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# Effect of moisture conservation practices on water expense efficiency, water use efficiency and economics of Pearlmillet [*Pennisetum glaucum* (L.) R. Br. emend Stuntz] Hybrids

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**Abstract**
A field experiment was conducted under loamy sand soil during two consecutive *kharif* seasons of 2018 and 2019 at Agronomy farm, S.K.N. College of Agriculture, Jobner, Jaipur to find out the best moisture conservation practices on water expense efficiency, water use efficiency and economics of pearlmillet [*Pennisetum glaucum* (L.) R. Br. emend Stuntz] hybrids. Hybrids *viz.*, RHB-173, RHB-177, MPMH-17 and HHB-67 in main plots and moisture conservation practices *viz.*, control, dust mulch, straw mulch, plastic mulch and seed line mulching of FYM in sub plots were tested using split plot design replicated four. Hybrid RHB-173 recorded the highest water expense efficiency (50.80 kg grain/ha-cm), grain yield (2097 kg/ha), stover yield (5500 kg/ha), net returns (43492 ₹/ha), B:C ratio (2.82) over hybrid MPMH-17 and HHB-67, while at par with hybrid RHB-177 in pooled analysis. Result showed that application of plastic mulch remained at par with straw mulch and significantly higher the water expense efficiency (51.98 kg grain/ha-cm), water use efficiency in (9.17 kg/ha-mm), grain yield (2145 kg/ha.), stover yield (5620 kg/ha), net returns (43889 ₹/ha), B:C ratio (2.76) of pearlmillet over control, dust mulch and seed line mulching of FYM in both the years of experimentation as well as on pooled basis.

**Keywords:** Pearlmillet, hybrids, moisture conservation practices, WEE, WUE, yield, net returns, B:C ratio

## Introduction
Pearlmillet [*Pennisetum glaucum* (L.) R.Br. emend Stuntz] is one of an important millet crop of India as well as Rajasthan. Pearlmillet is a short day, $C_4$ plant with high photosynthetic efficiency and dry matter production capacity adapted to hot climate. It is a warm weather coarse cereal crop grown in arid and semi–arid climate of tropical and subtropical regions a the country. It is staple food of poor and small land holders in these area provides source of fodder and feed for livestock in the rainfed area in Rajasthan. Pearlmillet is nutritionally better than many other cereals as 100 grams of pearlmillet has the nutritional values *viz.*, energy (361 kcal), moisture (12 g), fibre (1.2 g), fat (5 g), carbohydrate (67.5 g), protein content (12.1 g), calcium (42 mg), phosphorous content (296 mg), iron (8 mg), zinc (3.1 mg), vitamin-E and B-complex and many amino acids (Anonymous, 2018) [2].
India is the largest producer of pearlmillet globly occupying 6.93 mha area with annual production of 8.61 mt and average productivity of 1243 kg/ha (Anonymous, 2018-19) [3]. In the country, Rajasthan, UP, Maharashtra, Haryana and Gujarat account for about 90% of total area and production of the crop. Rajasthan rank first with respect to area and production of pearlmillet. Pearlmillet crop occupies an area of 42 lac ha and annual production of 5.05 mt with a productivity of 1190 kg/ha in the state of Rajasthan (Anonymous, 2019-20) [4]. More than 80% of the area under pearlmillet falls in arid and semi-arid regions of the country. In Rajasthan, Jodhpur, Nagaur, Jaipur, Alwar, Barmer, Jalore, Churu, Sikar, Jhunjhunu and Bikaner are major pearlmillet growing districts. The soil and condition of Rajasthan provides ideal condition for growing pearlmillet.
Recently, in pearlmillet, several high yielding hybrids with good adaptation to various environments have been developed and introduced. Despite the availability of newly developed hybrids, many of the obsolete varieties and traditional land races are occupying area under cultivation and contributing to penurious productivity of pearlmillet.

Hence, there is an urgent need to replace them with newly developed high potential hybrids for better production and profitability of the farmers. Pearlmillet hybrids may play an important role in boosting crop productivity and the superiority of hybrids over varieties of pearlmillet has already been proved (Sharma, 2014) [14].

