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Effect of integrated weed management and intercropping systems on growth and yield of pearlmillet (*Pennisetum glaucum*)

BALDEV RAM[1], G.R. CHAUDHARY[2], A.S. JAT[3] AND M.L. JAT[4]

Department of Agronomy, Rajasthan Agricultural University, Jobner 303 329

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ABSTRACT

An experiment was conducted during the rainy season (*kharif*) of 1999 and 2000 at College of Agriculture, Jobner (Jaipur), on a loamy sand soil, to evaluate the effect of integrated weed management and intercropping systems on growth and yield of pearlmillet [*Pennisetum glaucum* (L.) R.Br. emend. Stuntz]. Lowest weed population (117/m^2) and dry weight (975 kg/ha) were recorded under pearlmillet + cowpea [*Vigna unguiculata* (L.) Walp.] followed by pearlmillet + greengram (*Phaseolus radiatus* L.) while maximum under sole pearlmillet at harvest. The sole pearlmillet recorded significantly higher tillers/plant than all the 3 intercropping systems. Maximum plant height was recorded under sole pearlmillet, being at par with pearlmillet + clusterbean [*Cyamopsis tetragonoloba* (L.) Taubert]. Sole pearlmillet gave significantly more ear length, grain (20.8 q/ha) and stover (54.9 q/ha) than rest of the intercropping systems whereas highest pearlmillet-grain-equivalent yield was recorded under pearlmillet + clusterbean (39.2 q/ha) closely followed by pearlmillet + greengram. Hand-weeding twice at 30 and 45 DAS remained at par with pendimethalin and oxadiazon each at 1.0 kg/ha supplemented with hand-weeding once at 45 DAS significantly reduced the weed population (77/m^2) and dry-matter production (625 kg/ha) compared to rest of the weed-management practices. The plant height, tillers/plant, ears/plant and ear length increased significantly under all the weed-control measures compared to unweeded control with maximum values under hand-weeding twice. Similarly, maximum values were obtained under hand-weeding twice (22.9 q/ha grain, 61.5 q/ha stover and 41.4 q/ha pearlmillet grain-equivalent yields) followed by pendimethalin and oxadiazon each at 1.0 kg/ha + hand-weeding once at 45 days after sowing over weedy check.

Key words : Integrated weed management, Intercropping, Pearlmillet, Clusterbean, Cowpea, Greengram, Pendimethalin, Oxadiazon, Growth, Yield

Weeds compete with the crop plants for the essentials of growth, interfere with the utilization of land and water resources, and thus, adversely affect crop production. Weeds deplete 30–40% of applied nutrients from soil and compete with the crop plants for soil moisture and sunlight too (Mani, 1977). Keeping a crop weed-free throughout the crop season is a labour and cost-intensive affair. In order to get desired degree of weed control, the operation has to be repeated but manual operation at several times become difficult due to frequent intermittent rains. Moreover, hand-weeding is laborious, cumbersome and time-consuming besides being costly and economically not feasible in today's intensive agriculture. Chemical weed control is reported to be more effective and economical than mechanical weed control.

The arable land is a precious and scarce resource so, among the options to increase production, the cropping intensity and efficient utilization of available resources seems more feasible over increasing area under cultivation. But, under rainfed conditions only 1 growing season is available for cropping, so the farmers simultaneously have to raise two or more crops on the same piece of land to derive maximum out put per unit of land through intercropping system. Sowing of pearlmillet in paired row (30/60 cm) system has been proved advantageous over uniform row system, as it widens the scope of introducing a legume as an intercrop without having any adverse effect on the productivity of the base crop (Gautam, 1989). The present investigation was therefore carried out to increase the production of pearlmillet through integrated weed management and intercropping systems.

