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EFFECT OF DIFFERENT ROW ORIENTATIONS ON GROWTH AND YIELD OF PEARL MILLET CULTIVARS

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SUMMARY

As the global demand for food continues to rise, optimizing pearl millet production becomes increasingly important. This research paper investigates the impact of different row orientations (NS and EW) on the growth and yield of pearl millet cultivars, namely HHB 299, HC 20 Composite, and HHB 67 Improved. The field experiment was carried out at the Research Farm of Department of Agricultural Meteorology of CCS Haryana Agricultural University, Hisar, Haryana located at a geographical position of 75°46′ E longitude and 29°10′ N latitude, at an elevation of 215.2 meters above sea level during the 2022 *kharif* season, with four replications each. The maximum value of LAI was higher in NS direction (5.83) as compared to EW direction (4.82). Dry matter accumulation at maturity was 107.11 and 101.21 g/plant in NS and east west direction, respectively. Highest dry matter was produced by HHB 299 among cultivars. Furthermore, HHB 299 also yielded the maximum grain production, with the NS sown crops outperforming the EW sown ones in terms of grain yield. The harvest index was at its peak in the NS sowing orientation, standing at 24.6%, while the EW sowing displayed a slightly lower harvest index of 23.3%.

Key words: Dry matter accumulation, LAI, pearl millet, row orientation, yield

Pearl millet (*Pennisetum glaucum*) is a vital cereal crop that plays a crucial role in ensuring food security and sustainable agriculture, particularly in regions with challenging environmental conditions. Moisture and radiation constitute fundamental meteorological factors with significant implications for agriculture. In conceivable scenarios, provided there is an ample supply of moisture and crop fertility, radiation plays crucial role in determining crop growth and productivity. Therefore, managing the internal radiant energy within a crop field through appropriate adjustments in crop stand geometry, such as row orientation, offers a means to create optimal conditions within the crop canopy. (Lunagaria and Shekh, 2006) This is essential for maximizing the efficient utilization of solar energy in agricultural production. The present study aimed to examine the effects of varying row orientation on key parameters like leaf area index (LAI), dry matter accumulation (DMA), panicle characteristics and yield attributes in pearl millet crop situated in Hisar, Haryana with the goal of optimizing crop growth and productivity.

MATERIALS AND METHODS

Study location and climatic conditions

The study was carried out in the *kharif* season, 2022 at the CCS Haryana Agricultural University's Research Farm in Hisar. The test site is located in the subtropics at longitude 75°46′ E and latitude 29°10′ N, and it is 215.2 meters above mean sea level. Hisar experiences summertime daytime highs between 40 and 46°C. The SW Monsoon season (June to September) brings about 75 to 80 per cent of the annual rainfall. The average annual rainfall is about 450 mm, with the months of July and August receiving the majority of that amount, 133.4 and 116.2 mm, respectively. There are 27.5 wet days on average every year, 19 of which happen during the SW Monsoon. Intermittent dust storms are also common.

Experimental details

The right sowing direction is a crucial

management strategy for maximizing pearl millet seed output. In this context, field experiments were laid out during *kharif* 2022 at Hisar with three cultivars; HHB 299, HC 20 Composite and HHB 67 improved in two row orientations *i.e.,* North-South (NS) and East-West (EW). The design of the experiment was Factorial Randomized Block Design having four replications with a plot size of 4.5 m × 4.5 m. Row orientation's effects on pearl millet cultivars' growth and yield parameters were measured for total dry matter accumulation, leaf area index (LAI), panicle attributes (number of effective tillers per plant, panicle length, panicle girth, test weight no. of grains per panicle), and yield attributes (grain yield, straw weight, and harvest index). According to Panse and Sukhatme's (1985) description of a factorial randomised block design, the data were statistically analyzed using analysis of variance (ANOVA). The "F-test" was used to determine the significance of treatment effects at a 5 per cent level of significance.

DMA Measurement

Three randomly chosen plants from each plot were used to measure dry matter accumulation (DMA), which was measured every ten days beginning 20 days after seeding. The plants that were sampled were first sun dried, and then they were oven dried at 65 to 70 °C until they reached a constant weight.

