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Evaluation of yield and yield attributes of crop pearl millet under different growing environments at Hisar, Haryana

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Abstract

Pearlmillet [*Pennisetum glaucum* (L) R. Br.] is an important *kharif* crop which is known with various vernacular names such as *Bajra*, *Bajri* and *Kambu*. This crop plays a significant role in Indian agriculture, contributing to food security and providing a valuable source of nutrition for both humans and livestock. It is referred to as a “nutricereal” because it is very high in energy, proteins, ash, fats, carbohydrates, iron, zinc and dietary fiber. In Haryana total area under Pearlmillet is 0.45 million hectares with total production of 0.72 million tonnes and productivity of 1607 kg ha⁻¹. An experiment was conducted at CCS Haryana Agricultural University, Hisar, during kharif 2023 to evaluate yield and yield attributes of Pearlmillet crop. For this, pearl millet was sown on three different sowing dates *i.e.*, 30th June, 13th July and 27th July and three varieties were taken for this experiment *i.e.*, GHB 558, HHB 67 Improved and HHB 299. Experiment was laid out in factorial RBD design with four replications. Based on the results, 30th June (second fortnight of June) appears to be the most suitable time for sowing of Pearlmillet to attain better yield. Among the varieties, Variety GHB 558 attained better growth and produced highest yield and yield attributes. Leaf area index was also higher for the 30th June sown crop and higher plant height was attained in D₁- 30th June.

Keywords: Sowing time, pearlmillet, yield, yield attributes

1. Introduction

Pearlmillet [*Pennisetum glaucum* (L) R. Br.] is an important *kharif* crop which is known with various vernacular names such as *Bajra*, *Bajri* and *Kambu*. This crop plays a significant role in Indian agriculture, contributing to food security and providing a valuable source of nutrition for both humans and livestock. It is referred to as a “nutricereal” because it is very high in energy, proteins, ash, fats, carbohydrates, iron, zinc and dietary fiber. One of the notable characteristics of pearl millet is its high degree of cross-pollination, facilitated by the protogynous nature of its flowers. This dual-purpose nature, as both a food and fodder crop, enhances its importance in agricultural systems, particularly in regions where livestock rearing is prevalent. Besides providing food and fodder, millet stems are used for a wide range of purposes like construction of fences, hut walls, thatches, and also used for the production of baskets, sunshades, brooms, mats etc. (IFAD,1999) ^[9].

It is the most widely grown type of millet and India is the largest producer of pearl millet, both in term of area and production in the world and ranks third after wheat (*Triticum aestivum*) and rice (*Oryza sativa*) in area in India (GOI, 2008) ^[8] India stands out as the largest producer of pearlmillet globally, accounting for approximately 50% of the world's production. In Haryana total area under pearlmillet is 0.45 million hectares with total production of 0.72 million tonnes and productivity of 1607 kg ha⁻¹ (Anonymous, 2017) ^[1]. Major pearlmillet growing states of India are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh, Haryana, Tamil Nadu and Andhra Pradesh. Pearlmillet development is divided into three stages: The vegetative stage (from emergence to panicle initiation), the panicle development stage (from panicle initiation to flowering) and then the grain filling stage (from flowering to end of maturity).The tillering stage of pearlmillet is considered as a responsible factor for its adaptation to adverse

environmental conditions like high temperature and moisture stress at different stages of development (flowering, seed setting and grain filling) (Burman *et al.*, 2011; Sangeeta *et al.*, 2018) ^[3, 14]. About 89.5% of the cultivated area under pearl millet is rainfed, i.e. without irrigation.