MATERIALS AND METHODS

The field experiment was conducted during the rainy season (*kharif*) 1999 and 2000 at Agronomy Farm S.K.N. College of Agriculture, Jobner (Rajasthan). The soil was loamy sand in texture having bulk density 1.50 mg/m^3, with pH 8.2. The soil was poor in organic carbon (0.20%),

[1,2,3]**Present address :** [1]Assistant Professor, ARS, Kota, Rajasthan, [2]Professor, ARS, Durgapura, Rajasthan, [3]Research Associate, [4]Scientist PDCSR, Modipuram, Uttar Pradesh 250 110

low in available nitrogen (128.00 kg/ha), phosphorus (16.80 kg/ha) and medium in potash (157.50 kg/ha). The experiment consisted of 28 treatment combinations of 4 intercropping systems (sole pearlmillet, pearlmillet + cowpea, pearlmillet + clusterbean and pearlmillet + greengram) in main plot and 7 weed-control measures [unweeded control, pendimethalin at 1.0 kg/ha, pendimethalin at 1.0 kg/ha + hand-weeding once at 45 days after sowing (DAS), oxadiazon at 1.0 kg/ha, oxadiazon at 1.0 kg/ha + hand-weeding once at 45 DAS, hand weeding once at 30 DAS and hand-weeding twice at 30 and 45 DAS] in sub-plot was laid out in split-plot design and replicated 4 times. Pearlmillet variety 'MH 179' cowpea 'RC 19, clusterbean 'RGC 197' and greengram 'RMG 62' were sown on 12 July 1999 and 17 July 2000, respectively. The seeds were sown in rows 45 cm apart for sole pearlmillet. In intercrop situation, pearlmillet was sown in paired rows at 30 cm keeping 60 cm distance between 2 pair to adjust 1 row of intercrop (30/60 cm). The plant-to-plant distance of 15 cm in pearlmillet and 10 cm in intercrops was maintained. The recommended seed rates of 4 and 16 kg/ha of pearlmillet and intercrops, respectively, were used in the experiment. Herbicides were applied as pre-emergence and hand-weeding was done as per treatments. The recommended dose of 60 kg N/ha through urea and 30 kg P_2O_5/ha through single superphosphate was applied to sole as well as intercrops. Half dose of nitrogen and full dose of phosphorus were drilled before sowing and remaining half dose of nitrogen was top-dressed at 30 days after sowing.

RESULTS AND DISCUSSION

Intercropping systems

Population and dry matter of weeds : Intercropping systems significantly reduced the population and dry matter of weeds at harvest the compared to sole pearlmillet, but statistically remained at par with pearlmillet + cowpea and pearlmillet + greengram (Table 1). The lowest weed population (117/m^2) and dry weight (975 kg/ha) was observed under pearlmillet + cowpea followed by pearlmillet + greengram, while maximum population (162/m^2) and dry matter (1,333 kg/ha) were recorded in sole pearlmillet. The lowest population and dry matter of weeds under intercropping systems may be ascribed probably due to higher crop canopy than sole pearlmillet. Extensive canopy of intercrops precluded penetration of solar radiation up to the weeds and smothered them leading to lower weed dry weight. Our results corroborate with the findings of Tewari *et al.* (1989).

Growth parameters : Intercropping systems significantly influenced the plant height and tillers/plant of pearlmillet at 60 days and harvest (Table 1). The maximum plant height of pearlmillet was recorded under sole pearlmillet being at par with pearlmillet + clusterbean, significantly higher compared to pearlmillet intercropped with cowpea and greengram. Further, pearlmillet intercropped with clusterbean being at par with pearlmillet + greengram, attained significantly higher plant height over its association with cowpea. The respective increase in plant height at 60 days harvest under sole pearlmillet was 9.89 and 6.18 and 10.07 and 6.98% over pearlmillet + cowpea and pearlmillet + greengram. Similarly, sole pearlmillet gave significantly higher tillers/plant over pearlmillet intercropped with cowpea, clusterbean and greengram. However, pearlmillet intercropped with legumes did not differ significantly with each other in respect to tillers/plant at 60 days and at harvest. Among different intercropping systems, pearlmillet + clusterbean recorded the maximum plant height and tillers/plant. Better growth in sole pearlmillet might be the result of maximum utilization of nutrients and resources on account of competition-free atmosphere available under sole cropping with added advantage of optimum spacing. Singh and Joshi (1980) also reported similar results.

