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Significance of weed management in relation to weed dynamics, growth characters and productivity of sorghum [*Sorghum bicolor* (L.) Moench] cultivars

A.L. Jat[1], J.X. Massey[1], S.L. Yadav[1] and S.L. Jat[2]

[1]*Department of Agronomy, Rajasthan College of Agriculture*
Maharana Pratap University of Agriculture and Technology, Udaipur 313 001 (Rajasthan)
[2]*Directorate of Maize Research, New Delhi 110 012*
e-mail: aanandiagro508@gmail.com

ABSTRACT

A field experiment was conducted at Udaipur to study the effect of weed management practices on growth and productivity of sorghum [(*Sorghum bicolor* L.) Moench] cultivars during *kharif* 2010. Results showed that other then weed free check, intercropping with cowpea + 1 HW recorded higher dry matter accumulation, plant height, grain and stover yield of sorghum compared to rest of treatments. Intercropping with cowpea + 1 HW recorded lesser density of all type of weed flora, it was found significantly superior to other treatments in arresting total weeds population and recorded 51.15, 51.08 and 51.11 and 41.80, 42.66 and 42.34 per cent reduction in monocot, dicot and total weeds compared to weedy check at 30 and 60 DAS, respectively. In weed dry matter accumulation this treatment followed same trend and above as reduced biomass of all types of weeds at 30 as well as 60 DAS.

Key words: Chlorophyll, cultivars, weed management, weed dynamics and sorghum productivity.

Sorghum [*Sorghum bicolor* (L.) Moench] also known as the king of millets holds promise for food, feed, fodder and ration for human, cattle and poultry. Likewise other rainy season crops, sorghum also suffers serious stress from weeds. A wide-ranging yield reduction in the crop on account of weeds is well documented. Weeds in general cause 45 per cent annual loss of agriculture production (Singh, 1999). The farmers either do not pay attention to weeds or undertake one or two manual or mechanical weeding. Hence, weed control need to be restored during initial period of crop growth. Fast growing legumes cover the ground very quickly and give less chance for weed to grow. Inclusion of legume like cowpea has proved effective for reducing the weeds due to their smothering effect. The quick spreading of high yielding genotypes changed the scenario of sorghum production in India. Thus, there is need to work out optimum combination of different weed management practices and cultivars, so that it can exploit potential of these varieties under prevailing conditions. Thus, suitable cultivars and proper weed management practices are very important to get higher yield. Hence, the present study was undertaken to find out the effect of weed management practices on growth and productivity of Sorghum [(*Sorghum bicolor* L.) Moench] cultivars.

MATERIALS AND METHODS

A field investigation was carried out during the *kharif* 2010 at the Instructional Farm, Rajasthan College of Agriculture, Udaipur. The soil of experimental site was clay loam in texture having slightly alkaline pH (7.8) in reaction, medium with respect to available nitrogen (276.0 kg ha^{-1}), available phosphorus (22.0 kg ha^{-1}) and high in available potassium (459.0 kg ha^{-1}). The experiment consisted of five weed management practices (weedy check, weed free check, atrazine 0.5 kg ha^{-1} PE, atrazine 0.5 kg ha^{-1} PE + one hand weeding at 30 DAS, intercropping with cowpea + one hand weeding at 30 DAS) and four sorghum cultivars *viz.* CSH 16, CSH 23, CSV 20 and CSV

23 were tested in a split plot design having weed management practices in main plot and cultivars in sub plot treatments with three replications. Sorghum cultivars were sown on 14th July 2010 at 45 × 15 cm row and plant to plant spacing with a seed rate of 10 kg ha^{-1}. Chlorophyll was extracted by 80 per cent acetone and determined calorimetrically by Arnon (1949) method. The weeds were counted at 30 and 60 DAS and spots were selected randomly in each plot using 0.25 m^{-2} quadrate to mark the area. Separate counts were recorded for total individual weed species. The mean data were subjected to square root transformation (x + 0.5)1/2 to normalize their distribution (Gomez and Gomez, 1984). The samples were sun dried for few days and then oven dried at 70ºC till a constant weight was observed to obtain weed dry matter.

Results and Discussion

Effect on weeds

Weed density

The major weed flora found in experimental plots during the crop season were *Cynodon dactylon, Echinochloa* sp., *Cyperus rotundus* (L.), *Amaranthus sp. Commelina benghalensis* (L.), *Digera arvensis* (L.), *Trianthema monogyna* (L.) and *Parthenium hysterophorus* (L.).

