronic balance in order to get test weight. The plot yields taken as above were converted to yield per hectare after multiplying with suitable conversion value as expressed as kg/ha. Harvest index was calculated as per formula given by Singh and Stoskopf, 1971.

Data were analyzed as per analysis of variance technique for split plot design. Treatment means were compared using Fisher's test of significance at the 5% probability level, with standard errors and critical differences (5%) calculated to distinguish true treatment effects from chance variation.

RESULTS AND DISCUSSION

Growth parameters

The results indicated that different moisture conservation practices have a significant influence on plant height, dry matter accumulation, CGR and RGR at periodic growth stages. The data (Table 1) showed that running wheel after sowing significantly improved the plant height at 40 DAS, 60 DAS and at harvest in comparison to control. At 40 DAS, the magnitude of increase over control, was found to the tune of 22.03%, however, it did not differ significantly from application of Pusa hydrogel @ 10 kg/ha and compartmental bunding. At 60 DAS and harvest, running wheel after sowing registered the highest plant height of 149.4 cm and 169.3 cm, respectively, which was significant over compartmental bunding and control and found statistically at par with application of Pusa-hydrogel @ 10 kg/ha. Running wheel after sowing further proved superior in terms of dry matter accumulation at 40 DAS, 60 DAS and at harvest by 40.5% & 61.3%, 21.1% & 67.4% and 21.1% & 67.4% over compartmental bunding and control, respectively. When compared with Pusa hydrogel application @ 10 kg/ha, the effect of running wheel at sowing remained statistically at par at 60 DAS and significantly superior at 40 DAS and at harvest. The moisture conservation practices at sowing improved the CGR and RGR values of pearl millet. As compared to the control, significantly higher values of CGR were noted with running wheel after sowing, showing a 75.1% increase during 20–40 DAS and a 67.6% increase during 60 DAS–harvest. The maximum values of RGR of pearl millet were recorded with running wheel after sowing during 20–40 DAS and during 60 DAS–harvest but significant response was noted with application of Pusa hydrogel @ 10 kg/ha at sowing during 40–60 DAS. The improvement in growth parameters of pearl millet at various growth stages under the

Table 1. Effect of moisture conservation practices on plant height and dry matter accumulation

Treatment	Plant Height (cm)				Dry Matter Accumulation (g/plant)			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
Moisture conservation practices at sowing								
M_1 - Control	38.2	92.9	134.4	141.8	4.01	15.28	35.33	43.55
M_2 - Compartmental bunding	38.4	100.0	138.7	154.4	4.06	17.54	48.48	60.28
M_3 - Running wheel after sowing	42.7	113.0	149.4	169.3	4.92	24.65	59.14	72.95
M_4 - Application of Pusa hydrogel @ 10 kg/ha at sowing	39.9	108.2	145.2	160.8	4.04	20.31	55.87	67.81
SEm±	1.32	3.85	2.71	3.47	0.29	0.60	1.16	1.22
CD (P=0.05)	NS	13.31	9.38	12.01	NS	2.09	4.00	4.23
Moisture conservation practices in standing crop								
S_1- Soil mulch at 30 DAS	39.8	101.4	133.6	143.3	4.08	15.54	38.19	48.34
S_2 - Straw mulch @ 5 t/ha at 30 DAS	40.0	106.2	150.8	164.6	4.43	22.02	57.85	70.41
S_3 - Running hand plough at 30 DAS	39.8	105.3	145.5	162.4	4.38	20.82	52.98	65.19
S_4 - Kaolin spray @ 5% at dry spell	39.6	101.2	137.8	155.9	4.14	19.39	49.80	60.67
SEm±	1.20	1.76	2.79	3.49	0.12	0.69	0.86	1.15
CD (P=0.05)	NS	NS	8.13	10.19	NS	2.01	2.52	3.36
CV (%)	10.46	5.91	6.80	7.72	10.09	12.29	6.01	6.51