It is cultivated in the area where average annual rainfall is in range of 150-400 mm. (Basavaraj *et al.*, 2010) ^[2]. India is the largest producer of pearl millet. During 2010–2012, the average pearl millet area in India was 8.5 million ha and the average production was 9.4 million tons. It is taken up in an area of 6.93 million ha with an average production of 8.61 million tones and 1,243 kg/ha productivity (DMD, 2020) ^[7]. In addition, to include millets into the mainstream and exploit its nutritionally superior qualities and promote its cultivation, Government of India has declared Year 2018 as the “Year of Millets” and FAO Committee on Agriculture (COAG) forum has declared the current Year as “International Year of Millets” (Satyavathi *et al.*, 2021) ^[13]. In India, it is grown over an area 7652 hectares with total production of 10863 tones and productivity of 1420 kg/ha (Anonymous, 2022) ^[1]. The average yield of pearl millet in country is quite low as compared to its potential yield (5000 kg/ha) because it is grown in marginal areas of the country. (Singh, 2021) ^[15]. Pearlmillet is rich in nutrients, offers abundant energy, dietary fiber, proteins with a well-balanced amino acid composition, numerous essential minerals, certain vitamins, and antioxidants. These components play a crucial role in guarding against significant human health issues like diabetes, cancer, cardiovascular problems, and neurodegenerative diseases.

2. Materials and Methods

The present study was carried out during kharif season 2023 at CCS Haryana Agricultural University, Hisar. The study area is located between of 29° 10'N latitude and 75° 46' E longitude with an elevation of 215.2 meters above the mean sea level. Hisar is located in India's semi-arid, subtropical climate zone. Climate of this place is primarily characterized by dryness, temperature extremes, and little rainfall. The soils of this region are derived from Indo-Gangetic alluvium, which are very deep and sandy loam in texture and have some amount of calcium carbonate (CaCO₃) in the soil profile. The soil of experimental field station was sandy loam in texture and belongs to Entisols soil order. Soil has mechanical composition of Sand (56.7%), Silt (25.8%) and Clay (17.8%).

Table 1: Mechanical composition of soil

Components	Depth of soil profile (cm)	
	0-15 cm	15-30 cm
Sand (%)	56.7	55.2
Silt (%)	25.8	26.6
Clay (%)	17.8	18.4
Textural class	Sandy loam	Sandy loam

The experiment was conducted in FRBD (Factorial Randomized Block Design) design with four replications. Three dates of sowing were selected for pearl millet i.e., 30th June, 13th July and 27th July and three varieties were taken GHB 558, HHB 67 Improved and HHB 299 with four replications. Crop was examined at each phenophase from emergence to harvesting. Hoeing and hand weeding were done with the help of “kasola” at 25 and 45 DAS to maintain recommended spacing, proper aeration and weed free environment. The crop was harvested to record the biological yield, grain yield and stover yield from net

plot area and was harvested by cutting close to the ground with the help of sickle. In each plot, bundles were tied and tagged properly and leave for proper sun drying. After complete drying, the produce of each plot was weighed on hanging weighing balance and threshing was done by plot thresher. The clean grains obtained from individual plot were weighed separately and recorded as grain yield (kg/plot). By subtracting the grain yield from biological yield, then calculated Stover yield (kg/plot). These were converted into kg/hac.

2.1 Total number of tillers/plant

Three plants from each plot selected randomly for measurement of height were used to record the total number of tillers at harvest and averaged to express as number of tillers/plants.

2.2 Effective tillers/plant

Total ear bearing tillers of three tagged plants were counted at harvest from each plot and then average number of effective tillers/plants was computed.

2.3 Test weight (g)

One thousand grains were counted from each sample drawn from the winnowed and cleaned produce of each plot and their weight was recorded with the help of electric balance.

2.4 Grain yield (kg/ha)

The total biomass harvested from each net plot was threshed, cleaned and dried. Grains, thus obtained were weighed in terms of kg/plot and converted in kg/ha.

2.5 Stover yield (kg/ha)

Stover yield per plot was calculated by subtracting the grain yield from the biological yield and then expressed in kg /ha.

2.6 Biological yield (kg/ha)

After thorough sun drying of harvested material, weight was taken for biological yield per plot and then converted to kg/ha.