Yield attributes and yield : Sole pearlmillet significantly increased the ear length, grain and stover yields of pearlmillet by 8.1, 13.9 and 8.5, 5.4; 10.8 and 5.7; and 5.8, 12.1 and 6.2% over pearlmillet + cowpea, pearlmillet + clusterbean and pearlmillet + greengram intercropping systems, respectively. However, intercropping systems significantly influenced the pearlmillet-grain equivalent yield compared to sole pearlmillet. Maximum equivalent yield of 39.15 q/ha obtained under pearlmillet + clusterbean being at par with pearlmillet + greengram (38.89 q/ha) significantly higher over sole pearlmillet and pearlmillet + cowpea by 46.9 and 0.4%, respectively. Pearlmillet intercropped with cowpea, greengram and clusterbean being at par caused significant reduction in weed-competition index by 27.2, 25.9 and 24.3% compared to sole pearlmillet. Higher pearlmillet grain in sole pearlmillet than intercropping system is attributed to more ears/plant and ear length (Table 1). The reduction in grain yield of pearlmillet under intercropping seems to be associated with competitive effects due to vigorous and luxuriant vegetative growth of intercrops, whereas higher stover yield of pearlmillet was obtained in pure stand evidently owing to increase in growth parameters, viz. plant height and tillers/plant. Least weed competition was recorded under pearlmillet + cowpea (15.8%) closely followed by pearlmillet + greengram as compared to sole pearlmillet (21.7%). Extensive canopy of intercrops precluded penetration of solar radiation upto the weeds and thus smothered them.

Weed-control measures

Population and dry matter of weeds : All the weed-management practices significantly reduced the weed population and dry matter compared to unweeded control. Hand-weeding twice at 30 and 45 days being at par with pendimethalin and oxadiazon each at 1.0 kg/ha + hand-weeding once at 45 days recorded significantly lower weed population (77/m^2) and dry matter (625 kg/ha) at harvest than rest of the weed-management practices. Highest weed dry-matter production (2982 kg/ha) was recorded at harvest under unweeded control, while hand-weeding twice at 30 and 45 DAS reduced the weed dry matter production by 2,357 kg/ha compared to unweeded control. The increase in population and dry-matter production of weeds to such a high level under unweeded control may be attributed to uninterrupted weed growth throughout the crop season. Pendimethalin absorbed by germinating weeds inhibits cell-division in the meristematic tissues resulting in death of most of the weeds within a few days of their emergence, disruption of microtubule and inhibits synthesis of seedlings followed by chlorosis and inhibition of elongation of leaves therefore, most of the weeds died within a few days of their emergence. These herbicides gave almost season-long control of weeds obviously due to their persistence in soil for a sufficiently long time. The results are in conformity with those reported by Verma and Katyal (1989) in pearlmillet.

Growth parameters : Weed-control measures significantly increased the plant height and tillers/plant of the crop over unweeded control at 60 days and harvest (Table 1). Hand-weeding twice, pendimethalin and oxadiazon each at 1.0 kg/ha + hand-weeding once being at par with each other, significantly increased the plant height (174.0 cm) and tillers/plant (3.08) over rest of the weed-control treatments at 60 days and harvest. Hand-weeding once, pendimethalin and oxadiazon each at 1.0 kg/ha were at par with respect to growth parameters at 60 days and harvest. A linear relationship in weed-control efficiency and crop growth was noticed under all the weed-management practices. The better growth and development of the plants under different weed-control treatments was the resultant of weed-free environment with lesser competition for the essentials of crop growth. Verma and Katyal (1989) and Kumar and Mohammed (1993) also recorded similar findings in pearlmillet.

Yield attributes and yield: The weed-control measures significantly increased the yield attributes and yields over unweeded control (Table 1). Hand-weeding twice at 30 and 45 DAS being at par with pendimethalin and oxadiazon each at 1.0 kg/ha + hand-weeding once, resulted in the maximum ears/plant, (2.4), ear length (26.6 cm) as well as grain (22.92 q/ha), stover (61.4/ha) and grain-equivalent yields of pearlmillet (41.4 q/ha) yields of pearlmillet which were significantly higher over rest of the weed-

Table 1. Effect of intercropping systems and weed management on weeds, growth, yield attributes and yield of pearlmillet (pooled data of 2 years)