It is appraisal from data (Table 1) reveals that intercropping with cowpea + 1 HW recorded lesser density of *Cynodon dactylon, Echinochloa* sp., *Cyperus rotundus,* other monocots, *Commelina, Digera, Trianthema, Parthenium,* other dicot weeds, total monocots, total dicots and total weeds. It was tended to reduce density by 62.50, 59.40, 29.50, 33.60, 59.77, 50.75, 66.87, 29.68, 42.32, 51.15, 51.08 and 51.11 per cent, respectively compared to weedy check at 30 DAS. Whereas, the atrazine 0.5 kg ha^{-1} + 1 HW was found most effective in controlling *Amaranthus* up to 30 DAS. The data further indicated that all the treatments were found effective in arresting weed population and their growth up to 60 DAS. Intercropping with cowpea + 1 HW at 30 DAS follows same trend in decline the density of all type of weeds at 60 DAS (Table 2) due to initially rapid growth of cowpea and spreading of its branches and ground covering by its leaves. However, during this period the growth of weeds is suppressed by cowpea resulted in significant decrease in weed population. Inclusion of legume like cowpea has proved effective in reducing the weeds due to their smothering effect; the same has also been reported by Solaimalai and Shivakumar (2000).

Weed dry matter accumulation

All the weed control measures registered a significant reduction in weed dry matter accumulation at both 30 and 60 DAS compared to weedy check (Tables 3 and 4). Among the treatments intercropping with cowpea + 1 HW was found significantly superior in reduction of dry matter of individual as well as total weeds at both 30 and 60 DAS except *Amaranthus* at 30 DAS and *Trianthema* at both the stage 30 and 60 DAS, both the weeds reduced by atrazine 0.5 kg ha^{-1} + 1 HW. The per cent reduction in dry matter of total monocot, total dicot and total weeds due to intercropping with cowpea + 1 HW was 52.04, 50.76, and 51.17 per cent at 30 DAS and 51.50, 44.01 and 47.33 per cent at 60 DAS compared to weedy check. Fast growing legume cover the ground very quickly in suppressing weed growth and give less chance for weeds to grow. Sharanappa and Hosmani (1985) are conformity with the present trend of result. The reduced crop-weed competition in sorghum + cowpea treatment due to better performance of intercropping in suppressing weed growth and ultimately decline weed dry matter accumulation. Similar results were also observed by Solaimalai and Shivakumar (2000).

Effect on crop

Crop growth and productivity

Data (Table 5) clearly indicate that weed free treatment recorded maximum DMA of 3.94, 53.73 and 184.17 g $plant^{-1}$ at 30, 60 and at harvest and plant height (225.37cm) at harvest. Wherein the plants under the influence of application of atrazine alone attained significantly earlier flowering compared to weedy check. Weed free treatment recorded significantly (103.46 and 23.77 per cent) higher grain and stover yield over weedy check. A comparative study of the performance of sorghum cultivars under test

Table 1. Effect of weed management practices and cultivars on weed density (No. m^{-2}) at 30 DAS

