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Effect of moisture conservation and weed control on pearlmillet (*Pennisetum glaucum*) under rainfed conditions

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ABSTRACT

A field experiment conducted during the rainy season of 1988 and 1989 showed that moisture conservation practice suppressed the weed growth and improved the productivity and water-use efficiency of pearlmillet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz.] only in scanty rainfall year of 1989. The maximum reduction in weed density and dry weight was attained with flat bed + straw mulch, but crop productivity and water-use efficiency were the highest with ridge and furrow + straw mulch. In 1988, net return/ha and net return/rupee were highest with flat bed. In 1989, although highest net return/ha was recorded with ridge and furrow, none of the moisture-conservation treatments proved economical in respect of net return/rupee invested. Weeding caused remarkable reduction in weeds in both years, especially with hand-weeding. However, crop productivity and water-use efficiency were influenced favourably by weed-control measures only in 1988. The highest values of yield and water-use efficiency were associated with atrazine @ 0.50 kg/ha followed by hand-weeding. The highest net return/ha and net return/rupee were recorded with atrazine @ 0.50 kg/ha in both years except that none of the weed-control treatments proved economical in respect of net return/rupee invested in 1989.

Pearlmillet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz] is an important crop of rainfed areas of India. Generally, it faces moisture stress during its growing period either due to low and ill-distributed rainfall or run-off, resulting in poor yield. Many workers reported beneficial effects of rainwater harvesting in simple land layouts (Kaushik and Gautam, 1991) and various mulches (Pandey *et al.*, 1988) on the productivity and water-use efficiency of pearlmillet. Control of weeds is yet another important practice to increase the productivity of this crop under rainfed conditions (Vijay Kumar and Mohammad, 1993). Since information on the control of weeds in relation to moisture conservation is meagre, the present investigation was carried out on these aspects.

MATERIALS AND METHODS

A field trial was conducted during the rainy season of 1988 and 1989 at the Indian Agricultural Research Institute, New Delhi, in split-plot design with 3 replications. Four moisture-conservation practices (flat bed, ridge and furrow, flat bed + straw mulch and ridge and furrow + straw mulch) were assigned to main plots and 5 weed-control measures (unweeded control, hand weeding, atrazine @ 0.25 and 0.50 kg/ha and 2, 4-D @ 0.75 kg/ha) to subplots. Pearlmillet hybrid 'BK 560-230' was sown on 7 July in 1988 and 24 July in 1989 and fertilized with a uniform dose of 60 kg N/ha and 12 kg P/ha. The rainfall received during rainy

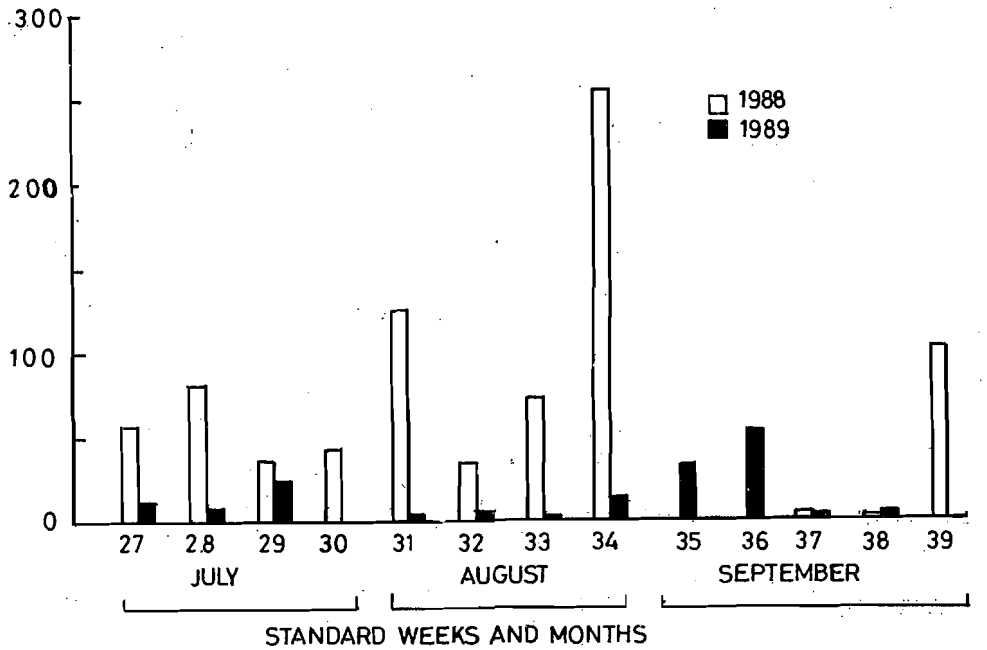

Fig. 1. Weekly rainfall during cropping seasons of 1988 and 1989

season of 1988 and 1989 is depicted in Fig. 1.