2.7 Harvest index

$$\text{Harvest index} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

3. Weather Conditions During Crop Season

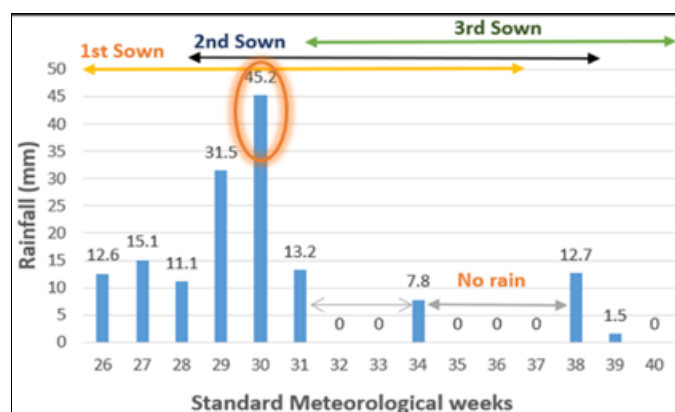


Fig 1: Rainfall distribution during crop season

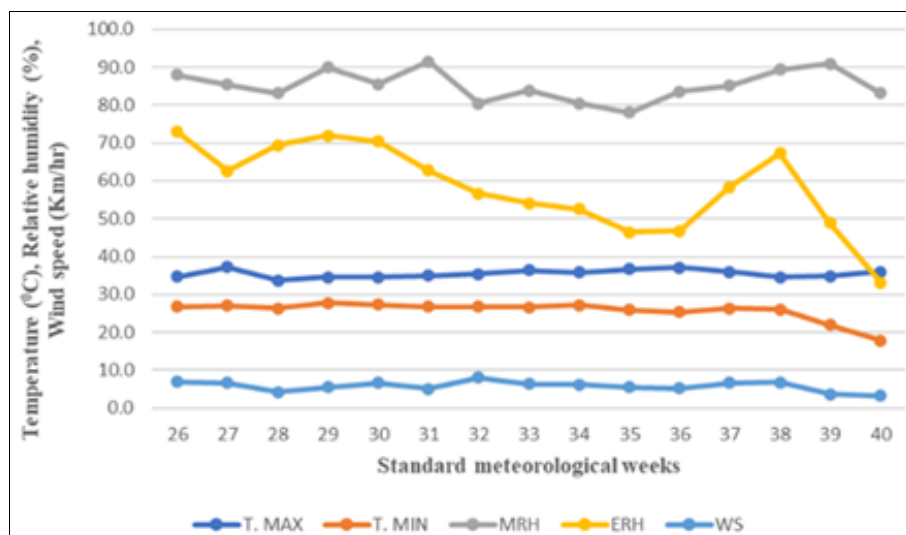


Fig 2: weather Parameters during crop season

4. Results and Discussion

The relationship between the source and sink as well as the various components of the source and sink determine the economic output of the crop. Total tillers per plant, Effective tillers per plant, panicle length, panicle girth, and test weight are some of the major factors that determine the output in the crop pearl millet. The main reason for the decline in the yield is the decline in these influencing components.

4.1 Total number of tillers plant⁻¹

The data presented in table 2 showed that the number of total tillers per plant are significantly influenced by sowing time in all the three varieties at the time of harvest. Among the three growing environments 30th June has highest number of total tillers plant⁻¹ (4.45 tillers) as compared to 13th July (3.89 tillers) and 27th July (3.36 tillers). Among the varieties, highest number of total tillers per plant at the harvesting time was produced by the GHB 558 (4.65 tillers) followed by HHB 299 (3.75 tillers) and HHB 67 Improved (3.29 tillers) during the crop growing season and the varieties also showed significant effect on total number of tillers per plant.

4.2 Number of effective tillers plant⁻¹

Number of effective tillers was significantly influenced by the growing environments. Among the three planting dates, sowing on 30th June has highest number of effective tillers per plant (2.98 tillers) compared to the 13th July (2.65 tillers) and 27th July (2.26 tillers). Varieties also showed a significant influence on the number of effective tillers per plant. Among the varieties, highest number of effective tillers plant⁻¹ at harvest produced by GHB 558 (2.92 tillers) followed by HHB 299 (2.56 tillers) and HHB 67 Improved (2.41 tillers).

