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Influence of Non-monetary and Low Cost Input in Sustainable Summer Pearlmillet (*Pennisetum Glaucum* L.) Production

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Abstract

An evaluation trial was carried at Navsari (India) during summer season to work out effect of non-monetary and low cost input on pearlmillet. Sowing pearlmillet during last week of January or first week of February increases the yield and net returns from the crop. Pearlmillet sown on 5 February (3.24 t ha^{-1}) gave significantly highest grain yield followed by 25 January (3.04 t ha^{-1}) sowing, while 15 February sowing gave significantly lowest yield. The results gained confirm that ridges and furrow along with early sowing date during summer season is beneficial. Ridges and furrow sowing of pearlmillet showed superiority in all needed agronomic trait of pearlmillet crop during summer and the increase in grain and stover yield under ridges and furrow was 20.00 and 17.71 per cent over flat bed sowing, respectively.

Keywords: Non-monetary inputs;Low cost inputs; summer pearlmillet; Pennisetum glaucum; Dates of sowing; Land configuration; Seed bed.

1. Introduction

Pearlmillet known in India as *Bajra*. Pearlmillet (*Pennisetum glaucum* L.) has originated in tropical western Africa, where the greatest number of both wild ancestors and cultivated forms occur. It belongs to family Gramineae (Poaceae). The cultivated species are *Pennisetum glaucum* L. (2n=14) used for grain and fodder and *Pennisetum purpureum* L. (2n=28) used for green and dry fodder. It is highly cross pollinated crop due to protogynous nature of the flowers (more than 85% outcrossing) diploid annual (2n=2x=14) with a large genome size (2450 Mbp). Average composition of the edible portion of seed is 12% moisture, 10-12% protein, 3-5% fat, 60-70% carbohydrates, 1.5-3% fibre and 1.5-2% ash. Its nutritional value is somewhat superior to maize, rice, sorghum and wheat. Stalks are also used for thatching, as fuel and made into mats for winnowing.

Pearlmillet production during summer season is affected by different factors *viz.* soil type, sowing time, seed bed, varieties, spacing, quality of water, judicious use of water as well as nutrients, weed, insect and disease management. Among them time of sowing and land configuration play a vital role for pearlmillet cultivation.

Sowing time is the most important non-monetary input influencing crop yield. Sowing at optimum time improves the productivity by providing suitable environment at all the growth stages. Upadhyay *et al.* (2001) have reported higher grain yield of summer pearlmillet when sown on 15 march and found reduction in grain yield with delay in sowing. Identifying suitable time of sowing for pearlmillet during summer is important to have proper growth and development of plants, save the crop from early monsoon showers and timely vacate the field for succeeding *kharif* crop.

Waterlogging in heavy black soil and salt injury due to saline irrigation water are the important factors for low productivity of pearlmillet in south Gujarat. Under these conditions land configuration can play a vital role to overcome these problems by providing easy and uniform germination as well as good growth and development of plants. Land configuration increases water use efficiency as reported by Chiroma *et al.* (2008) and also increases availability of nutrients to crops. It is particularly useful in areas having saline irrigation water because it helps to avoid direct contact of young plants with saline irrigation water. The superiority of ridges and furrow system could be ascribed to proper drainage of excess water coupled with adequate aeration at the time of irrigation or heavy rainfall. Parihar *et al.* (2009) reported that ridges and furrow sowing method improved grain as well as stover yield of pearlmillet and succeeding mustard over the flat bed method of sowing.

2. Materials and Methods

The site of experiment was Instructional Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during summer season of 2010. Geographically, Navsari is located at 20.95^0 N latitude, 72.93^0 E longitude and at height of 9 metres above the mean sea level.

The weekly mean maximum and minimum temperature varied from 29.8 ^{o}C to 38^{o}C and 13.2^{o}C to 28.8^{o}C, respectively during the course of investigation. The maximum and minimum relative humidity ranged from 68 to 91 per cent and 26 to 73 per cent, respectively and daily sunshine hours from 7.5 to 10.8 were available during the crop period. There was no rainfall during the crop season.

The soils of South Gujarat are locally known as ‘Black Cotton Soil’. The soil of Navsari campus falls under the great group Ustochrepts and has been placed under

Jalalpur series. These soils are dominated by montmorillonite clay, which cracks heavily after drying. The soil of the experimental site was dark grayish brown type having medium to poor drainage and good water holding capacity.