In ridge and furrow treatment the crop was sown in furrows. Straw mulch of rice @ 5 tonnes/ha was applied at the onset of drought in the second week of September in 1988 and second week of August in 1989. Hand-weeding treatment was given twice at 3 and 6 weeks after sowing. Atrazine @ 0.25 and 0.50 kg/ha was sprayed the next day of sowing as pre-emergence application. Water-use efficiency was computed by dividing grain yield with seasonal consumptive use of water. The net return per hectare and per rupee were estimated on the basis of prevailing market rates during the respective years.

RESULTS AND DUSCUSSION

Weed

The major weed flora observed in experimental plots consisted of *Echinochloa colonum* (L.) Link, *Cyperus rotundus* (L.) Pers., *Cynodon dactylon* (L.) Pers., *Eleusine indica* (L.) Gaertn., *Trianthema portulacastrum* L., *Digeria arvensis* (L.) Forsskal and *Corchorus fascicularis* (Lam.). In general, weed infestation was more in 1988 mainly because of higher rainfall.

Straw mulch either applied in flat beds or ridge and furrow reduced the weed density and dry weight/m^2 significantly compared with flat bed and ridge and furrow without mulch only in 1989 (Table 1). Reduction in

Table 1. Effects of moisture conservation and weed control on weed intensity and growth and yield-contributing characters of pearlmillet

Treatment	Weed population at harvest (per m^2)		Dry weight of weeds (g/m^2)		Plant height (cm)		Tillers/ plant		Dry weight/ plant (g)		1,000-grain weight (g)	
	1988	1989	1988	1989	1988	1989	1988	1989	1988	1989	1988	1989
Moisture conservation												
Flat bed	60.4	7.6	64.6	8.5	182	117	3.08	2.10	53.9	46.2	6.27	6.47
Ridge and furrow	60.2	7.2	65.1	8.4	188	130	3.20	2.34	57.2	53.1	6.39	6.74
Flat bed + straw mulch	58.3	6.2	61.4	7.2	183	131	3.15	2.32	55.1	46.9	6.28	6.56
Ridge and furrow + straw mulch	61.0	6.3	59.4	7.5	187	131	3.20	2.42	58.3	56.6	6.39	6.75
CD (P = 0.05)	NS	0.8	NS	0.9	NS	NS	NS	0.17	NS	4.0	NS	0.10
Weed control												
Unweeded control	78.2	9.9	86.4	10.9	172	120	2.81	2.17	51.7	47.0	6.00	6.44
Hand-weeding	50.4	5.0	48.2	6.4	191	133	3.25	2.49	59.0	52.8	6.57	6.73
Atrazine @ 0.25 kg/ha	58.5	6.6	62.4	6.8	186	130	3.10	2.21	56.0	50.2	6.38	6.64
Atrazine @ 0.50 kg/ha	53.6	5.4	54.8	6.8	192	137	3.39	2.47	61.0	54.6	6.48	6.88
2, 4-D @ 0.75 kg/ha	56.3	7.1	60.2	7.4	183	125	3.17	2.24	56.0	50.1	6.27	6.60
CD (P = 0.05)	3.5	0.9	6.3	1.1	5	NS	0.29	NS	4.2	NS	0.26	NS

weed density and dry-matter accumulation due to mulching could be attributed to its smothering effect on weeds.

Weeding remarkably reduced weed density and dry weight/m^2 in both years (Table 1). Hand-weeding proved best of all, as it controlled the early as well as late-emerging weeds more effectively than other treatments. Pre-emergence application of atrazine at higher dose (0.50 kg/ha) was also equally effective because of its prolonged broad-spectrum activity (Verma *et al.*, 1989). However, weed-killing efficiency of this herbicide reduced notably when applied at lower dose (0.25 kg/ha). Similarly, 2, 4-D also did not prove as effective probably because of its weed-killing action confined only to dicot weeds, consequently resulting in partial weed control. Kaushik and Gautam (1984) also reported similar results.

Crop

Growth and yield attributes: The soil-moisture conservation improved the plant growth (number of tillers and dry matter/plant) and yield attributes (1,000-grain weight) compared with flat-bed planting only in drought year of 1989 (Table 1). Ridge and furrow + straw mulch; however, recorded highest values of growth and yield attributes followed by ridge and furrow alone.

Weeding caused remarkable improvement in plant height, number of tillers and dry matter/plant, and 1,000-grain weight as compared with unweeded control only in 1988 (Table 1). Atrazine @ 0.50 kg/ha and hand-weeding showed maximum improvement in these growth and yield attributes. Next best treatment was atrizine @ 0.25 kg/ha, followed by 2, 4-D @ 0.75 kg/ha. Contribution of the weed-control measures towards the enhancement of growth and yield attributes could be ascribed to their effect in reducing the crop—weed competition and hence better utilization of natural and applied inputs by crop plants. Improvement of growth and yield components due to elimination of severe crop—weed competition in pearlmillet was also reported by Kaushik and Gautam (1984).