*NS= Non-Significant DAS= Days After Sowing

influence of running wheel after sowing might be due to improvement in soil physical conditions and enhanced moisture availability by running wheel after sowing because of compacting soil and better seed-soil contact in the seed zone. This ensures better germination, uniform seedling emergence and reduced evaporation losses. The resulting steady moisture supply promotes higher plant height, leaf area and biomass accumulation. Improvement in growth parameters with compaction by rubber wheel was also noticed by Shekhawat *et al.,* (2015). Further, application of Pusa hydrogel @ 10 kg/ha at sowing also significantly enhanced the plant height and dry matter accumulation. This improvement was attributed to better moisture retention and prolonged availability, which promoted cell division, expansion and elongation, thereby enhancing growth attributes. Dry matter production was significantly higher with Pusa hydrogel compared to control, indicating more efficient resource utilization, improved light interception and ultimately higher yield. The results obtained by Yadav *et al.*, (2021) in pearl millet and Ashraf *et al.*, (2020) in dryland Cotton corroborate the present findings.

From the data pertaining to different growth attributes (Table 1 and 2), it is clear that different moisture conservation practices in standing crop did not significantly influence plant height at 20 and 40 DAS, dry matter accumulation at 20 DAS and CGR during 60 DAS to harvest. However, maximum plant height at 60 DAS (12.9% increase) and at harvest (14.9% increase) were observed with straw mulch @ 5 t/ha at 30 DAS in comparison to application of soil mulch at 30 days after sowing and found at par with running hand plough at 30 DAS. Application of straw mulch @ 5 t/ha at 30 DAS led to a significant increase in dry matter accumulation at 40 DAS, 60 DAS and at harvest by 13.6 & 41.7%, 16.3% & 51.6% and 16.0% & 45.6% per cent over kaolin spray @ 5% at dry spell and soil mulch at 30 DAS, respectively, while dry matter accumulation at 40 DAS remaining statistically comparable to running hand plough. As compared to the soil mulch and kaolin spray, the application of straw mulch @ 5 t/ha at 30 DAS resulted in significantly higher CGR during 20–40 DAS and 40–60 DAS. RGR responded significantly to moisture conservation practices and recorded 21.9% increase over soil mulch only during the 20–40 DAS period and showed no significant variation during the later growth stages. Application of straw mulch improves plant growth parameters of pearl millet by modifying the microclimate, conserving soil moisture, regulating temperature and suppressing weeds, thereby reducing irrigation needs. Organic mulch is more effective as it not only conserves moisture and controls weeds but also enriches the soil with nutrients through decomposition, making both moisture and nutrients more available to crops. Lal *et al.* (2017) in sesame, Kanwar *et al.* (2017) in pearl millet, Rummana *et al.* (2018), Morya *et al.* (2023) in mustard and Ola *et al.* (2024) in pearl millet also

Table 2. Effect of moisture conservation practices on CGR and RGR

Treatment	CGR (g m^{-2} day^{-1})			RGR (mg g^{-1}day^{-1})		
	20-40 DAS	40-60 DAS	60 DAS-harvest	20-40 DAS	40-60 DAS	60 DAS-harvest
Moisture conservation practices at sowing						
M_1 - Control	6.26	11.14	3.52	66.3	42.5	7.56
M_2 - Compartmental bunding	7.49	17.19	5.04	73.2	50.7	8.60
M_3 - Running wheel after sowing	10.96	19.16	5.90	81.8	42.4	9.05
M_4 - Application of Pusa hydrogel @ 10 kg/ha at sowing	9.04	19.75	5.10	79.5	51.7	6.87
SEm±	0.35	0.67	0.44	3.36	1.71	0.799
CD (P=0.05)	1.20	2.31	1.50	NS	5.90	NS
Moisture conservation practices in standing crop						
S_1- Soil mulch at 30 DAS	6.37	12.58	4.34	66.1	45.8	8.41
S_2 - Straw mulch @ 5 t/ha at 30 DAS	9.78	19.90	5.37	80.6	48.1	7.81
S_3 - Running hand plough at 30 DAS	9.13	17.87	5.22	77.5	46.3	8.19
S_4 - Kaolin spray @ 5% at dry spell	8.47	16.89	4.64	76.6	47.1	7.68
SEm±	0.40	0.57	0.40	2.50	1.84	0.691
CD (P=0.05)	1.17	1.65	NS	7.30	NS	NS
CV (%)	16.49	11.64	28.22	11.52	13.64	29.87