The treatment combinations comprise two levels of land configurations viz., flat bed (L_1) and ridges and furrow (L_2) and three dates of sowing *i.e.* 25 January (D_1), 5 February (D_2) and 15 February (D_3) were evaluated in factorial randomized block design with three replications.

3. Results & Discussion

3.1 Effect of weather on pearlmillet crop in summer season

The results on growth and yield attributes, yield, nutrient content and uptake as well as water use efficiency data were presented in the previous chapter indicated profound effect of environment factors. Weather condition plays an important role on the growth and yield of pearlmillet in summer season. It is evident from the meteorological data that the weather condition prevailed during the entire crop period was favorable and congenial for the normal growth and development of pearlmillet crop. No severe incidences of diseases and pests were observed during the entire crop growth period. Thus, it is expected that the variation observed in the experimental results were mainly due to the treatment effects only.

3.2 Effect of soil

The soil properties *viz.*, texture, pH, EC and available nutrients were estimated before sowing. The soil of experimental field was found clayey in texture, slightly alkaline (pH 7.8), low in available nitrogen (176 kg/ha), with medium availability of phosphorus (32 kg/ha) and fairly rich in potash (350 kg/ha), which is suitable for proper growth and development of pearlmillet crop.

3.3 Effect of dates of sowing on growth and growth attributes

Growth components of pearlmillet *viz.*, plant height, leaf area index, dry matter accumulation, effective number of tillers, days to 50 per cent flowering and days to maturity varied significantly due to time of sowing (Table 1 and 2). Only the plant height, leaf area index and dry matter accumulation measured at 20 DAS was not significant due to changes in sowing time. Summer pearlmillet sown at normal time on 25 January registered measurable increase in growth components as compared to late sown crop.

Thus, results were in favour for sowing of summer pearlmillet on 25 January (D_1) far to on 5 February (D_2) than late sowing i.e. on 15 February (D_3). This is probably due to early sown crop may enjoy favourable climatic conditions in term of temperature and other climatic parameters during various crop growth stages, which reflected into better growth. Similar results of summer pearlmillet growth were observed by Andhale *et al.* (2007), Upadhyay *et al.* (2001), Patel and Patel (2002) and Patel *et al.* (2004).

Days required to 50 per cent flowering and physiological maturity was also remarkably influenced under varying sowing time. Late sown crop advanced the flowering and maturity over early sowing in summer pearlmillet and 15 February sowing took minimum days to 50 per cent flowering and maturity. It might be due to the availability of required photoperiod to early sown pearlmillet crop at reproductive stage. Similar findings were also reported by Andhale *et al.* (2007) in pearlmillet.

3.4 Effect of land configuration on growth and growth attributes

Different techniques of land configuration showed remarkable influence on crop growth. Significant differences in plant height, leaf area index, dry matter accumulation and number of effective tillers per plant (Table 1) at different growth stages of crop was observed due to the effect of various methods of land configuration.

The periodical plant height and leaf area index recorded at various growth stages were significantly higher except 20 DAS under ridges and furrow (L_2). This might be due to maintenance of proper air moisture regimes under ridges and furrow sowing which might have improved the drainage resulting in good supply of required moisture, available nutrients, soil aeration, soil environment and better growth and development. The results were in conformity with those reported by Ugale *et al.* (1995) for plant height in *kharif* pearlmillet and by Patel *et al.* (2008) in sorghum.

Better plant height and leaf area index under ridges and furrow (L_2) reflected into significant increase in dry matter accumulation except in 20 DAS) and number of effective tillers per plant. Kiran *et al.* (2008) observed similar results in sorghum in terms of dry matter accumulation.

Different land configuration treatments did not produce any significant effect on days to 50 per cent flowering and physiological maturity (Table 2).

Table 1: Plant height (cm) leaf are index, dry matter (g) and number of tillers of summer pearlmillet at 20, 40, 60 DAS and at harvest as influenced by land configurations and dates of sowing.