Use of mulching in crop fields increase water use efficiency, protect against solar radiation, regulates soil temperature, suppress weed growth, minimizes leaching loss of nutrients, reduces soil erosion, checks excessive evaporation, increase infiltration of rain water and improve soil moisture, production and quality of field crops (Rummana *et al.,* 2018) [13]. Mulch is also being used for its beneficial effects on crop growth and fodder yield, as it decreases soil temperature, evaporation, weed growth and conserving soil moisture content (Din *et al.,* 2013) [5]. Use of Organic mulch has also been found to increase the nutrient content of soil following decomposition and mineralization, hence, can increase the vegetative growth of plants, which ultimately results in high yield (Ahamefule and Peter, 2014) [1].

## Materials and Methods

A field experiment was conducted under loamy sand soil during two consecutive *kharif* seasons of 2018 and 2019 at Agronomy farm, S.K.N. College of Agriculture, Jobner, Jaipur Rajasthan (26° 05' N, 75° 20' E, 427 m above mean sea level). The soil of the experimental field was loamy sand with slightly alkaline in reaction pH 8.3. It was moderately fertile, being low in organic carbon (0.17%), low in available nitrogen (130.7 kg/ha), medium in available phosphorus (14.81kg/ha) and potassium (148.63 kg/ha). The experiment was carried out in split plot design comprising four Hybrids *viz.,* RHB-173, RHB-177, MPMH-17 and HHB-67 in main plots and five moisture conservation practices *viz.,* control, dust mulch, straw mulch, plastic mulch and seed line mulching of FYM in sub plots with four replications. The recommended dose of fertilizers (RDF) for *kharif* pearlmillet in semi-arid eastern plain zone of Rajasthan is 60 kg N/ha and 30 kg $P_2O_5$/ha was given in the form of urea and SSP. Half of the nitrogen was applied at sowing time as basal dose along with the full quantities of phosphorus to all the plots. The remaining half dose of nitrogen was applied as top dressed in two splits through urea. The different weather parameters were recorded during crop growing period in both the years. The maximum and minimum temperature recorded during *kharif* season were in the rage of 30.0 to 42.8° C and 19.1 to 27.6° C in 2018 and 30.5 to 45.3° C and 19.5 to 24.9° C in 2019. The total rainfall received during *kharif* season was 307.2 mm in 2018 and 392 mm in 2019, respectively. The treatments wise moisture conservation practices were done in earmarked plots *i.e.* dust mulching done after each heavy rainfall by "*kassi*" upto a depth of about 4-5 cm, mustard straw mulch @ 5 t/ha (sun dried) was spread over the soil surface uniformly in between rows at 11 DAS, plastic mulch (0.05 mm thick) was placed in between the rows at 11 DAS and seed line mulching of FYM @ 2 t/ha over the soil surface uniformly in rows at 1 DAS. The crop was harvested at physiological maturity stage on 28 September, 2018 and 30 September, 2019. The soil moisture was determined, soil samples were collected from central area of each plot from seven successive layers *viz.,* 0-15 cm, 15-30 cm, 30-45 cm, 45-60 cm, 60-75 cm, 75-90 cm and 90-100 cm at sowing, before and 24 hours after each irrigation and at harvest with the help of soil auger in aluminum boxes. After recording initial weights, boxes were kept in hot air oven at $105^0$ C for 24 hours till constant weight. Per cent soil moisture on oven dry weight basis was calculated as under:

$$\text{Per cent soil moisture} = \frac{\text{Weight of wet soil – weight of oven dry soil}}{\text{Weight of oven dry soil}} \times 100$$