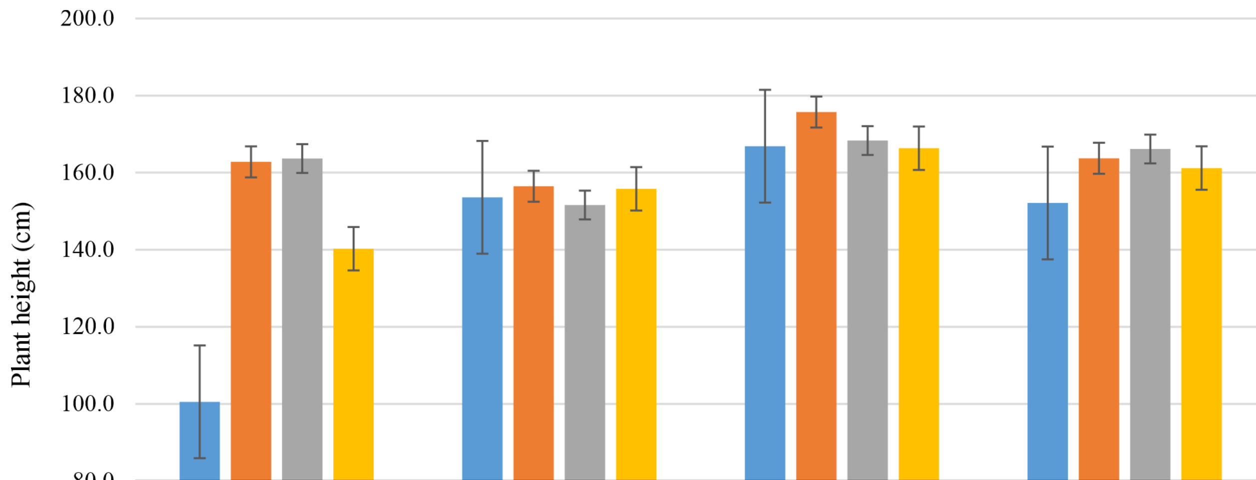
*NS=Non-Significant DAS=Days After Sowing

reported higher growth parameters (plant height and dry matter accumulation) with the application of straw mulch. Additionally, the beneficial effects of running hand plough on growth parameters may be attributed to increased infiltration of rain water, improved soil moisture retention, aeration and enhanced biological activity, particularly nitrogen fixation, which ensures nitrogen turnover matching crop demand. Consequently, better nitrogen availability, efficient physiological processes and increased photosynthate supply promote meristematic activity and overall plant growth. Consistent effects of soil moisture management practices on crop growth have also been reported by Parihar *et al.* (2009) (pearl millet), Sornpoon and Jayasuriya (2013) (corn) and Usman *et al.* (2014) (pearl millet).

The data Table alongside Fig. 1 and 2 illustrate the combined effect of various moisture conservation practices on plant height and dry matter accumulation at harvest. The highest plant height and dry matter accumulation at harvest were recorded with the running wheel after sowing combined with application of straw mulch @ 5 t/ha at 30 DAS. Improved plant height and dry matter observed with running wheel at sowing were further enhanced by application of straw mulch @ 5 t/ha at 30 DAS might be due to better seed-soil contact at sowing and conservation of rain water through reduced evaporation and weed population, moderate soil temperature thus better utilization of rain water by straw mulch further improved it.