Treatments	Plant height (cm)				Leaf area Index				Dry matter (g)				No. of effective tillers
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest	
Dates of sowing (D)													
D1 = 25 Jan.	24.11	54.66	167.32	175.09	1.40	3.62	5.52	1.20	6.27	26.67	42.11	47.36	3.09
D2 = 5 Feb.	23.73	53.20	162.65	168.49	1.38	3.57	5.08	1.12	6.20	26.05	41.74	46.99	3.06
D3 = 15 Feb.	23.19	50.66	155.11	164.89	1.33	3.43	4.91	1.08	6.08	25.06	39.96	44.94	2.89

S.Em.+	0.35	0.69	1.96	2.41	0.021	0.05	0.10	0.02	0.09	0.43	0.63	0.66	0.06
C.D. at 5%	NS	1.97	5.63	6.93	NS	0.15	0.28	0.05	NS	1.24	1.79	1.90	0.17
Land configurations (L)													
L1 = Flat bed	23.51	51.83	156.73	162.70	1.37	3.47	4.99	1.11	6.10	25.27	40.18	45.24	2.83
L2 = Ridges and furrow	23.84	53.86	166.66	176.28	1.38	3.61	5.36	1.16	6.27	26.59	42.35	47.62	3.19
S.Em.+	0.30	0.56	1.60	1.97	0.017	0.04	0.08	0.01	0.07	0.35	0.51	0.54	0.05
C.D. at 5%	NS	1.61	4.60	5.66	NS	0.13	0.23	0.04	NS	1.01	1.46	1.55	0.14

3.5 Effect of dates of sowing on yield attributes and yield

Various yield attributes *viz.*, length and girth of earhead and test weight were significantly influenced under varying sowing time (Table 2). Crop sown either on 25 January (D_1) or 5 February (D_2) recorded higher values for almost all the above yield characters than late sown crop i.e. on 15 February (D_3).

Better growth of plant in terms of plant height, leaf area and dry matter accumulation under 25 January (D_1) or 5 February (D_2) sowing reflected into better development of yield attributes under early sown crop. Moreover, congenial climatic conditions during early sowing also play vital role in development of yield attributes. These findings are substantiated with those reported by Patel and Patel (2002) and Patel *et al.* (2004).

Thus, the overall better growth and higher values of most of the yield attributes under 5 February sowing resulted into maximum grain yield of 3.24 t ha^{-1} (Table 2), however, it remained statistically at par with 25 January sowing with grain yield (3.04 t ha^{-1}). Late sowing on 15 February recorded lowest grain yield of 2.46 t ha^{-1}. Crop sown on 5 February increased the grain yield by 6.57 and 31.70 per cent, respectively over 25 January and 15 February sowing.

The reason for higher yield in D_1 or D_2 might also be due to ideal maximum temperatures around 29-32^oC during vegetative and flowering periods resulting in better translocation to reproductive structures, seed set and seed development. When the crop is sown on 15 February, the flowering period coincides with higher mean maximum temperature of around 37-38^oC, which adversely affected the seed set and translocation of nutrients resulting in poor grain yields. The yield attributing characters such as length and girth of earhead and 1000 grain weight were also significantly higher with the crop sown on D_1 or D_2 dates. These result land support to those reported by Shinde *et al.* (2003).

Similarly, better development of various growth parameters *viz.*, plant height, dry matter accumulation and leaf area under early sowing reflected into significant variation in stover yield recorded under different sowing times. Though, 5 February sowing produced highest stover yield (7.95 t ha^{-1}) it remained statistically at par with 25 January (7.78 t ha^{-1}). Whereas lowest stover yield (6.21 t ha^{-1}) was recorded under late sowing on 15 February. The crop sown on 5 February increased the stover yield in pearlmillet by 2.19 and 28.02 per cent, respectively over 25 January and 15 February sowings. Similar findings were also reported by Patel and Patel (2002) at S.K. Nagar (Gujarat), Patel *et al.* (2004) at S.K. Nagar (Gujarat) and Deshmukh *et al.* (2009).

3.6 Effect of land configuration on yield attributes and yield

The yield attributes *viz.*, length and girth of earhead and test weight were significantly influenced by land configuration treatments (Table 2).

Significantly higher length and girth of earhead and test weight was recorded under ridges and furrow (L_2) sowing. This might be due to better growth of plant in terms of dry matter accumulation under ridges and furrow sowing which might have adequately supplied more photosynthates for development of sink. The present findings were in accordance with those of Ugale *et al.* (1995) in pearlmillet and Patel *et al.* (2008) in sorghum for length and girth of earhead and with Kumar (2008) in maize with respect to test weight.