## Results and Discussion

### Soil moisture studies

Data presented in the (Table 1&2) indicated that water use efficiency did not differ significantly due to pearlmillet hybrids in both the years of study and in pooled analysis. Hybrid RHB-173 recorded the highest water expense efficiency (50.80 kg grain/ha-cm) and showed higher values 11.86 and 27.95 per cent, respectively, over hybrid MPMH-17 and HHB-67, while at par with hybrid RHB-177 (48.46 kg grain/ha-cm) in pooled analysis. The possible season could be on the basis of differences in their growth in term of number of tillers and dry matter accumulation per plant. The differences in the value of water expense efficiency of pearlmillet hybrids were also reported by Kumar *et al.,* 2003 [9], Parihar *et al.,* 2005 [10] and Rathore, 2006 [11]. Result showed that different moisture conservation practices significantly influenced the water expense efficiency and water use efficiency of pearlmillet hybrids. Application of plastic mulch recorded maximum water expense efficiency (51.98 kg grain/ha-cm) and water use efficiency (9.17 kg/ha-mm), being remained at par with straw mulch over control, dust mulch and seed line mulching of FYM in both the years of experimentation as well as on pooled basis. The plastic mulch significantly increase water expense efficiency by 40.63, 13.81 and 13.99 per cent and water use efficiency by 25.61, 4.32 and 6.50 per cent over control, dust mulch and seed line mulching of FYM, respectively. More rain water storage as well as less loss of water by evaporation by plastic mulch might have resulted in availability of more soil moisture for plant growth and development, as a result there was more water use by the plants for growth and development. Similar results were also reported by Yadav, 2005 [20] in mustard, Tetarwal and Rana, 2006 [16] in pearlmillet, Yadav and Bhati, 2013 [19] on fennel and Ren *et al.,* 2016 [12] in corn with application of mulch.

### Yield

An investigation of data (Fig.1) revealed that pearlmillet hybrids varied significantly in the grain and biological yield during both the year of experimentation. Hybrid RHB-173 recorded significantly higher grain yield (2097 kg/ha) and stover yield (5500 kg/ha) over MPMH-17 and HHB-67 during both the years and on pooled data. This hybrid recorded an increase of 11.72 and 27.78 per cent grain yield, 8.43 and 25.28 per cent stover yield, respectively, over MPMH-17 and HHB-67 on pooled mean basis. However, hybrid RHB-177 remained at par with RHB-173. All mulching treatments brought a significant improvement in grain yield of pearlmillet. Similar results were also reported by Sharma, 2014 [14], Yadav *et al.,* 2014 [18] and Gupta *et al.,* 2016 [7]. Application of plastic mulch found maximum grain yield (2145 kg/ha) and stover yield (5620 kg/ha) of pearlmillet which was significantly higher during both the years as well as in pooled analysis over rest of the mulching treatments but remained statistically at par with straw mulch. The mean

increase due to plastic mulch over control, dust mulch and seed line mulching of FYM was to the extent of 40.37, 13.55 and 13.73 per cent grain yield and 34.06, 11.19 and 10.39 per cent stover yield, respectively. The results of the investigation are in agreement to those of Kanwar *et al*., 2017 [8] in pearlmillet and Vidyashree *et al.*, 2019 [17] in French bean.

**Economics**

Data presented in (Table 3) showed that pearlmillet hybrids differed significantly in the net returns and B:C ratio during both the years of experimentation and in pooled analysis. Among pearlmillet hybrid, RHB-173 gave significantly higher net returns (43492 ₹/ha) and B:C ratio (2.82) as compared to MPMH-17 and HHB-67 during both the years of experimentation and on pooled data. Hybrid RHB-173 recorded 17.03 and 48.66 per cent net returns and 10.58 and 27.02 per cent higher B:C ratio over hybrids MPMH-17 and HHB-67, respectively, however, it remained at par with HHB-177 on pooled basis. All the mulching treatments significantly increased net returns and B:C ratio of pearlmillet over control. Application of plastic mulch observed significantly higher net returns (43889 ₹/ha) and B:C ratio (2.76) of pearlmillet over seed line mulching of FYM, dust mulch and control in both the years of experimentation as well as on pooled data. However, it remained at par with straw mulch. On pooled basis, the plastic mulch registered an increase of 17.60, 19.93 and 53.30 per cent net returns and 7.81, 10.84 and 17.94 per cent B:C ratio over control, dust mulch and seed line mulching of FYM, respectively. The might be due to high returns to investment of hybrid RHB-173 besides significant increase in grain and stover yields over RHB-177, MPMH-17 and HHB-67. These results are in close conformity with the findings of Gupta, 2015 [6], Suresh, 2016 [15] and Yamank, 2017 [21].