Yield Attributes and Yields

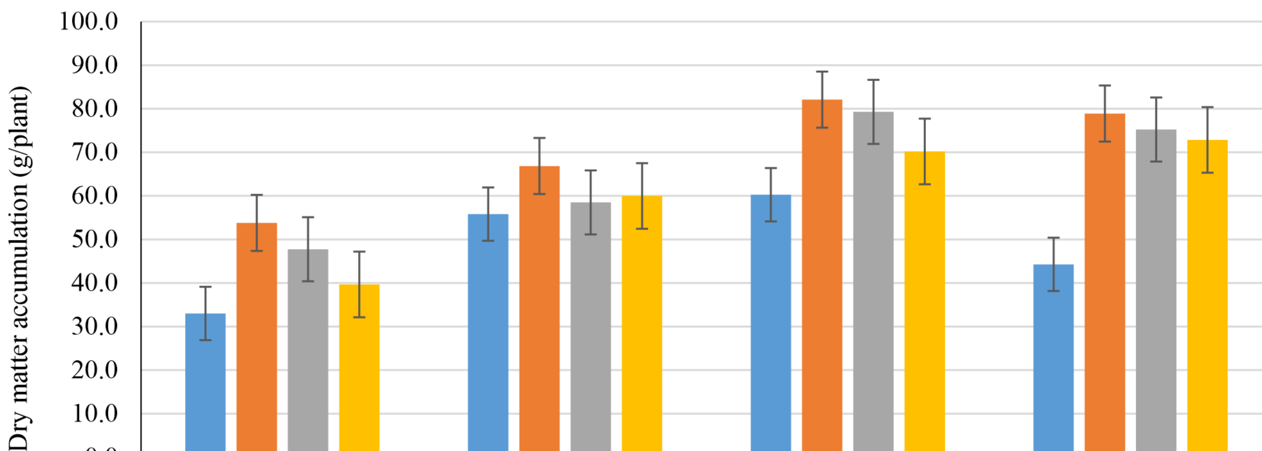
Number of effective tillers/plant and ear head length were found significantly higher (14.0% and 13.2% increase, respectively) with running wheel after sowing as compared to control. An investigation of the data (Table 3) further revealed that maximum grain, stover and biological yields were recorded when the practice of running wheel after sowing was employed. The running wheel after sowing brought about significantly higher pearl millet yields with increase of 16.7% and 46.5% in grain yield, 14.61% and 31.3% in stover yield and 15.2% and 35.2% in biological yield over compartmental bunding and control, respectively, but remained at par with the application of Pusa hydrogel @ 10 kg/ha at sowing. Moisture conservation practices slightly improved the ear head diameter, test weight and harvest index but failed to achieve the level of significance. Shekhawat *et al.* (2015) found the same result for an increase in total tillers/plant, ear head length and 1000-grain weight of pearl millet with compaction through running wheel. By maintaining a more stable and moist environment in the root zone with running wheel after sowing, crops experience less water stress, which supports better nutrient uptake and overall plant health. Further, the improvement in crop yield and its components facilitated by Pusa hydrogel application, can be attributed to the enhanced water availability in the root zone during the early growth stages. Pusa hydrogels absorb and retain large quantities of water, forming gel-like structures that



	M1	M2	M3	M4
S1	100.5	153.6	166.9	152.1
S2	162.8	156.5	175.7	163.7
S3	163.7	151.6	168.3	166.1
S4	140.3	155.8	166.3	161.2

SEm± = 6.98 CD (P=0.05) = 20.37

Fig. 1. Interactive effect of moisture conservation practices at sowing and in standing crop on plant height (cm)



	M1	M2	M3	M4
S1	33.0	55.8	60.3	44.3
S2	53.8	66.9	82.1	78.9
S3	47.8	58.5	79.3	75.2
S4	39.7	60.0	70.2	72.8

SEm± = 2.30 CD (P=0.05) = 6.71

Fig. 2. Interactive effect of moisture conservation practices at sowing and in standing crop on dry matter accumulation (g/plant)

serve as localized water reservoirs. Improvement in yield attributes under water stress conditions due to hydrogel use in pearl millet have also been reported by Rehman *et al.* (2011) and Jorwal *et al.* (2021).

Data (Table 3) further revealed that all moisture conservation practices in standing crop slightly or significantly enhanced the yield attributes and yields of pearl millet in comparison to soil mulch.

Table 3. Effect of moisture conservation practices on yield attributes, yields (kg/ha) and harvest index (%) of pearl millet