Yield: The grain and stover yields of pearlmillet increased significantly due to treatments of soil-moisture conservation except flat bed + straw mulch only in the drought year of 1989 (Table 2). The highest grain and stover yields were noted with ridge and furrow + straw mulch being on a par with ridge and furrow alone. The increased productivity of grain and stover in ridge and furrow with or without mulch resulted from the favourable effects of moisture conservation on growth and yield attributes. Thus ridge and furrow system of planting showed superiority to conventional method of flat bed planting of pearlmillet, particularly during low-rainfall season. Ridges and furrows retained comparatively more rain water which facilitated rapid germination and vigrous growth of seedlings in early stages. Performance of this system further enhanced when furrows were covered with straw mulch as evident from increased yields. Mulching of furrows prolonged the period of water availability which consequently favoured better development of crop at later stages resulting in higher yields. The results confirm the findings of Kaushik and Gautam (1991).

Grain and stover yields remained unaffected by moisture conservation in 1988 as well on pooled data basis. There was enough rainfall in 1988 season (Fig. 1) to meet the evapo-transpiration demand of the crop and hence minimizing the effect of moisture-conservation practices on crop growth. Though these practices significantly im-

Table 2. Effect of moisture conservation and weed control on yield, water-use efficiency and economics of pearlmillet

Treatment	Grain yield (q/ha)			Straw yield (q/ha)			Water-use efficiency (grain kg/ha-mm)		Net return (Rs/ha)		Net return/ rupee invested	
	1988	1989	Pooled	1988	1989	Pooled	1988	1989	1988	1989	1988	1989
Moisture conservation												
Flat bed	21.2	12.0	16.6	52.8	32.5	42.6	7.37	5.75	2,522	1,024	1.57	0.63
Ridge and furrow	21.5	13.0	17.3	53.9	34.0	43.9	7.64	7.35	2,513	1,152	1.54	0.68
Flat bed + straw mulch	22.8	12.1	17.4	53.0	32.6	42.8	8.38	6.26	2,478	757	1.31	0.40
Ridge and furrow + straw mulch	22.2	13.3	17.8	53.7	35.5	44.6	8.17	8.04	2,337	949	1.24	0.59
CD (P = 0.05)	NS	0.8	NS	NS	1.6	NS						
Weed control												
Unweeded control	19.2	12.2	15.7	48.6	33.2	40.9	6.85	6.36	2,154	1,065	1.34	0.66
Hand-weeding	23.6	13.0	18.3	56.6	34.1	45.3	8.55	7.15	2,520	805	1.24	0.39
Atrazine @ 0.25 kg/ha	21.7	12.6	17.2	52.8	33.3	43.1	7.82	6.80	2,343	1,089	1.52	0.65
Atrazine @ 0.50 kg/ha	23.7	13.0	19.4	56.1	34.0	45.0	8.53	7.07	2,843	1,102	1.65	0.63
2, 4-D @ 0.75 kg/ha	21.5	12.2	16.8	52.6	33.7	43.1	7.68	6.46	2,490	1,014	1.49	0.60
CD (P = 0.05)	1.9	NS	1.5	2.5	NS	2.4						

proved grain and stover yields in 1989, but not so markedly as to influence the pooled effect.

Controlling weeds either manually or chemically increased the grain and stover yields only in 1988 (Table 2) by their marked effects in boosting various growth and yield parameters. Increase in grain and stover yields by suppression of weeds under dryland condition was also reported by Pal and Kaushik (1975). Atrazine at higher dose (0.50 kg/ha) and hand-weeding resulted in highest grain and stover yields. However, atrazine at lower dose (0.25 kg/ha) and 2, 4-D @ 0.75 kg/ha failed to maintain their superiority over unweeded check when the pooled analysis of the data was carried out. All the weed-control treatments although caused significant reduction in the weed density and dry-matter accumulation in 1989 also, there was no effect of weed control on yield because of negligeable crop–weed competition this year.

Water-use: The moisture-conservation treatments showed considerable increase in water-use efficiency, the maximum values being with flat bed + straw mulch in 1988 and ridge and furrow + straw mulch in 1989. However, the magnitude of increase in water-use efficiency was more conspicuous in 1989 as compared to 1988. The increase in water-use efficiency due to moisture conservation was attributed to increased crop productivity. The results confirm the findings of Pandey *et al.* (1988) and Kaushik and Gautam (1991).

Water-use efficiency in terms of grain yield increased appreciably due to weed-control measures. However, the highest values of water-use efficiency were recorded with hand-weeding, followed by atrazine @ 0.50 kg/ha in both the years. The increase in water-use efficiency due to weed-control measures was mainly because of their higher grain yield as a result of higher consumptive-use of water as compared with the unweeded control.

Economics: In 1988, flat-bed treatment fetched highest net return/ha and net return/rupee invested. However, in 1989 although net return/ha was highest with ridge and furrow without mulch, none of the moisture-conservation treatments proved economical in respect of net return/rupee invested.

In 1988, highest net return/ha and net return/rupee were recorded with atrazine @ 0.50 kg/ha. In 1989 also highest net return/ha was obtained with atrazine @ 0.50 kg/ha, none of the weed-control treatments proved economical in respect of net return/rupee invested.

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