**Table 1:** Effect of moisture conservation practices on water expense efficiency of pearlmillet hybrids

| Treatments | Water expense efficiency (kg grain/ha-cm) | | |
|---|---|---|---|
| | 2018 | 2019 | Pooled |
| **Hybrids** | | | |
| RHB-173 | 57.35 | 44.24 | 50.80 |
| RHB-177 | 54.47 | 42.46 | 48.46 |
| MPMH-17 | 51.38 | 39.43 | 45.41 |
| HHB-67 | 45.04 | 34.37 | 39.70 |
| S.Em+ | 1.21 | 0.99 | 0.87 |
| CD (P=0.05) | 3.87 | 3.16 | 2.59 |
| **Moisture conservation practices** | | | |
| Control | 41.96 | 31.95 | 36.96 |
| Dust mulch | 51.58 | 39.75 | 45.67 |
| Straw mulch | 56.64 | 43.87 | 50.26 |
| Plastic mulch | 58.61 | 45.35 | 51.98 |
| Seed line mulching of FYM | 51.51 | 39.69 | 45.60 |
| S.Em+ | 0.92 | 0.72 | 0.62 |
| CD (P=0.05) | 2.61 | 2.04 | 1.74 |
| CV (%) | 7.05 | 7.15 | 8.52 |

**Table 2:** Effect of moisture conservation practices on water use efficiency of pearlmillet hybrids

| Treatments | Water use efficiency (kg/ha-mm) | | |
|---|---|---|---|
| | 2018 | 2019 | Pooled |
| **Hybrids** | | | |
| RHB-173 | 9.35 | 8.95 | 9.15 |
| RHB-177 | 8.70 | 8.39 | 8.55 |
| MPMH-17 | 8.70 | 8.26 | 8.48 |
| HHB-67 | 8.35 | 7.89 | 8.12 |
| S.Em+ | 0.23 | 0.16 | 0.27 |
| CD (P=0.05) | NS | NS | NS |
| **Moisture conservation practices** | | | |
| Control | 7.52 | 7.08 | 7.30 |
| Dust mulch | 9.00 | 8.58 | 8.79 |
| Straw mulch | 9.19 | 8.80 | 9.00 |
| Plastic mulch | 9.35 | 8.99 | 9.17 |
| Seed line mulching of FYM | 8.82 | 8.41 | 8.61 |
| S.Em+ | 0.17 | 0.14 | 0.12 |
| CD (P=0.05) | 0.48 | 0.39 | 0.32 |
| CV (%) | 7.77 | 6.61 | 8.51 |

NS=Non significant

**Table 3:** Effect of moisture conservation practices on net returns and B:C ratio of pearlmillet hybrids

| Treatments | Net returns (₹/ha) | | | B:C ratio | | |
|---|---|---|---|---|---|---|
| | 2018 | 2019 | Pooled | 2018 | 2019 | Pooled |
| **Hybrids** | | | | | | |
| RHB-173 | 45372 | 41612 | 43492 | 2.93 | 2.71 | 2.82 |

