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Effect of Integrated Weed Management on Yield, Quality and Economics of Summer Sorghum (*Sorghum bicolor* L.)

B.R. Verma*, H.M. Virdia and Dinesh Kumar

Department of Agronomy, N.M. College of Agriculture, Navsari Agricultural University, Navsari – 396 450, Gujarat, India
**Corresponding author*

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A B S T R A C T

A field experiment was conducted at College Farm, Navsari Agricultural University, Navsari (Gujarat) during summer season of the year 2016 under south Gujarat. The experiment was laid out in randomized block design with three replications and ten treatments with pre and post emergence herbicides (Atrazine, 2, 4-D and metsulfuron methyl) alone or combination of these herbicide followed by hand weeding and inter-culturing operation. Two hand weeding and inter-culturing operation at 20 and 40 DAS recorded significantly higher grain (3302.67 kg/ha) and straw (7638.67 kg/ha) yields. However, grain and straw yield was remained at par with treatments T_8 *i.e.* Atrazine @ 0.50 kg /ha as PE *fb* Atrazine @ 0.50 kg/ha PoE 25 DAS *fb* HW and IC at 40 DAS (2936.67 kg/ha, 7374 kg/ha) and T_9 *i.e.* Atrazine @ 0.50 kg/ha as PE *fb* 2, 4-D @ 0.50 kg/ha as PoE at 25 DAS *fb* HW and IC at 40 DAS (2867 kg/ha, 7274 kg/ha) respectively. The maximum net returns (₹54,623 per ha) was realized under the treatment of two hand weeding and inter-culturing operation at 20 and 40 DAS followed by treatments T_4 *i.e* Atrazine @ 0.50 kg/ha as PE *fb* atrazine 0.50 kg/ha as post emergence (PoE) at 25 DAS (₹ 50,179). However, the maximum gross returns (₹ 88,969 per ha) was recorded with treatment T_2 *i.e.* two hand weeding and inter-culturing operation at 20 and 40 DAS followed by T_8 *i.e.* Atrazine @ 0.50 kg /ha as PE *fb* Atrazine @ 0.50 kg/ha PoE 25 DAS *fb* HW and IC at 40 DAS (₹ 80,855). Whereas, the maximum B:C was recorded under the treatment T_4 *i.e.* Atrazine @ 0.50 kg/ha as PE *fb* atrazine 0.50 kg/ha as post emergence (PoE) at 25 DAS (2.88).

Introduction

Sorghum (*Sorghum bicolor* L.) is one of the globally important cereal crop after wheat, maize, rice and barley. Sorghum is a unique crop among the major cereals and the staple food and fodder crop of the world's poor and most food-insecure populations, located primarily in the semi-arid tropics. Sorghum is grown on 43.81 million ha area in the world, producing about 65.42 million tonnes grain with an average yield of 1523 kg/ha. India and USA have largest share of global sorghum area, while the maximum production of sorghum occur in the USA. India presently produces about 5.54 million tonnes of sorghum grain from area of 6.16 million ha and productivity of 884 kg/ha (Anon., 2016). The crop is primarily produced in Maharashtra, Andhra Pradesh, Gujarat and Karnataka. In Gujarat, sorghum occupies about 0.14 million ha area and annual

production of 0.19 million tonnes with productivity of 1350 kg/ha (Anonymous, 2016).

Sorghum is one of the important dry land crop grown in poor lands with minimum inputs and in dry conditions that tolerate to heat, salt and water-logging. Sorghum is a preferred in tropical, warm and semiarid regions of the world with high temperature and water stress with the threat of climate change looming large on the crop productivity, sorghum is hardy crop that play an important role in food, feed and fodder security in dry-land economy (Paterson *et al.,* 2009). The integration of herbicides with some cultural operations and use of pre-emergence, post-emergence herbicides in combination with mechanical methods can prove to be more successful. This way integrated weed management is gaining importance in management of weeds for preventing losses and higher input-use efficiency (Ishya *et al.,* 2007).