4.3 1000-grains weight (Test weight, g)

The weight of 1000-grains showed significant difference among the different growing environments. Highest 1000-grain weight was recorded in the crop sown on 30th June (9.14 g) followed by 13th July (8.84 g) and 27th July (7.98 g). Different varieties are non-significantly influenced the 1000-grain weight. The 1000-grain weight was highest in GHB 558 (8.80 g) followed by HHB 299 (8.66 g) and HHB 67 Improved (8.49 g) at the time of harvest.

4.4 Grain Yield (kg ha⁻¹)

Table 2 represented above showed the analyzed data of grain yield and revealed that the different growing environments and varieties has significantly influenced the grain yield. The yield of pearl millet crop was reduced with each delay in sowing time. The highest yield was obtained from the crop sown on 30th June (3588 kg ha⁻¹) followed by 13th July (2763.3 kg ha⁻¹) and 27th July (1443.1 kg ha⁻¹). Among the varieties, maximum grain yield was obtained from the GHB 558 (2824.1 kg ha⁻¹) followed by HHB 299 (2616.3 kg ha⁻¹) and HHB 67 Improved (2354 kg ha⁻¹) at the time of harvest.

4.5 Stover Yield (kg ha⁻¹)

This was revealed that three growing environments and varieties significantly influenced the stover yield. Among the three dates of sowing, the maximum stover yield was recorded from the crop sown on 30th June (11331 kg ha⁻¹) followed by 13th July (8993.1 kg ha⁻¹) and 27th July (4971.1 kg ha⁻¹). Among the varieties, highest stover yield was obtained from the GHB 558 (8941 kg ha⁻¹) followed by HHB 299 (8483.8 kg ha⁻¹) and HHB 67 Improved (7870.4 kg ha⁻¹).

4.6 Biological Yield (kg ha⁻¹)

This was observed that growing environments and varieties significantly influenced the biological yield. Among the three different environments, maximum biological yield was obtained from the crop sown on 30th June (14919 kg ha⁻¹) followed by 13th July (11756.4 kg ha⁻¹) and 27th July (6414.2 kg ha⁻¹). And among the three varieties, maximum biological yield was obtained from GHB 558 (11765 kg ha⁻¹) followed by HHB 299 (11100.1 kg ha⁻¹) and HHB 67 Improved (10224.4 kg ha⁻¹).

4.7 Harvest Index (%)

It was revealed that the growing environments and varieties significantly influenced the harvest index. Maximum harvest index was recorded in the crop sown on 30th June (24.4%) followed by 13th July (23.5%) and 27th July (22.5%). Among the varieties, maximum harvest index was recorded from GHB (23.8%) followed by HHB 299 (23.5%) and HHB 67 Improved (22.7%).

Table 2: Effect of growing environment and varieties on yield and yield attributes of the crop

Treatments	Total no. of tillers plant ⁻¹	No. of effective tillers plant ⁻¹	1000-grain weight	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
Factor A (Sowing dates)							
D1 30 th June	4.45	2.98	9.14	3588	11331	14919	24.4
D2 13 th July	3.89	2.65	8.84	2763.3	8993.1	11756.4	23.5
D3 27 th July	3.36	2.26	7.98	1443.1	4971.1	6414.2	22.5
SE (m)	0.22	0.12	0.15	52.1	192.4	241.5	0.1
CD@5%	0.79	0.43	0.52	183.3	678.7	852.1	0.5
Factor B (Varieties)							
V1 GHB 558	4.65	2.92	8.80	2824.1	8941	11765	23.8
V2 HHB 67 Imp.	3.29	2.41	8.49	2354	7870.4	10224.4	22.7
V3 HHB 299	3.75	2.56	8.66	2616.3	8483.8	11100.1	23.5
SE (m)	0.18	0.08	0.15	39.6	123.8	154.4	0.2
CD@5%	0.54	0.25	NS	118.6	370.6	462.3	0.6

5. Discussion

The relationship between the source and sink as well as the various components of the source and sink determine the economic output of the crop. Total tillers per plant, Effective tillers per plant, panicle length, panicle girth, and test weight are some of the major factors that determine the output in the crop pearl millet. The main reason for the decline in the yield is the decline in these influencing components. Number of effective tillers per plant was higher in the 30th June sown crop (2.98 tillers) followed by 13th July (2.65 tillers) and 27th July (2.26 tillers).