| | | | | | | |
|---|---|---|---|---|---|---|
| RHB-177 | 42858 | 39903 | 41381 | 2.82 | 2.64 | 2.73 |
| MPMH-17 | 39226 | 35094 | 37160 | 2.66 | 2.44 | 2.55 |
| HHB-67 | 31266 | 27244 | 29255 | 2.33 | 2.12 | 2.22 |
| S.Em+ | 1021 | 962 | 784 | 0.05 | 0.05 | 0.04 |
| CD (P=0.05) | 3268 | 3078 | 2330 | 0.16 | 0.15 | 0.11 |
| **Moisture conservation practices** | | | | | | |
| Control | 30505 | 26750 | 28628 | 2.46 | 2.23 | 2.34 |
| Dust mulch | 38648 | 34540 | 36594 | 2.60 | 2.38 | 2.49 |
| Straw mulch | 44269 | 41091 | 42680 | 2.84 | 2.65 | 2.75 |
| Plastic mulch | 45615 | 42163 | 43889 | 2.86 | 2.66 | 2.76 |
| Seed line mulching of FYM | 39367 | 35274 | 37320 | 2.67 | 2.45 | 2.56 |
| S.Em+ | 756 | 690 | 549 | 0.04 | 0.04 | 0.03 |
| CD (P=0.05) | 2150 | 1962 | 1542 | 0.13 | 0.11 | 0.09 |
| CV (%) | 7.6 | 7.9 | 9.2 | 6.61 | 6.44 | 7.46 |

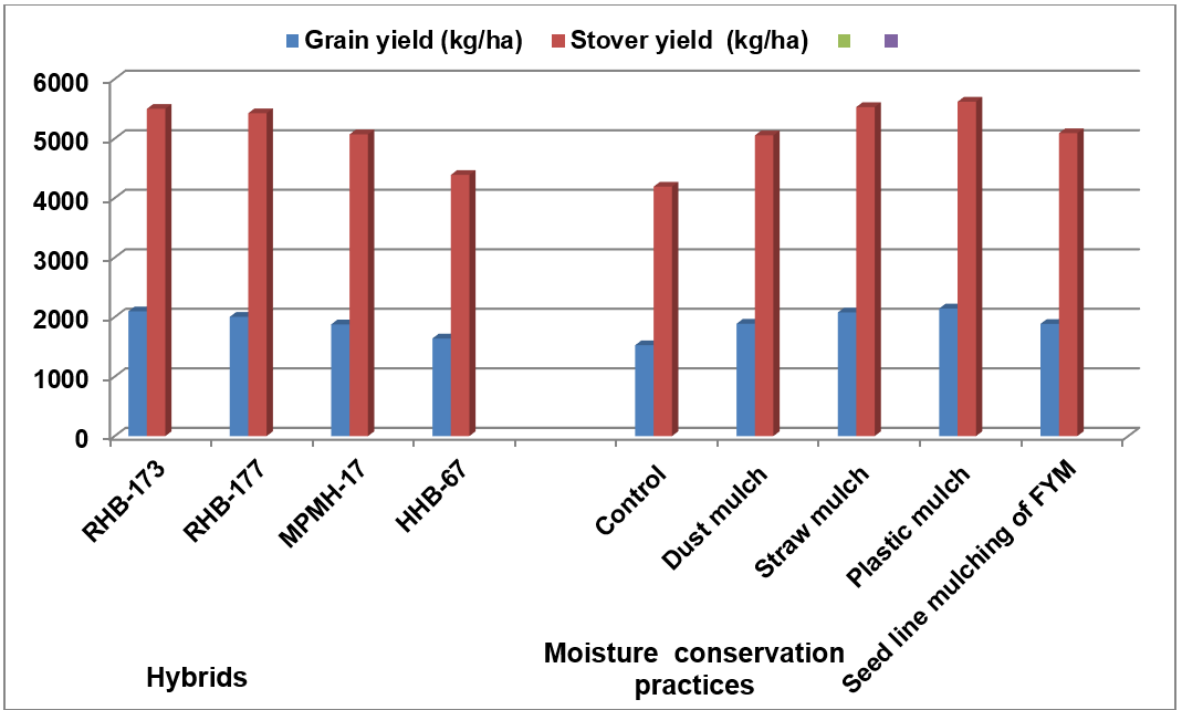


**Fig 1:** Effect of moisture conservation practices on grain and stover of pearlmillet hybrids

## Conclusion

Based on results of two years experimentation, it may be concluded that hybrid RHB-173 recorded significantly higher water expense efficiency, water use efficiency and economics being remained at par with RHB-177. Use of plastic mulch proved to be the most suitable moisture conservation practices as it provided significantly water expense efficiency, water use efficiency and economics, remained at par with straw mulch.

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