Materials and Methods

The experiment was conducted at plot number B-12 of the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during summer season of 2016. Navsari Agricultural University campus is located on southern part of Gujarat state and geographically located at 20º57' N latitude and 72º54' E longitude at an altitude of 10 meters above the mean sea level. The soil of the experimental field was clayey in texture, dark grayish brown type, flat topography and characterized by medium to poor drainage with good water holding capacity. The soil available nutrient status showed lower availability of nitrogen (195.16 kg/ha) medium for phosphorus (29.83 kg/ha) and high for potassium (364.70 kg/ha). The soil was slightly alkaline (P^H 7.7) with normal electric conductivity (0.36 dS/m). Ten treatments comprising of weed management practices *viz.,* T_1: Un-weeded control, T_2: Two hand weeding (HW) and inter-culturing at 20 and 40 DAS, T_3: Atrazine @ 1.0 kg /ha as pre-emergence (PE), T_4: Atrazine @ 0.50 kg/ha as PE *fb* atrazine 0.50 kg/ha as post emergence (PoE) at 25 DAS, T_5: Atrazine @ 0.50 kg/ha as PE *fb* 2, 4-D @ 0.50 kg/ha as PoE at 25 DAS, T_6: Atrazine @ 0.50 kg/ha as PE *fb* metsulfuron methyl @ 6 g/ha as PoE, T_7: Atrazine @ 1 kg/ha as PE *fb* HW and IC at 40 DAS, T_8: Atrazine @ 0.50 kg /ha as PE *fb* Atrazine @ 0.50 kg/ha PoE 25 DAS *fb* HW and IC at 40 DAS, T_9: Atrazine @ 0.50 kg/ha as PE *fb* 2, 4-D @ 0.50 kg/ha as PoE at 25 DAS *fb* HW and IC at 40 DAS, T_{10}: Atrazine @ 0.50 kg/ha as PE *fb* metsulfuron methyl @ 6 g/ha as PoE 25 DAS *fb* HW and IC at 40 DAS, were evaluated in randomized block design with three replications. The improved and popular cultivar *i.e.* GJ 42 of sorghum was used for cultivation. The weed management treatments were used in sorghum with other cultural practices

Results and Discussion

Effect on yield

Number of panicles per hill

Significantly higher number of panicles (Table 1) in summer sorghum per hill was recorded under treatment T_2 (2.60). While treatments T_8 (2.50), T_9 (2.40) and T_7 (2.31) were found statistically at par with each other. Significantly higher number of panicles per hill was recorded due to lower weed competition in the treatments with good control in earlier days as well as in later phase of crop development. These results are in close conformity with Priya and Kubsad (2013).

Seed yield

Significantly higher seed yield (3302.67 kg/ha) (Table 1) were reported under

treatment T_2 and it was remain at par with treatments T_8 (2936.67 kg/ha), T_9 (2867 kg/ha) and T_4 (2776.67 kg/ha). The higher seed yield was mainly due to maintenance of weed free environment, especially from initial as well as during critical growth stages of crop, reduce crop weed competition helped in better growth and development of sorghum crop resulting in more height and tillers which resulted in higher yield.

Table.1 Grain and straw yield of summer sorghum as influenced by different weed management practices

Treatment		Number of panicles per hill	Grain yield (kg) Per ha	Straw yield (kg) Per ha
T_1	Un weeded control	1.60	2164.00	5975.00
T_2	Two hand weeding and inter-culturing (IC) at 20 and 40 DAS	2.60	3302.67	7638.67
T_3	Atrazine @ 1.0 kg /ha as pre-emergence (PE)	1.87	2577.67	6929.67
T_4	Atrazine @ 0.50 kg/ha as PE *fb* atrazine 0.50 kg/ha as post emergence (PoE) at 25 DAS	2.13	2776.67	7134.00
T_5	Atrazine @ 0.50 kg/ha as PE *fb* 2, 4-D @ 0.50 kg/ha as PoE at 25 DAS	2.00	2615.33	7003.33
T_6	Atrazine @ 0.50 kg/ha as PE *fb* metsulfuron methyl @ 6 g/ha as PoE	1.70	2343.33	6396.00
T_7	Atrazine @ 1 kg/ha as PE *fb* hand weeding and IC at 40 DAS	2.31	2804.33	7161.67
T_8	Atrazine @ 0.50 kg/ha as PE *fb* atrazine @ 0.50 kg/ha PoE 25 DAS *fb* hand weeding and IC at 40 DAS	2.50	2936.67	7374.00
T_9	Atrazine @ 0.50 kg/ha as PE *fb* 2, 4-D @ 0.50 kg/ha as PoE at 25 DAS *fb* HW and IC at 40 DAS.	2.40	2867.00	7242.00
T_{10}	Atrazine @ 0.50 kg/ha as PE *fb* metsulfuron methyl @ 6 g/ha as PoE 25 DAS *fb* HW and IC at 40 DAS	1.90	2453.33	6512.33
	S.Em±	0.14	187.58	318.36
	C.D. at 5 %	0.41	557.34	945.93
	C.V.	11.39	12.10	7.95

Table.2 Harvest index, test weight (g) and protein content in grain of summer sorghum as influenced by different weed management practices