Treatments	Monocot weeds				Dicot weeds						Total		Total weeds
	Cynodon dacylon	*Echino-chloa* sp.	*Cyperus rotundus*	Other	*Amaran-thus* sp.	*Comme-lina*	*Digera*	*Trianthe-ma*	*Parthe-nium*	Other	*Monocot*	*Dicot*	
W*eed Management*													
Weedy check	3.72*	6.03	3.26	3.66	3.55	4.13	3.44	5.26	4.49	3.02	8.53	9.80	12.98
	(13.33)	(35.92)	(10.17)	(12.92)	(12.17)	(16.58)	(11.33)	(27.17)	(19.67)	(8.67)	(72.33)	(95.58)	(167.92)
Weed free	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	-	-	-	-	-	-	-	-	-	-	-	-	-
Atrazine 0.5 kg ha^{-1}	2.70	4.15	3.13	3.53	2.77	3.07	2.73	3.30	4.09	2.72	6.74	7.57	10.11
	(6.83)	(16.75)	(9.33)	(12.00)	(7.33)	(9.00)	(7.00)	(10.42)	(16.25)	(6.92)	(44.92)	(56.92)	(101.83)
Atrazine 0.5 kg ha^{-1}	2.48	4.06	2.98	3.19	2.63	2.90	2.45	3.13	3.81	2.43	6.35	7.03	9.45
+ 1 HW #	(5.67)	(16.00)	(8.42)	(9.75)	(6.58)	(7.92)	(5.58)	(9.33)	(14.08)	(5.42)	(39.83)	(48.92)	(88.75)
Intercropping	2.34	3.88	2.77	3.00	2.64	2.67	2.46	3.08	3.78	2.34	5.98	6.87	9.09
+ 1HW#	(5.0)	(14.58)	(7.17)	(8.58)	(6.67)	(6.67)	(5.58)	(9.00)	(13.83)	(5.00)	(35.33)	(46.75)	(82.08)
CD (P=0.05)	0.121	0.178	0.072	0.170	0.326	0.196	0.167	0.174	0.243	2.44	0.138	0.173	0.176
Cultivars													
CSH 16	2.37	3.82	2.56	2.80	2.42	2.71	2.37	3.12	3.36	2.27	5.67	6.40	8.47
	(6.07)	(17.27)	(6.93)	(8.47)	(6.27)	(8.07)	(5.93)	(11.33)	(12.60)	(5.33)	(38.73)	(49.53)	(88.27)
CSH 23	2.40	3.74	2.52	2.90	2.44	2.64	2.26	3.06	3.37	2.20	5.67	6.29	8.39
	(6.20)	(16.27)	(6.73)	(9.20)	(6.40)	(7.73)	(5.40)	(10.93)	(12.67)	(5.00)	(38.40)	(48.13)	(86.53)
CSV 20	2.38	3.73	2.61	2.88	2.63	2.65	2.39	3.10	3.38	2.28	5.68	6.47	8.54
	(6.13)	(16.20)	(7.27)	(9.07)	(7.67)	(7.73)	(6.13)	(11.20)	(12.80)	(5.40)	(38.67)	(50.93)	(89.60)
CSV 23	2.41	3.78	2.59	2.69	2.35	2.78	2.40	3.09	3.40	2.22	5.63	6.42	8.46
	(6.27)	(16.87)	(7.13)	(7.87)	(5.87)	(8.60)	(6.13)	(11.27)	(13.00)	(5.07)	(38.13)	(49.93)	(88.07)
CD (P=0.05)	NS	NS	NS	0.131	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: Figures in parenthesis are original value and * transformation value $\sqrt{(x + 0.5)}$

#HW = Hand weeding at 30 DAS was done after taking weed count observation at 30 DAS

Table 2. Effect of weed management practices and cultivars on weed density (No. m^{-2}) at 60 DAS

Treatments	Monocot weeds				Dicot weeds						Total		Total weeds
	Cynodon dactylon	*Echino-chloa* sp.	*Cyperus rotundus*	Other monocot	*Amaran-thus* sp.	*Comme lina*	*Digera*	*Trianthe-ma*	*Parthe-nium*	Other Dicot	*Monocot*	*Dicot*	
Weed Management													
Weedy check	4.59*	6.44	3.11	4.48	4.47	5.13	4.46	7.26	4.62	4.28	9.53*	12.50	15.70
	(20.58)	(41.00)	(9.17)	(19.58)	(19.50)	(25.83)	(19.50)	(52.17)	(20.83)	(17.83)	(90.33)	(155.67)	(246)
Weed free	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	-	-	-	-	-	-	-	-	-	-	-	-	-
Atrazine 0.5 kg ha^{-1}	3.26	5.12	2.97	4.13	3.29	4.32	3.53	5.30	4.31	3.94	7.83	10.09	12.75
	(10.17)	(25.75)	(8.33)	(16.58)	(10.33)	(18.17)	(12.08)	(27.58)	(18.08)	(15.08)	(60.83)	(101.33)	(162.17)
Atrazine 0.5 kg ha^{-1}	3.07	4.93	2.81	3.88	3.13	4.19	3.29	5.10	4.01	3.69	7.43	9.57	12.10
+ 1 HW #	(8.92)	(23.83)	(7.42)	(14.58)	(9.33)	(17.08)	(10.42)	(25.50)	(15.58)	(13.17)	(54.75)	(91.08)	(145.83)
Intercropping +	3.00	4.91	2.58	3.85	3.02	4.14	3.27	5.08	3.97	3.67	7.28	9.47	11.93
1HW#	(8.50)	(23.58)	(6.17)	(14.33)	(8.67)	(16.67)	(10.25)	(25.33)	(15.33)	(13.00)	(52.58)	(89.25)	(141.83)
LSD (P=0.05)	0.117	0.150	0.077	0.196	0.148	0.090	0.201	0.180	0.184	0.216	0.190	0.266	0.229
Cultivars													
CSH 16	2.90	4.45	2.42	3.41	2.97	3.71	3.16	4.66	3.53	3.29	6.56	8.53	10.69
	(9.47)	(23.33)	(6.13)	(13.00)	(9.87)	(15.67)	(11.13)	(25.87)	(14.00)	(12.07)	(51.93)	(88.60)	(140.53)
CSH 23	2.93	4.40	2.38	3.45	2.94	3.68	2.88	4.66	3.54	3.27	6.55	8.40	10.58
	(9.67)	(22.60)	(5.93)	(13.40)	(9.67)	(15.40)	(9.13)	(25.80)	(14.07)	(11.87)	(51.60)	(85.93)	(137.53)
CSV 20	2.93)	4.41	2.48	3.38	2.92	3.67	3.04	4.69	3.57	3.27	6.55	8.48	10.65
	(9.73)	(22.67)	(6.47)	(12.80)	(9.53)	(15.33)	(10.53)	(26.13)	(14.40)	(11.93)	(51.67)	(87.87)	(139.53)
CSV 23	2.93	4.42	2.46	3.39	2.86	3.72	3.13	4.74	3.45	3.20	6.55	8.46	10.63
	(9.67)	(22.73)	(6.33)	(12.87)	(9.20)	(15.80)	(11.00)	(26.67)	(13.40)	(11.40)	(51.60)	(87.47)	(139.07)
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	0.122	NS	NS	NS	NS	NS	NS