Total number of tillers per plant was higher in the 30th June (4.45 tillers) sown crop followed by 13th July (3.89 tillers) and 27th July (3.36 tillers). Among the varieties, maximum number of tillers per plant was recorded in the GHB 558 (4.65 tillers) followed by HHB 299 (3.75 tillers) and HHB 67 Improved (3.29 tillers). similar results were recorded by the Craufurd and Bidinger (1988) [4]. Similar trend was followed in the number of effective tillers per plant.

Grain yield was higher for the 30th June sown crop (3588 kg ha⁻¹) followed by 13th July (2763.3 kg ha⁻¹) and 27th July (1443.1 kg ha⁻¹). Early sown crop has longer photo-period in the growing season results into more assimilates and more number of tillers. Among the varieties, higher grain yield was recorded by the GHB 558 (2824.1 kg ha⁻¹) followed by HHB 299 (2616.3 kg ha⁻¹) and HHB 67 Improved (2354 kg ha⁻¹). Similar findings were reported by Maiti and Soto (1990) [10], Uzoma *et al.* (2010) [17] and Nirval *et al.* (1995) [12].

Highest 1000- grain weight was in the crop sown on 30th June (9.14 g) followed by 13th July (8.84 g) and 27th July (7.98 g). Early sown crop obtained longer growth period with favorable environmental conditions and it resulted into heavier grains produced as compared to other two late sowing crops. These results were supported by the findings of Teare *et al.* (1994) [16] who concluded that early sown crop has higher test weight as compared to late sown crop. Test weight in 27th July sown crop was decreased due to the short duration and other influencing weather parameters. Among the varieties, GHB 558 has higher 1000 grain weight (8.80 g) followed by HHB 299 (8.66 g) and HHB 67 Improved (8.49 g) at the time of harvesting due to its bold seed character.

Highest grain yield, stover yield and biological yield were recorded by the 30th June sown crop followed by 13th July and 27th July. Early sown crop has higher grain yield compared to late sowing due to longer growth period. Grain yield, stover yield and biological yield also decreased with the delay in sowing time. This was due to weather conditions and irregular rainfall distribution. These results were supported by the

findings of Mayura *et al.* (2016) and Deshmukh *et al.* (2009) [5]. Among the varieties, the grain yield, stover yield and biological yield of GHB 558 was highest followed by HHB 299 and HHB 67 Improved at crop harvest. The GHB 558 took advantage of its comparatively longer duration with superior yield attributes.

Harvest index was recorded maximum for the crop sown on 30th June (24.4%) followed by 13th July sown crop (23.5%) and 27th July sown crop (22.5%). These results were supported by the findings of Mayura *et al.* (2016). This was due to more yield in the crop sown on 30th June, while in the late sown crop harvest index was low. Among the varieties, the GHB 558 recorded higher Harvest index (23.8%), followed by HHB 299 (23.5%) and HHB 67 Improved (22.7%). These results were supported by Divya *et al.* (2017) [6].

6. Conclusion

Among the three growing environments 30th June sown has higher total number of tillers per plant and effective tillers per plant compared to other two growing environments. Grain yield, stover yield and biological yield was also higher for the crop sown on 30th June. Among the varieties, GHB 558 has higher number of effective tillers per plant than other two cultivars *i.e.*, HHB 67 Improved and HHB 299. Grain yield, stover yield and biological yield also followed same trend among the varieties.

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