LAI Measurement

At 10-day intervals, 20 days after planting, the leaf area from each plot was calculated using the plant leaves that were isolated from samples that were taken for the calculation of DMA. Using a leaf area meter (CI-203 Handheld Laser Leaf Area Meter, Biosciences), the green leaf area (cm^2) was measured. The leaf area measured with the use of a leaf area meter was utilized for calculating the leaf area index using the formula below.

$$LAI = \frac{\text{Leaf area (cm}^2\text{)}}{\text{Land area covered by plant cm}^2\text{)}}$$

RESULTS AND DISCUSSION

DMA Measurement

Data on dry matter accumulation for the three cultivars under two row orientations are shown in Table 1. Dry matter under row orientation was found to be greater in NS orientation (107.11 g), however it was significantly smaller in EW orientation (101.21 g). Growing the crop in rows facing north and south as opposed to east and west may end up resulting in higher dry matter accumulation due to increased light penetration into the lower canopy of the plant with a NS orientation. (Kumar, 2012 and Lunagaria, 2006). The buildup of dry matter rose as the plant grew older, from 20 DAS to 70 DAS. The maximum dry matter content was recorded in cultivar HHB 299 (109.29 g) at 70 DAS, followed by HC 20 Composite (104.71 g) and HHB 67 Improved (98.48 g), in that order. This could be as a result of the pearl millet cultivar HHB 299 having the highest LAI and PAR absorption. The genetic characteristics of the crop have an effect on growth.

Leaf Area Index

The LAI statistics for the three cultivars are displayed in Table 2. When compared to the EW orientation, the NS orientation had a higher LAI having peak values of 5.23 and 4.82 respectively. These findings imply that crop row orientation in the NS direction supports significantly larger leaf expansion than crop row in the EW direction due to its stronger light penetration

TABLE 1

Dry matter accumulated (g/ plant) of different cultivars of pearl millet under two row orientations

Treatments	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS
Variety						
HHB 299	1.25	7.91	32.15	59.55	96.27	109.29
HC 20 Composite	1.38	8.74	35.92	57.16	92.56	104.71
HHB 67 improved	1.20	9.94	37.48	52.39	81.40	98.48
CD (0.05%)	0.09	0.31	2.27	3.65	4.45	5.67
Row orientation						
North-South	1.25	10.77	37.97	60.00	96.36	107.11
East-West	1.30	6.95	32.40	52.73	83.80	101.21
CD (0.05%)	NS	0.26	1.85	2.98	3.63	4.63

in the lower plant canopy. These findings concur with research on wheat by Lungaria *et al.*, 2006 and beans by Tsubo *et al.*, 2001. As the crop matured up to 50 DAS, the leaf area index of the crop grown under cultivars in two row orientations increased; after that, it began to drop, as is the case with many other plants with identical growing habits. HHB 299 among pearl millet cultivars recorded the highest LAI (5.9) in comparison to HC 20 Composite (5.25) and HHB 67 Improved (4.35) throughout the growth season. This is because HHB 299's leaves have different morphological characteristics, mature more quickly, and absorb more PAR. (Kumar *et al.,* 2012; Singh *et al*., 2012).

Panicle Characteristics

At harvest, the average length and circumference of the ear heads were estimated; the harvest information is shown in Table 3. Sowing in the N-S direction exhibited a slight advantage over sowing in the E-W direction in terms of panicle features, but the difference was insignificant. The mean panicle lengths measured in HHB 299, HC 20 Composite, and HHB 67 Improved were 26.91 cm, 26.5 cm, and 22.81 cm, respectively. Additionally, the mean panicle girths measured in HHB 299, HC 20 Composite, and HHB 67 Improved were 8.62, 8.68, and 7.96 cm, respectively. HHB 67 Improved (10.36 g.) had the highest test weights, followed by HHB 299 (9.47 g.) and HC 20 Composite (8.58 g.). Crops that were sown in an EW row orientation (9.2) had a lower test weight than those that were grown in a NS row (9.74 g). HHB 299 (2080) had the most grains per panicle, followed by HC 20 Composite (2063.1) and HHB 67 Improved (1553.7). Crops planted with an EW row orientation (1779.5) contained considerably fewer grains per panicle than those sown with a NS row orientation (2018.3).