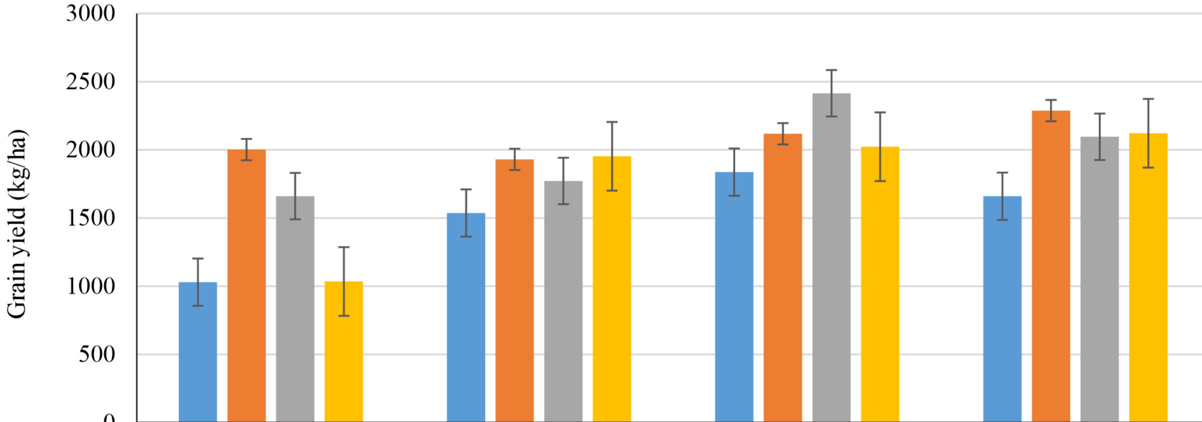
Treatment	Effective tillers per plant at harvest	Ear head length (cm)	Ear head diameter (cm)	Test weight (g)	Grain yield	Stover yield	Biological yield	Harvest index
Moisture conservation practices at sowing								
M_1 - Control	2.35	25.82	2.63	8.91	1432	4215	5646	24.97
M_2 - Compartmental bunding	2.48	27.36	2.72	9.10	1798	4830	6628	27.57
M_3 - Running wheel after sowing	2.68	29.24	2.73	9.51	2098	5536	7634	27.58
M_4 - Application of Pusa hydrogel @ 10 kg/ha at sowing	2.59	28.12	2.69	9.44	2042	5350	7392	27.65
SEm±	0.05	0.56	0.04	0.19	42	194	223	0.67
CD (P=0.05)	0.18	1.95	NS	NS	146	670	772	NS
Moisture conservation practices in standing crop								
S_1- Soil mulch at 30 DAS	2.40	26.52	2.66	8.81	1516	4515	6031	25.01
S_2 - Straw mulch @ 5 t/ha at 30 DAS	2.64	28.54	2.73	9.55	2084	5384	7468	28.06
S_3 - Running hand plough at 30 DAS	2.58	27.96	2.72	9.43	1986	5185	7171	27.99
S_4 - Kaolin spray @ 5% at dry spell	2.47	27.51	2.66	9.17	1783	4847	6630	26.71
SEm±	0.06	0.45	0.03	0.26	68	137	153	0.91
CD (P=0.05)	0.17	1.32	NS	NS	198	401	447	NS
CV (%)	7.92	5.67	3.64	9.59	13	10	8	11.67

*NS= Non-Significant DAS= Days After Sowing

Application of straw mulch @ 5 t/ha at 30 DAS brought about significant response for effective tillers/plant and ear head length of pearl millet over soil mulch at 30 DAS. However, it remained statistically at par with running hand plough at 30 DAS. Application of straw mulch @ 5 t/ha at 30 DAS registered a significant increase of 16.9% and 37.5% in grain yield, 11.1% and 19.2% in stover yield, 12.6% and 23.8% in biological yield, over kaolin spray @ 5% at dry spell and soil mulch at 30 DAS, respectively, however it did not differ significantly from running hand plough at 30 DAS. This might be due to superiority of straw mulch lies in its ability to reduce evaporation losses by obstructing external evaporation and reflecting part of the solar radiation from the soil surface. By moderating soil temperature and conserving moisture, straw mulch improves plant growth, accelerates attainment of heat units, enhances nutrient availability and ultimately boosts yield attributes and yield of pearl millet in light-textured soils of arid regions. A significant improvement in yield attributing characters was also found by Kanwar *et al.* (2017), Yadav *et al.* (2021) and Ola *et al.* (2024). The ridges and furrows created by running hand plough at 30 DAS retained moisture during the flower primordia stage, supporting improved flowering, fertilization and grain formation, which resulted in higher yields. Our findings corroborate the results of Usman *et al.* (2014) who also reported similar effects of ridging in pearl millet. Mishra *et al.* (2014) in sorghum, Sinha (2015) in pearl millet have also reported beneficial effects of ridge and furrow on yield and yield attributes.

