

Effect of intercropping and weed control on nutrient uptake and water-use efficiency of pearl millet (*Pennisetum glaucum*) under rainfed conditions

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ABSTRACT

A field experiment was conducted during the rainy seasons of 1993 and 1994 to study the effect of intercropping and weed-control measures on nutrient uptake and water-use efficiency of pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz]. Dry-matter accumulation and N, P and K depletion by weeds and yield of pearl millet did not differ due to intercropping. But greengram (*Phaseolus radiatus* L.) as an intercrop gave higher yield than cowpea [*Vigna unguiculata* (L.) Walp.]. However, total uptake of N, P and K was influenced significantly by intercropping system, being maximum with pearl millet + greengram intercropping. This treatment also registered the highest water-use efficiency. Dry-matter accumulation and nutrients depletion by weeds were minimum under hand-weeding twice closely, followed by pendimethalin at 0.75 kg/ha + hand-weeding 6 weeks after sowing. Consequently, these treatments were equally effective in improving grain yield and nutrients uptake and water-use efficiency of crops. Pendimethalin at 0.75 kg/ha alone proved to be the least effective in these regards.

Key words : Intercropping, Pearl millet, Weed control, Nutrient uptake, Water-use efficiency

Significant progress has been made in crop production through Green Revolution during the last 3 decades. However, beneficial effects of Green Revolution have been confined only to irrigated areas. The productivity of rainfed areas is still very low. Recent research work has shown that intercropping with specific planting geometry and selection of compatible crops is a profitable practice to make use of

available soil moisture and nutrients more efficiently and thus, improving productivity of dryland crops (De *et al.*, 1978; Kaushik and Gautam, 1987). Control of weeds is another important practice to increase the yield of crops by improving nutrient uptake and water-use efficiency (Kaushik and Gautam, 1984; Sandhu *et al.*, 1988; Kumar *et al.*, 1995; Gopinath, 1999). Therefore, present study was undertaken to determine

the most compatible grain legume for intercropping in pearl millet and also to identify a suitable method of weed control for various intercropping systems.

MATERIALS AND METHODS

A field experiment was conducted during the rainy seasons (*kharif*) of 1993 and 1994 at New Delhi, on sandy loam (pH 7.2) soil, low in N (organic carbon 0.48%) and available P (4.4 kg/ha). The treatments consisted of 3 intercropping systems (uniform row planting of sole pearl millet at 50 cm, paired row planting of pearl millet at 30 and 70 cm + cowpea and greengram) as main plot and 4 weed-control measures (unweeded control, hand-weeding twice, i.e. 3 and 6 weeks after sowing, pre-emergence application of pendimethalin at 0.75 kg a.i./ha and pre-emergence application of pendimethalin at 0.75 a.i./ha + 1 hand-weeding 6 weeks after sowing) as subplot treatments in split-plot design with 4 replications. Seeds of 'Pusa 23' pearl millet, 'Pusa 779' cowpea and 'PS 16' greengram were sown on 18 July, 1993 and 20 July 1994. Nitrogen @ 40 kg/ha through urea was applied to pearl millet in 2 equal splits—half at sowing and remaining half at 4 weeks after sowing. Phosphorus was applied @ 40 kg P₂O₅/ha as single superphosphate, at planting. Intercrops were not fertilized separately. Adequate plant-protection measures were adopted. Thinning and gap-filling of pearl millet and both intercrops were carried out to maintain their optimum plant population. Total rainfall during cropping seasons of 1993 and 1994 was 702.80 and 655.20 mm respectively. Water-use efficiency (WUE)

was worked out on the basis of moisture depleted up to 90 cm by the following formula :

$$WUE = \frac{\text{Yield of economic produce (kg)}}{\text{Consumptive use of water (mm)}}$$

RESULTS AND DISCUSSION

Weed flora

The major weed flora infesting the experimental field comprised *Echinochloa colonum* (L.) Link, *Cyperus rotundus* (L.) Pers., *Cynodon dactylon* (L.) Pers., *Eleusine indica* (L.) Gaertn., *Trianthema portulacastrum* L., *Digera arvensis* (L.) Forsskal and *Corchorus fascicularis* (Lam.)

Dry-matter accumulation

Dry-matter accumulation by weeds did not vary significantly due to intercropping treatments in the both years (Table 1). But different weed-control measures significantly reduced the dry-matter accumulation by weeds. Hand-weeding twice at 3 and 6 weeks after sowing was best in this regard, followed by pendimethalin + 1 hand-weeding in both the years. Weed-killing efficiency was reduced when pendimethalin was applied alone.

Nutrient depletion

Total amount of N, P and K depleted by weeds did not differ significantly due to intercropping treatments, because there was no difference in the dry-matter accumulation and N, P and K contents in weeds under different treatments (Goswami, 1997). Total nitrogen, phosphorus and potassium depletion by weeds significantly varied due to weed-control treatments in both the years. Hand-weeding twice resulted

in significantly minimum depletion of these nutrients, because it effectively controlled both early as well as late-emerging weeds. Pre-emergence application of pendimethalin 0.75 kg/ha coupled with 1 hand-weeding proved next to it. However, pendimethalin alone did not prove so efficient, as it failed to suppress the late-emerging weeds.

Pearlmillet yield

Intercropping systems did not influence the grain and stover yields of pearl millet in both years because change in planting system did not vary grain yield of pearl millet at a constant level of plant population (De *et al.*, 1978). Among the 2 intercrops, greengram gave higher grain and stalk yields than cowpea.