Table 2: Influence of land configurations and dates of sowing on physiology and yield of summer pearlmillet.

Treatments	**50% flowering (days)**	**Physiological maturity (days)**	**Girth of earhead (cm)**	**Length of earhead (cm)**	**Test Weight (g)**	**Grain yield (t ha-1)**	**Stover yield (t ha-1)**
Dates of sowing (D)							
D1 = 25 Jan.	51.17	84.06	9.13	20.06	11.88	3.04	7.78
D2 = 5 Feb.	50.61	82.06	9.98	20.59	11.72	3.24	7.95
D3 = 15 Feb.	48.61	80.50	8.85	18.81	11.01	2.46	6.21
S.Em.+	0.62	0.98	0.18	0.25	0.18	0.10	0.23
C.D. at 5%	1.77	2.83	0.51	0.73	0.52	0.28	0.65
Land configurations (L)							
L1 = Flat bed	49.85	81.89	9.00	19.22	11.27	2.65	6.72
L2 = Ridges and furrow	50.41	82.52	9.64	20.42	11.80	3.18	7.91
S.Em.+	0.50	0.80	0.15	0.21	0.15	0.08	0.18
C.D. at 5%	NS	NS	0.42	0.59	0.42	0.23	0.53

The better performance of pearlmillet crop observed in terms plant height, dry matter accumulation, and length and girth of earhead and test weight obtained under ridges and furrow (L_2) sowing treatment which in turn converted into the maximum grain and stover yields. An increase in grain and stover yield under ridges and furrow was 20.00 and 17.71 per cent over flat bed sowing, respectively. This might be due to the cumulative effect exerted from better improvement in drainage, soil environment, aeration, root development, optimum moisture-air equilibrium throughout the crop growth besides supply of available nutrients to the crop resulting in better growth and development ultimately reflected in better grain and stover yields. These findings were corroborated the results of Patel *et al.* (2008) and Kiran *et al.* (2008) in *rabi* sorghum. Parihar *et al.* (2009) also found resembling results in pearlmillet for grain and stover yield with sowing on ridges and furrow treatment over flat bed.

3.7 Effect of dates of sowing on economics

From the economics (Table 3) point of view, maximum net returns of Rs.15541 ha^{-1} with B:C ratio of 2.03 was obtained with 5 February sowing treatment (D_2), followed by 25 January sowing treatment (D_1) with Rs.13971 ha^{-1} of net returns and 1.93 B:C ratio. Whereas, the net returns and B:C ratio obtained from 15 February (D_3) were Rs. 8341 ha^{-1} and 1.55, respectively. This might be due to higher yields of pearlmillet crop gained from D_2 and D_1 treatments. The results resembled with Sukhadia and Dhoble (1992).

Table 3: Economics of summer pearlmillet as influenced by land configurations and dates of sowing.

Treatments	Net returns (Rs. ha-1)	B:C ratio
Dates of sowing (D)		
D1 = 25 January	13971.00	1.93
D2 = 5 February	15541.00	2.03
D3 = 15 February	8341.00	1.55
Land configurations (L)		
L1 = Flat bed	10181.04	1.67
L2 = Ridges and furrow	14081.00	1.88

3.8 Effect of land configuration on economics

It is obvious from the data (Table 3) reported in that ridges and furrow treatment irrespective of land configuration markedly increased the returns over flat bed treatment giving returns of Rs.14081ha^{-1} and B:C ratio of 1.88. Whereas, the net returns and B:C ratio obtained from flat bed treatment (L_1) were Rs.10181.04 ha^{-1} and 1.67, respectively. This might be due to higher yields of crop gained from ridges and furrow treatment (L_2). It clearly brings out the fact that adoption of ridges and furrow techniques of land configuration was more paying than flat bed techniques. Results of Kiran *et al.* (2008) and Parihar *et al.* (2009) add to the compliance of obtained results.

4. Conclusion

From the results of the experiment, it can be concluded that non-monetary and low cost inputs in agriculture *viz.*, manipulation in dates of sowing and seed bed can determine significant effect for getting higher profitable production of summer pearlmillet. The outcome of this experiment revels to sow summer pearlmillet crop on 5 February on ridges and furrow for better growth of crop and to obtain higher yields and net returns.

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