The data depicted in Fig. 3, along with the accompanying table, highlights the combined effects of different treatment practices on grain yield. Notably, the maximum grain yield was recorded with the implementation of running hand plough at 30 DAS in conjunction with the running wheel after sowing. Moisture conserved by running wheel after sowing could have been maintained for longer time till the end of the flowering and start of grain formation by running hand plough at 30 DAS may result in improved growth attributes, yield parameters and yields.

On the basis of present investigation, it was concluded that running wheel after sowing observed to be significant for improving growth parameters, yield attributes and yields of pearl millet. Application of straw mulch @ 5 t/ha was found to be best among moisture conservation practices in standing crop as it registered significantly higher growth and yield parameters. Running wheel after sowing when combined with application of straw mulch @ 5 t/ha at 30 DAS resulted in maximum growth parameters and running hand plough at 30 DAS along with running wheel after sowing showed higher grain yield as compared to soil mulch at 30 DAS in control plots.



	M1	M2	M3	M4
S1	1030	1537	1837	1660
S2	2002	1930	2118	2288
S3	1661	1772	2415	2096
S4	1035	1953	2023	2122

SEm± = 135.84 CD (P=0.05) = 396.49

Fig. 3. Interactive effect of moisture conservation practices at sowing and in standing crop on grain yield (kg/ha)

REFERENCES

Anonymous, 2023. Agriculture statistics at a glance. *Department of Agriculture and Farmers Welfare, Economics and Statistics Division, New Delhi, 36.* https://desagri.gov.in/wp-content/uploads/2023/05/Agriculture-Statistics-at-a-lance-2023.pdf)

Anonymous, 2023-24. Rajasthan Agriculture Statistics at a Glance. *Commisionarate of Agriculture (CSO) Cell. Government of Rajasthan, Jaipur, 71.* https://jankalyanfile.rajasthan.gov.in)

Ashraf, A.M., Ragavan, T. and Begam, S.N. (2020). Influence of in-situ soil moisture conservation practices with Pusa hydrogel on physiological parameters of rainfed cotton. *International Journal of Bio-resource and Stress Management*, *11*(6), 548–557.

Bhardwaj, A.K., Singh, Y., & Mishra, V.K. (2011). Ecological management of intensively cropped systems for sustainable productivity. *Journal of Sustainable Agriculture*, *35*(6), 651–669.

Jalgaonkar, B.R., Yadav, K.K., Gautam, V.K. and Singh, R. (2020). Effect of moisture conservation practices on growth and yield of rainfed crops. *Journal of Natural Resource Conservation and Management*, *1*(1), 35–40.

Jorwal, M., Dudwal, B.L., Garg, K., Meena, B.L. and Meena, S. (2021). Effect of moisture conservation practices and sulphur fertilization on growth, yield attributes and yield of mothbean [*Vigna aconitifolia* (Jacq.) Marechal]. *International Journal of Current Microbiology and Applied Sciences*, *10*(2), 2319–2326.

Kanwar, S., Gupta, V., Rathore, P.S. and Singh, S.P. (2017). Effect of soil moisture conservation practices and seed hardening on growth, yield, nutrient content, uptake and quality of pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Journal of Pharmacognosy and Phytochemistry*, *6*(4), 110–114.

Lal, B., Yadav, L.R., Bamboriya, S.D., Choudhary, K.M. and Choudhary, S.P. (2017). Effect of vermicompost and moisture conservation practices on growth parameters, yield attributes and yield of sesame. *Journal of Pharmacognosy and Phytochemistry*, *6*(4), 1656–1659.

Mishra, J.S., Thakur, N.S., Singh, P., Kubsab, V.S., Kalpana, R., Alse, U.N. and Nemade, S.M. (2014). Tillage and integrated nutrient management in rainy season grain sorghum (*Sorghum bicolor*). *Indian Journal of Agronomy*, *59*(4), 619–623.

