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Effect of summer ploughing and *in-situ* moisture-conservation practices on growth and yield of rainfed pearlmillet (*Pennisetum glaucum*)

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ABSTRACT

A field experiment was conducted during the rainy season (*kharif*) of 1997 and 1998 with hybrid 'Pusa 322' pearlmillet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz]. The treatments comprised 3 summer ploughing (no summer ploughing, summer ploughing, summer ploughing + FYM + herbicide + insecticide) and 6 *in-situ* moisture-conservation methods (uniform row sowing, paired row sowing, ridge and furrow sowing, organic mulch, kaolin spray and mulch + kaolin). Significant increase in growth and yield of pearlmillet was observed owing to summer ploughing and the maximum grain yield was recorded under summer ploughing + FYM + herbicide + insecticide (22.70 and 25.09 q/ha in 1997 and 1998 respectively). Straw mulch + kaolin spray was found on a par with straw mulch alone and kaolin spray alone for grain yield during both the years. The increase in grain yield of pearlmillet owing to straw mulch + kaolin spray was 9.93 and 10.33 q/ha over uniform row sowing and 7.34 and 5.02 q/ha over ridge and furrow sowing in 1997 and 1998 respectively. Growth and yield-attributing characters showed similar trend. The soil-moisture depletion pattern was influenced by summer ploughing and moisture-conservation treatments only during 1998. Irrespective of the treatment applied, maximum soil moisture was depleted from top 0–30 cm soil layer and the lowest being from 60–90 cm soil layer.

Key words : Summer ploughing, *In situ* moisture-conservation practices, Rainfed pearlmillet, Growth and yield, Soil-moisture depletion

Pearlmillet occupies a pivotal position in drylands, as about 97% of its area is rainfed. Poor fertile soils having low moisture availability and high runoff losses are the main causes of low yields in drylands. Browning *et al.* (1994) and Singh *et al.* (1997) reported favourable effects of summer ploughing and FYM incorporation

Present address: [1]Project Directorate for Cropping Systems Research, Modipuram, Uttar Pradesh 250 110 on growth and yield of rainfed pearlmillet. Mid-season drought during growing season is one of the main causes of low yields of rainfed pearlmillet. Dryland practices have shown tremendous potential to increase and stabilize pearlmillet productivity (Kaushik and Gautam, 1994; Kaushik and Lal, 1997; Bhatnagar *et al.*, 1998). The present investigation was therefore undertaken under rainfed conditions to find out the suitable practice for *in-situ* moisture conservation to increase the productivity of pearlmillet under limited moisture availability.

MATERIALS AND METHODS

A field experiment was conducted at research farm of Indian Agricultural Research Institute, New Delhi (28° 41' N and 77° E) during the rainy (*kharif*) season of 1997 and 1998. New Delhi has a semi-arid and sub-tropical climate with hot dry summers and severe cold winters. The mean annual rainfall is about 650 mm, of which 80% is received during the monsoon season. The mean annual pan evaporation is about 850 mm. The total rainfall received during crop season was 337.00 mm in 1997 and 468.20 mm in 1998. The soil was loamy sand in texture with neutral reaction (pH 7.30). The experiment was laid out in split-plot design with 3 summer ploughing treatments (no summer ploughing, summer ploughing, summer ploughing + FYM @ 10 tonnes/ha + atrazine @ 0.5 kg a.i./ha + HCH (BHC) @ 25 kg/ha) as main-plot treatments and 6 *in-situ* moisture-conservation practices (uniform row sowing (45 cm), 30/60 paired row sowing, ridge and furrow sowing (45 cm), straw mulch @ 5 tonnes/ha, 6% kaolin spray and straw mulch @ 5 tonnes/ha + 6% kaolin) as subplot treatments with 3 replications. Pearlmillet hybrid 'Pusa 322' was sown on 2 July 1997 and 18 June 1998 using 5 kg seed/ha. The crop was fertilized with a uniform dose of 40 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha. Half of N and full dose of P and K were drilled at the time of sowing and the remaining half N was broadcast 25 days after sowing. Deep ploughing (30 cm) during summer months was done as per treatments. FYM @ 10 tonnes/ha along with HCH @ 25 kg/ha was also mixed in the soil at the time of summer ploughing. Atrazine @ 0.5 kg a.i./ha was applied as pre-emergence for controlling germinating weeds. In ridge and furrow treatments, crop was sown in furrows. Straw mulch @ 5 tonnes/ha and kaolin (6% spray) were applied when the drought set in, i.e. third week August and first week of September in 1997 and fourth week of July and second week of August in 1998. Soil samples were collected from 3 soil depths, viz. 0–30, 30–60 and 60–90 cm soil layers, at 25-day interval using tube auger for calculating soil-moisture depletion from each layer.