Note: Figures in parenthesis are original value and * transformation value $\sqrt{(x + 0.5)}$

#HW = Hand weeding at 30 DAS was done after taking weed count observation at 30 DAS

Table 3. Effect of weed management practices and cultivars on weed dry matter accumulation (g m^{-2}) at 30 DAS

Treatments	Monocot weeds				Dicot weeds						Total		Total weeds
	Cynodon dactylon	*Echino-chloa* sp.	*Cyperus rotundus*	Other monocot	*Amaran-thus* sp.	*Comme lina*	Digera	*Trianthe-ma*	*Parthe-nium*	Other Dicot	*Monocot*	*Dicot*	
Weed Management													
Weedy check	5.67	17.36	3.64	5.67	8.52	11.44	8.16	19.36	14.87	6.05	32.34	68.39	100.72
Weed free	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atrazine 0.5 kg ha^{-1}	2.91	8.10	3.32	5.28	5.13	6.21	5.06	7.42	12.29	4.83	19.61	40.93	60.54
Atrazine 0.5 kg ha^{-1} + 1 HW	2.41	7.74	3.00	4.29	4.61	5.46	4.04	5.65	10.65	3.78	17.43	35.18	52.61
Intercropping + 1 HW	2.13	7.05	2.55	3.78	4.68	4.60	4.04	6.41	10.46	3.48	15.51	33.67	49.18
LSD (P=0.05)	0.294	1.042	0.123	0.537	1.167	0.796	0.627	0.834	1.319	0.745	1.168	1.718	2.017
Cultivars													
CSH 16	2.58	8.35	2.47	3.72	4.39	5.56	4.29	8.08	9.53	3.72	17.12	35.56	52.68
CSH 23	2.64	7.86	2.39	4.04	4.48	5.33	3.90	7.79	9.58	3.49	16.94	34.57	51.51
CSV 20	2.62	7.83	2.58	3.99	5.37	5.34	4.43	7.98	9.68	3.77	17.02	36.56	53.58
CSV 23	2.66	8.15	2.56	3.46	4.12	5.93	4.41	8.03	9.89	3.53	16.83	35.85	52.68
LSD (P=0.05)	NS	NS	NS	0.395	NS	NS	NS	NS	NS	NS	NS	1.317	NS

Note: HW = Hand weeding at 30 DAS and NS= Non significant

Table 4. Effect of weed management practices and cultivars on weed dry matter accumulation (g m^{-2}) at 60 DAS