Mishra, V. K., Singh, Y., Bhardwaj, A. K., & Sharma, P. K. (2015). Resource conservation strategies for rice–wheat systems in degraded agro-ecosystems. *Journal of Sustainable Agriculture*, *39*(4), 110-122.

Morya, R., Mastkar, A., Morya, R., Bhargava, A. and Kushwaha, H.S. (2023). Effect of moisture conservation practices on yield attributes, yield and quality of Indian mustard [*Brassica juncea* (L.) Czern. & Coss.]. *International Journal of Plant & Soil Science*, *35*(22), 289–294.

Ola, G., Shekhawat, P.S., Ramniwas, Gautam, P., Nitharwal, P.K., Choudhary, K., Choudhary, L., Choudhary, P., Choudhary, K. and Yadav, A.K. (2024). Pearl millet (*Pennisetum glaucum*) growth and productivity under different sowing methods, mulching and foliar feeding of nutrients. *Indian Journal of Agricultural Sciences*, *94*(7), 707–712.

Parihar, C.M., Rana, K.S. and Parihar, M.D. (2009). Crop productivity, quality and nutrient uptake of pearl millet (*Pennisetum glaucum*)–Indian mustard (*Brassica juncea*) cropping system as influenced by land configuration and direct and residual effect of nutrient management. *Indian Journal of Agricultural Sciences*, *79*(11), 927–931.

Prasad, V., Yousuf, A. and Sharma, N. (2020). Hydrogel application for improving soil moisture availability and crop productivity. *Journal of Natural Resource Conservation and Management*, *1*(1), 29–34.

Rahman, A., Sarkar, B., Kumar, A., Sarma, K. and Pathak, K. (2020). Soil moisture dynamics and productivity under conservation agriculture practices. *Journal of Natural Resource Conservation and Management*, *1*(1), 41–46.

Rehman, A., Ahmad, R. and Safdar, M. (2011). Effect of hydrogel on the performance of aerobic rice sown under different techniques. *Plant, Soil and Environment*, *57*(7), 321–325.

Rummana, S., Amin, A.K.M.R., Islam, M.S. and Faruk, G.H. (2018). Effect of irrigation and mulching materials on growth and yield of wheat. *Bangladesh Agronomy Journal*, *21*, 71–76.

Satyavathi, T., Khandelwal, V., Rajpurohit, S.B., Supriya, A., Beniwal, R.B., Kamlesh, K., Sushila, B., Shripal, S., Mahesh, K.C. and Yadav, S.L. (2018). Pearl Millet—Hybrids and Varieties. ICAR–All India Coordinated Research Project on Pearl Millet, Mandor, Jodhpur, India. pp. 142.

Shekhawat, P.S., Kumawat, N. and Shekhawat, R.S. (2015). Effect of in-situ moisture conservation practices on growth, yield and economics of pearl millet under dryland conditions. *Journal of Soil and Water Conservation*, *14*(4), 306–309.

Singh, R.P. and Stoskopf, N.C. (1971). Harvest index in cereals. *Agronomy Journal*, *63*(2), 224–226.

Sinha, B.L. (2015). Effect of tillage practices and nutrient management on yield of pearl millet and soil health in semi-arid tropics. *International Journal of IT, Engineering and Applied Sciences Research*, *4*(2), 33–39.

Sornpoon, W. and Jayasuriya, H.P.W. (2013). Effect of different tillage and residue management practices on growth and yield of corn cultivation in Thailand. *Agricultural Engineering International*, *15*(3), 86–94.

Upadhyaya, A. (2020). Water conservation and moisture management practices in dryland agriculture. *Journal of Natural Resource Conservation and Management*, *1*(1), 23–28.

Usman, Y.M., Hussaini, M., Musami, B. and Sheriff, B. (2014). Effect of different tillage methods on the growth and yield of pearl millet under rainfed conditions. *The International Journal of Science and Technology*, *2*(11), 62–67.

Yadav, K.S., Dudwal, B.L., Yadav, L.V., Yadav, K.C.S. and Yadav, J.K. (2021). Effect of moisture conservation practices and zinc fertilization on nutrient status and quality of pearl millet [*Pennisetum glaucum* (L.)] under rainfed condition. *Indian Journal of Agricultural Research*, *55*(5), 629–633.