RESULTS AND DISCUSSION

Growth attributes

Summer ploughing + FYM + herbicide + insecticide recorded significant increase in growth characters (plant height, effective tillers/plant, leaf-area index/plant and dry-matter accumulation) over no summer ploughing, but was found statistically at par with summer ploughing alone (Table 1). Among the various moisture-conservation practices, straw mulch alone or in combination with kaolin spray recorded the maximum increase in plant height, effective tillers/plant, leaf-area index (LAI)/plant and dry-matter accumulation and both these practices were found significantly superior to all other practices, but were at par with each other with respect to all the growth characters. The results confirm the fundings of Pandey *et al.* (1988).

Yield attributes

Summer ploughing recorded significant increase in yield-attributing characters (ears/m^2, length and girth) in both the years. Summer ploughing + FYM + herbicide + insecticide recorded the maximum values of yield-attributing characters but was statistically at par with summer ploughing alone. Straw mulch + kaolin spray proved most effective practice which gave maximum increase in yield-attributing characters (Table 2). However, this treatment was statistically at par with straw mulch alone and kaolin spray alone. Ali and Prasad (1974) and Panday *et al.* (1988) also reported significant increase in yield-attributing characters of pearlmillet owing to favourable effect of mulching and kaolin on soil moisture and crop growth.

Yield

In general, the yield was higher in 1998 than in 1997, owing to receipt of more favourable rainfall during the crop-growth period. However, the impact of summer ploughing and moisture-conservation practices was observed during both the years (Table 2). Summer ploughing

Table 1. Effect of summer ploughing and moisture-conservation practices on growth characters of pearlmillet at harvest

Treatment	Plant height (cm)		Effective tillers/plant		Leaf-area index/ plant		Dry-matter accumulation (g/plant)	
	1997	1998	1997	1998	1997	1998	1997	1998
Summer ploughing								
No summer ploughing	186.38	181.99	1.98	1.91	1.20	1.17	62.08	61.11
Summer ploughing	200.71	197.95	2.12	2.10	1.38	1.34	67.05	64.52
Summer ploughing + FYM + herbicide + insecticide	204.24	204.76	2.24	2.05	1.43	1.35	68.32	66.37
CD (P = 0.05)	13.43	16.09	0.18	0.03	0.09	0.08	4.76	5.56
Moisture-conservation practice								
Uniform row sowing	174.54	175.56	1.95	1.74	1.17	1.10	61.35	57.69
Paired row sowing	193.77	190.67	2.11	1.85	1.29	1.24	64.63	62.30
Ridge and furrow	190.11	193.33	1.96	2.04	1.33	1.34	63.28	64.04
Straw mulch	210.84	205.96	2.26	2.15	1.43	1.38	69.67	67.75
Kaolin spray	200.58	193.49	2.07	2.00	1.35	1.24	65.49	63.07
Straw mulch + kaolin	212.80	210.40	2.32	2.26	1.46	1.43	70.47	68.86
CD (P = 0.05)	18.99	22.75	0.25	0.18	0.13	0.13	6.74	7.87

Table 2. Effect of summer ploughing and moisture-conservation practices on yield attributes and yield of pearlmillet