Yield attributes and grain yield

At harvest, yield attributes and grain yield were calculated; the outcome is shown in Table 4. During the crop season, HHB 299, HC 20 Composite, and HHB 67 Improved produced the 4.6, 4.3 and3.6 effective tillers per plant respectively. Crops that were planted in a NS direction had more earheads (4.3) than those that were planted in an EW direction (4.0). In comparison to the EW row orientation, which produced a grain yield of 2823.8 kg/ha, the NS row orientation provided

TABLE 2

Leaf area index in different cultivars of pearl millet under two row orientations

Treatments	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS
Variety						
HHB 299	0.56	1.48	3.81	5.49	4.24	3.56
HC 20 Composite	0.47	1.5	4.01	5.25	3.93	3.17
HHB 67 improved	0.49	1.78	4.35	4.34	2.78	2.47
CD (0.05%)	NS	0.03	0.05	0.16	0.11	0.07
Row orientation						
North-South	0.51	1.74	4.33	5.23	3.85	3.15
East-West	0.5	1.44	3.77	4.82	3.45	2.98
CD (0.05%)	NS	0.03	0.04	0.13	0.09	0.06

TABLE 3

Panicle Characteristics in different cultivars of pearl millet under two row orientations

Treatments	Panicle Length (cm)	Panicle Girth (cm)	Test weight (g)	No. of Grains/ panicle
Variety				
HHB 299	26.91	8.62	9.47	2080.0
HC 20 Composite	26.50	8.28	8.58	2063.1
HHB 67 improved	22.81	7.96	10.36	1553.7
CD (0.05%)	NS	NS	1.35	183.63
Row orientation				
North-South	25.64	8.28	9.74	2018.3
East-West	25.17	8.3	9.2	1779.5
CD (0.05%)	NS	NS	NS	149.94

TABLE 4
Yield attributes and grain yield in different cultivars of pearl millet under two row orientations

Treatments	No. of effective tillers/plant	Grain yield (kg/ha)	Straw weight (kg/ha)	Harvest Index (%)
Variety				
HHB 299	4.6	3585.8	9839.5	26.7
HC 20 Composite	4.3	2482.3	10293	19.4
HHB 67 improved	3.6	2839.8	8117.6	25.9
CD (0.05%)	0.72	123.64	284.24	1.08
Row orientation				
North-South	4.3	3114.8	9541.6	24.6
East-West	4.0	2823.8	9291.8	23.3
CD (0.05%)	NS	100.95	232.08	0.88

a much greater grain yield (3114.8 kg/ha). The lowest grain yield was produced by HC 20 Composite (2482.3 kg/ha), and the highest grain yield was produced by HHB 299 (3585.7 kg/ha). In comparison to the EW row orientation's 9291.8 kg/ha, the NS row orientation produced a straw yield that was much greater at 9541 kg/ha. The least amount of straw was generated by HHB67 Improved (811.6 kg/ha), and the most was produced by HC 20 Composite (10293 kg/ha). HHB 299 (26.7%) had the greatest harvest index, followed by HHB 67 Improved (25.9%) and HC 20 Composite (19.4%). The EW harvest index was higher (23.3%) than the NS harvest index (24.6%), indicating only a very slight difference between the orientations. These factors mostly account for the greater yield. Because it received more radiation per plant, the NS crop row orientation yielded a higher grain yield than the EW crop row orientation. Due to the rows of the crop being aligned EW and creating a shade effect over one another, the middle and lower tiers of the plant were not getting enough sunlight. Multi-reflectance may have improved this situation.

CONCLUSION

In conclusion, row orientation is a critical agronomic factor for pearl millet that can significantly influence crop growth and yield. Results revealed significant cultivar-specific responses to row orientation. Cultivar HHB 299 with NS row orientation performed best in terms of LAI, DMA as well as for yield attributes. HHB 299 also produced panicles that were longer, girthier, and contained more grains than other cultivars, giving rise to the highest grain output. Test weight was higher for HHB 67 Improved than for other cultivars because its grains were bolder. Cultivar HC 20 Composite produced more straw, which also led to a lower harvest index, possibly because leaves deposit more photosynthetic material than grains do. HHB 299 got the greatest harvest index because it produced more economically than other cultivars. Physiological mechanisms like light interception, water use, and microclimate influence underpinned these responses. Farmers, agronomists, and policymakers can tailor row orientation strategies to specific cultivars and local conditions, potentially enhancing yields and food security. Future research should refine these guidelines and explore broader implications for sustainable agriculture and food production.

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