Control of weeds either manually or chemically alone as well as in combination of both resulted in significant increase in grain and stover yields of pearl millet

compared with unweeded control in both the years. Sandhu *et al.* (1988) also reported increased grain and stover yields of pearl millet by curtailing weed growth. Hand-weeding twice resulted in the highest grain and stover yields, followed by pendimethalin at 0.75 kg/ha superimposed with 1 hand-weeding 6 weeks after sowing. Pendimethalin at 0.75 kg/ha alone was least effective among the weed-control treatments. These results are in close conformity with the findings of Sandhu *et al.* (1988). Grain and stalk yields of both intercrops were also favourably influenced by weed control and the values were maximum with hand-weeding twice, closely followed by pendimethalin + 1 hand-weeding. Lagoke *et al.* (1982) also reported similar results.

Nutrient uptake

Maximum amount of N, P and K was removed by pearl millet + greengram

Table 1. Effect of intercropping and weed-control measures on dry-matter accumulation and nutrients depletion by weeds

Treatment	Dry weight of weeds (q/ha)		Total depletion of nutrients (kg/ha)					
			N		P		K	
	1993	1994	1993	1994	1993	1994	1993	1994
<i>Intercropping</i>								
Pearlmillet sole	8.12	8.24	9.90	10.20	1.69	2.37	9.18	9.72
Pearlmillet + cowpea	8.49	8.40	9.43	10.07	1.75	2.22	9.14	9.83
Pearlmillet+greengram	9.53	8.35	9.30	9.85	1.63	2.25	8.86	9.49
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS
<i>Weed control</i>								
Unweeded control	11.37	11.06	13.75	12.82	2.62	2.98	13.18	13.00
Hand-weeding twice	5.65	6.03	6.75	7.34	1.06	1.32	6.37	6.95
Pendimethalin at 0.75 kg/ha	8.80	9.41	10.64	11.00	1.76	1.78	9.85	11.00
Pendimethalin at 0.75 kg/ha + 1 hand-weeding	5.97	6.83	8.03	8.13	1.41	1.71	6.85	7.77
CD (P = 0.05)	0.40	0.32	0.46	0.38	0.17	0.15	0.46	0.47

Table 2. Effect of intercropping and weed-control measures on yield, nutrients uptake and water-use efficiency of pearl millet

Treatment	Grain yield (q/ha)		Stover yield (q/ha)		Total uptake of nutrients (kg/ha)						Water-use efficiency (grain kg/ha-mm)	
	1993	1994	1993	1994	N		P		K		1993	1994
					1993	1994	1993	1994	1993	1994		
<i>Intercropping</i>												
Pearlmillet alone	18.61	20.85	53.54	62.73	63.49	73.22	24.31	28.46	85.58	99.86	7.36	7.95
Pearlmillet + cowpea	17.67 (2.32)	21.36 (1.65)	51.09 (10.75)	64.91 (8.98)	81.14	92.33	25.64	31.44	97.43	108.92	9.43	9.56
Pearlmillet + greengram	17.90 (2.89)	20.46 (2.73)	52.56 (12.56)	72.32 (12.65)	84.13	95.05	27.94	30.52	99.81	110.63	9.91	90.45
CD (P = 0.05)	NS	NS	NS	NS	8.62	7.56	2.12	2.35	11.40	10.13		
<i>Weed control</i>												
Unweeded control	14.34 (1.68)	14.79 (1.45)	42.82 (8.32)	46.25 (7.60)	61.15	66.20	20.83	21.50	73.34	77.00	6.57	6.28
Hand-weeding twice	21.19 (1.68)	24.58 (2.85)	61.20 (14.08)	73.73 (13.38)	98.07	110.60	32.35	36.99	112.95	131.02	10.89	11.27
Pendimethalin at 0.75 kg/ha	17.23 (2.70)	21.14 (1.72)	48.76 (12.03)	63.39 (14.71)	81.25	90.90	25.24	20.26	87.38	108.77	8.67	9.05
Pendimethalin at 0.75 kg/ha + 1 hand-weeding	19.46 (2.85)	23.06 (2.75)	56.56 (12.75)	69.91 (12.72)	92.61	104.69	29.62	24.97	110.53	123.59	9.74	11.02
CD (P = 0.05)	2.24	2.96	6.72	8.13	10.42	9.83	3.53	3.41	15.60	13.40		

Figures in parentheses are yields of intercrops

*Computed on the basis of total productivity

intercropping system which was at par with pearl millet + cowpea intercropping, but both of them removed significantly higher amount of N, P and K as compared to pearl millet sole (Table 2).

All weed-control treatments resulted significantly higher uptake of nutrients than unweeded control in both the years. Hand-weeding twice resulted in maximum uptake of nutrients, followed by pendimethalin spray coupled with 1 hand-weeding and both of them proved significantly superior to pendimethalin alone.

Water-use efficiency

Maximum water-use efficiency was recorded with pearl millet + greengram intercropping which was at par with pearl millet + cowpea. Pearl millet alone had the lowest value of water-use efficiency in both the years (Table 2).

Weed-control treatments brought about appreciable improvement in water-use efficiency and the value was maximum with hand-weeding twice in both the years. Pre-emergence application of pendimethalin + 1 hand-weeding was next best treatment in this regard.

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