Treatment	Ears/ m^2		Ear length (cm)		Ear girth (cm)		1,000-grain weight (g)		Grain yield (q/ha)		Stover yield (q/ha)	
	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998
Summer ploughing												
No summer ploughing	26.50	27.67	22.89	23.13	9.00	9.20	5.27	5.13	18.18	18.12	56.52	56.55
Summer ploughing	28.33	29.33	24.17	25.04	9.79	10.46	5.39	5.41	21.73	22.92	61.41	59.76
Summer ploughing + FYM + herbicide + insecticide	29.50	30.33	25.16	25.91	10.94	10.99	5.42	5.65	22.70	25.09	62.72	62.17
CD (P = 0.05)	1.84	1.71	1.87	1.64	0.72	0.62	NS	0.39	1.90	1.55	4.72	4.39
Moisture-conservation practice												
Uniform row sowing	24.33	25.33	21.11	22.11	8.11	8.39	5.01	5.23	15.26	16.24	54.23	52.98
Paired row sowing	27.00	27.67	23.88	23.67	9.78	9.16	5.17	5.25	20.09	20.77	59.73	56.66
Ridge and furrow	26.67	30.00	22.89	24.55	9.00	10.33	5.05	5.28	17.85	21.95	56.93	59.84
Straw mulch	30.00	31.33	25.89	25.94	11.25	10.98	5.64	5.55	24.04	25.54	64.25	64.19
Kaolin spray	29.33	27.67	24.66	24.85	9.78	10.28	5.49	5.43	21.78	22.39	60.55	58.00
Straw mulch + kaolin	31.33	32.67	26.00	27.03	11.55	12.17	5.72	5.64	25.19	26.97	65.61	65.28
CD (P = 0.05)	2.60	2.42	2.65	2.32	1.02	0.88	NS	NS	2.69	2.19	6.67	6.21

practices resulted in significantly higher grain yield over no summer ploughing. Summer ploughing + FYM + herbicide + insecticide though recorded the maximum grain yield, it was on a par with summer ploughing alone. Straw yield showed the trends almost similar to grain yield. These results confirms the findings of Browing *et al.* (1994) and Singh *et al.* (1997).

Of the moisture-conservation practices, straw mulch + kaolin spray proved best treatment, giving significantly higher grain and stover yields, followed by straw mulch alone, kaolin spray alone and paired row planting. Thus moisture conservation during the mid-season moisture-stress conditions increased the productivity of pearlmillet. Straw mulch minimized the evaporation losses and kaolin spray transpiration losses, resulting in extended periods of storage and availability of water in soil profile for crop growth (Kaushik and Gautam, 1994; Bhatnagar *et al.* 1998).

Soil-moisture depletion

In general soil-moisture depletion was higher in top layers of soil (0–30 cm) and it diminished with increasing depth (30–90 cm), irrespective of the treatment applied (Table 3). Summer ploughing influenced soil-moisture depletion during 1998 only, in all the soil layers. In 0–30 cm soil layer, plants grown in plots receiving summer ploughing + FYM + herbicide + insecticide depleted remarkably less moisture as compared to no summer ploughing. Similar trend was observed in 60–90 cm soil layer, whereas maximum moisture depleted in 30–60 cm soil layer under the summer ploughing alone treatment, followed by summer ploughing + FYM + herbicide + insecticide. The higher depletion of moisture in 0–30 layer under no summer ploughing treatment might have attributed

Table 3. Effect of summer ploughing and moisture-conservation practices on soil-moisture depletion (mm) in different soil layers

Treatment	Soil depth (cm)					
	1997			1998		
	0–30	30–60	60–90	0–30	30–60	60–90
Summer ploughing						
No summer ploughing	107.42	78.84	61.63	113.57	91.20	72.51
Summer ploughing	109.75	81.88	66.67	114.16	96.62	77.29
Summer ploughing + FYM + herbicide + insecticide	109.50	82.10	68.47	115.84	98.86	80.36
Moisture-conservation practice						
Uniform row sowing	105.50	77.75	61.42	108.57	89.91	68.69
Paired row sowing	106.47	78.78	62.81	112.05	92.87	73.96
Ridge and furrow	107.57	79.96	95.10	116.66	97.09	75.30
Straw mulch	111.33	83.07	68.66	115.74	99.86	80.55
Kaolin spray	109.01	80.61	64.91	116.49	95.67	78.62
Straw mulch + kaolin	112.18	84.29	69.86	116.11	99.98	82.63

due to slow infiltration and surface feeding of roots (Singh *et al.*, 1997). Moisture-conservation practices brought about marked influence on soil-moisture depletion in different soil layers. In 0–30 cm soil layer, maximum moisture was depleted under uniform row sowing and the minimum under straw mulch + kaolin and straw mulch alone. However, reverse was true in case of 30–90 cm soil layer where the maximum moisture was depleted under straw mulch + kaolin spray, followed by straw mulch alone. This was mainly because of more moisture availability and also by increased rooting depth or more uniformly distributed root system under these treatments (McIntyre *et al.*, 1995). None of the interaction effect was found to be significant.

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