Treatment	Weed density (No./m^2)	Weed dry matter (kg/ha)	Plant height (cm)	Tillers/ plant	Ears/ plant	Ear length (cm)	Test weight (g)	Yield (q/ha)			Pearlmillet grain equivalent yield (q/ha)	Weed competition index (%)
								Grain	Stover	Intercrop		
Intercropping system												
Sole pearlmillet	162	1333	164.8	3.04	2.1	25.8	6.0	20.77	54.86		20.77	21.7
Pearlmillet + cowpea	117	975	148.2	2.61	1.9	23.7	6.1	17.89	50.18	5.09	35.07	15.8
Pearlmillet + clusterbean	129	1023	158.4	2.68	2.0	24.4	6.1	18.52	51.72	5.34	39.15	16.4
Pearlmillet + greengram	119	988	153.3	2.62	2.0	24.3	6.2	18.25	51.46	4.76	38.89	16.1
CD (P=0.05)	8	56	5	0.11	NS	0.8	NS	0.99	1.89		1.48	0.7
Weed control												
Unweeded control	363	2982	122.4	2.02	1.1	19.7	5.9	10.00	29.60	1.92	15.52	55.9
Pendimethalin 1.0 kg/ha PE	111	894	151.7	2.70	2.0	24.2	6.1	18.56	51.29	4.98	32.97	18.8
Pendimethalin 1.0 kg/ha PE + HW once at 45 DAS	761	641	173.0	3.03	2.4	26.2	6.2	22.18	60.19	6.15	39.94	3.1
Oxadiazon 1.0 kg/ha PE	114	913	149.6	2.64	1.9	24.1	6.0	18.11	51.00	4.92	32.32	20.7
Oxadiazon 1.0 kg/ha PE + HW once at 45 DAS	791	649	168.1	3.00	2.4	26.1	6.2	21.56	59.69	5.97	38.81	5.7
HW once at 30 DAS	103	858	154.6	2.70	2.0	24.8	6.1	18.67	51.36	5.08	33.37	18.3
Hand-weeding-twice at 30, 45 DAS	77	625	174.0	3.08	2.4	26.6	6.3	22.92	61.48	6.41	41.41	
CD (P=0.05)	8	62	6.5	0.12	0.1	1.0	NS	1.03	2.07		1.31	0.8

PE, Pre-emergence; HW, hand-weeding; DAS, days after sowing

control measures. However, this treatment also significant over oxadiazon 1.0 kg/ha + hand-weeding once in case of grain yield. It registered an increase of 129.2, 23.5, 26.5, 22.8 and 6.3% in grain yield over unweeded control, pendimethalin at 1.0 kg/ha, oxadiazon at 1.0 kg/ha, hand-weeding once and oxadiazon at 1.0 kg/ha + hand-weeding once, respectively. Hand-weeding once, pendimethalin and oxadiazon each at 1.0 kg/ha being at par with each other, though proved least effective among the weed-control measures in giving grain yield but were significantly superior to unweeded control.

As none of the treatments was found free of weeds, the highest yield giving treatment, i.e. hand-weeding twice, was treated as weed-free plot to work out the weed competition index in the present study. Weed-control measures significantly reduced the weed-competition index compared to unweeded control. The season-long weed infestation reduced the pearlmillet seed yield by 55.9% in comparison to hand-weeding twice. Among the weed-control measures, pendimethalin at 1.0 kg/ha + hand-weeding once recorded the minimum weed competition index (3.1%), followed by oxadiazon at 1.0 kg/ha + hand-weeding once (5.7%) which were significantly lower than recorded under rest of the weed-control treatments. The variation in grain and stover yield due to different weed-control treatments is associated with the similar variation in weed dry-matter production. The lowest grain and stover yields recorded in unweeded control plots may be ascribed to the maximum competition of weeds with the crop plants for growth essentials leading to maximum weed competition index (55.9%). On the other hand, the higher grain yield obtained owing to hand-weeding twice, pendimethalin and oxadiazon each at 1.0 kg/ha accompanied by hand-weeding once was associated with least competition of weeds under these treatments. Further, hand-weeding twice was done manually with the help of hand hoe, which makes the soil porous and creates favourable environment for root growth in addition to effective control of weeds. Higher seed yield, thus, obtained under hand-weeding twice was obviously due to cumulative effect of reduced weed competition and higher value of yield attributes.

The results obtained are in close conformity with the findings of Verma and Katyal (1989) and Kumar and Mohammed (1993).

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