Treatments	Monocot weeds				Dicot weeds						Total		Total weeds
	Cynodon dactylon	*Echino-chloa* sp.	*Cyperus rotundus*	Other monocot	*Amaran-thus* sp.	*Comme lina*	*Digera*	*Trianthe-ma*	*Parthe-nium*	Other Dicot	*Monocot*	*Dicot*	
Weed Management													
Weedy check	65.84	105.08	25.14	34.98	38.01	80.98	28.50	88.89	27.07	26.98	231.04	290.44	521.48
Weed free	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atrazine 0.5 kg ha^{-1}	33.92	56.84	19.56	25.74	20.35	55.65	20.62	43.15	23.11	18.46	136.05	181.33	317.39
Atrazine 0.5 kg ha^{-1} + 1 HW	30.64	52.01	17.02	23.41	18.28	52.86	17.78	39.27	21.66	16.93	123.07	166.61	289.85
Intercropping + 1 HW	29.10	48.00	13.48	21.47	17.50	52.19	17.07	39.71	21.32	14.82	112.05	162.61	274.66
LSD (P=0.05)	2.905	3.043	1.750	2.194	1.778	2.737	2.053	3.602	1.092	2.028	8.427	6.769	11.811
Cultivars													
CSH 16	31.61	54.50	14.85	20.79	19.55	48.76	16.49	41.93	18.49	15.61	121.75	160.84	282.58
CSH 23	31.94	52.35	14.13	22.19	18.70	47.89	16.75	42.60	18.57	14.89	120.61	159.41	280.01
CSV 20	31.94	51.66	15.73	20.79	18.95	47.89	17.06	41.71	18.79	16.01	120.12	160.43	280.55
CSV 23	32.11	51.02	15.45	20.71	18.11	48.81	16.87	42.57	18.66	15.24	119.30	160.27	279.56
LSD (P=0.05)	NS	2.247	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: HW = Hand weeding at 30 DAS and NS= Non significant

Table 5. Effect of weed management practices on growth characters and productivity of sorghum cultivars

Treatments	Dry matter accumulation (g plant^{-1})			Plant height at harvest (cm)	Days to 50% flowering	Chlorophyll content (mg g^{-1}) at 60 DAS	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
	30 DAS	60 DAS	At harvest					
Weed Management								
Weedy check	3.54	45.76	130.33	192.83	70.08	2.27	1866.18	8321.25
Weed free	3.94	53.73	184.17	225.37	68.42	2.41	3797.00	10299.97
Atrazine 0.5 kg ha^{-1}	3.78	49.06	158.19	204.28	67.33	2.37	2991.11	8822.64
Atrazine 0.5 kg ha^{-1} +1 HW	3.86	49.74	160.62	216.48	67.92	2.39	3204.42	9179.08
Intercropping with cowpea + 1 HW	3.87	50.87	166.33	223.57	67.42	2.39	3446.47	9742.87
LSD (P = 0.05)	0.240	4.138	8.336	19.467	1.285	NS	234.518	561.002
Cultivars								
CSH 16	3.62	44.74	161.44	200.11	66.40	2.48	3347.59	8816.89
CSH 23	3.71	39.40	149.78	198.88	66.07	2.44	3262.60	8216.26
CSV 20	3.86	58.59	167.09	228.67	69.80	2.31	2837.56	10214.37
CSV 23	4.00	56.59	161.40	222.36	70.67	2.23	2796.49	9845.12
LSD (P = 0.05)	0.117	2.001	6.448	11.267	0.947	0.110	185.017	418.590

HW= *Hand Weeding* at 30 DAS

NS= Non significant

reveals that CSV 23 at 30 DAS and CSV 20 at 60 DAS and harvest recorded maximum dry matter accumulation and also plant height while, CSH 23 attained earlier flowering (66.07 days) compared to rest of cultivars. Chlorophyll content (2.48 mg g^{-1}) was higher in CSH 16. Data further indicated that CSH 16 (3347.59 kg ha^{-1}) and CSH 23 (3262.60 kg ha^{-1}) yielded significantly higher than rest of the cultivars. The grain yield of CSV 20 and CSV 23 were at par. However, maximum stover yield (10214.37 kg ha^{-1}) was recorded by CSV 20. Thus, the improvement in growth and yield components was as a consequence of lower crop-weed competition, which shifted the balance in favour of crop in utilization of nutrients, moisture, light and space. These results are in conformity with the findings of Kamble *et al.* (2005).

Based on the above-mentioned discussion it can be concluded that intercropping with cowpea +1 hand weeding in sorghum resulted into less crop-weed competition and higher crop productivity while CSH 16 and CSH 23 proved best cultivar.

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