Treatment		Harvest index (%)	Test weight (g)	Protein content (%)
T_1	Un weeded control	26.65	21.73	9.94
T_2	Two hand weeding and inter-culturing (IC) at 20 and 40 DAS	30.20	24.28	10.63
T_3	Atrazine @ 1.0 kg /ha as pre-emergence (PE)	28.21	23.45	10.19
T_4	Atrazine @ 0.50 kg/ha as PE *fb* atrazine 0.50 kg/ha as post emergence (PoE) at 25 DAS	27.99	23.57	10.15
T_5	Atrazine @ 0.50 kg/ha as PE *fb* 2, 4-D @ 0.50 kg/ha as PoE at 25 DAS	27.13	23.52	10.31
T_6	Atrazine @ 0.50 kg/ha as PE *fb* metsulfuron methyl @ 6 g/ha as PoE	26.93	22.95	10.25
T_7	Atrazine @ 1 kg/ha as PE *fb* HW and IC at 40 DAS	27.01	23.85	10.35
T_8	Atrazine @ 0.50 kg /ha as PE *fb* atrazine @ 0.50 kg/ha PoE 25 DAS *fb* HW and IC at 40 DAS	28.53	24.00	10.44
T_9	Atrazine @ 0.50 kg/ha as PE *fb* 2, 4-D @ 0.50 kg/ha as PoE at 25 DAS *fb* HW and IC at 40 DAS	28.40	23.89	10.36
T_{10}	Atrazine @ 0.50 kg/ha as PE *fb* metsulfuron methyl @ 6 g/ha as PoE 25 DAS *fb* HW and IC at 40 DAS	27.41	23.33	10.26
	S.Em±	1.76	0.41	0.11
	C.D. at 5 %	NS	1.21	0.32
	C.V.	10.92	3.02	1..81

Table.3 Economics as influenced by different weed management practices of summer sorghum

Treatment		Gross return (₹ per ha)	Net return (₹ per ha)	B:C Ratio
T_1	Un weeded control	61205	35559	2.39
T_2	Two hand weeding and inter-culturing (IC) at 20 and 40 DAS	88969	54623	2.59
T_3	Atrazine @ 1.0 kg /ha as pre-emergence (PE)	72342	45761	2.72
T_4	Atrazine @ 0.50 kg/ha as PE *fb* atrazine 0.50 kg/ha as post emergence (PoE) at 25 DAS	76935	50179	2.88
T_5	Atrazine @ 0.50 kg/ha as PE *fb* 2, 0 kg/ha as PoE at 25 DAS	73317	46741	2.76
T_6	Atrazine @ 0.50 kg/ha as PE *fb* metsulfuron methyl @ 6 g/ha as PoE	66055	39229	2.46
T_7	Atrazine @ 1 kg/ha as PE *fb* HW and IC at 40 DAS	77572	46641	2.51
T_8	Atrazine @ 0.50 kg /ha as PE *fb* atrazine @ 0.50 kg/ha PoE 25 DAS *fb* HW and IC at 40 DAS	80855	49749	2.60
T_9	Atrazine @ 0.50 kg/ha as PE *fb* 2, 4-D @ 0.50 kg/ha as PoE at 25 DAS *fb* HW and IC at 40 DAS	79066	48140	2.56
T_{10}	Atrazine @ 0.50 kg/ha as PE *fb* metsulfuron methyl @ 6 g/ha as PoE 25 DAS *fb* HW and IC at 40 DAS	68604	37428	2.20

Seed yield is primarily a function of accumulation of photosynthates resulted in growth and increase yield. These results are in corroboration with findings of Dhar *et al.*, (2006), Rathod *et al.*, (2010), Kumar *et al.*, (2012) and Priya and Kubsad (2013).

Straw yield

Significantly higher straw yield was reported under treatment T_2 (7638.67 kg/ha) (Table 1) and it was remain at par with treatments T_8 (7374 kg/ha), T_9 (7274 kg/ha), T_7 (7161.67 kg/ha), T_4 (7134 kg/ha), T_5 (7003.33 kg/ha) and T_3 (6929.67 kg/ha). Significantly higher straw yield was revealed due to avoiding crop weed competition under these treatments with affect on growth and yield attributes. These results are in corroboration with finding of Dhar *et al.*, (2006), Rao *et al.*, (2007), Kumar *et al.*, (2012) and Priya and Kubsad (2013).

Harvest index

It can be seen from the (Table 2) that treatment T_2 (30.20 %) had higher harvest index followed by treatments T_8 (28.53 %), T_9 (28.40 %) and T_3 (28.21 %).

Test weight

Treatment T_2 (24.28 g) recorded significantly higher test weight and noticed that most of treatments (Table 2) were at par with it except treatments T_1 (21.73 g) and T_6 (22.95 g). Significantly higher test weight noticed due to lesser weed competition in treatments at earlier as well as later phase of crop growth period. Similar results were also reported by Priya and Kubsad (2013).

Protein content in seed

Treatment T_2 registered significantly higher protein content (10.63 %) which was at par with the treatments T_8 (10.44 %), T_9 (10.36 %), T_7 (10.35 %) and T_5 (10.31 %). While, significantly lower protein content was recorded under un-weeded control (9.94 %) over rest of treatments (Table 2).

This was fact that weed management controlled weed effectively and significantly reduction in crop-weed competition ultimately benefited to the crop and higher uptake and utilization of nutrients directly or indirectly that help in protein synthesis in grain of sorghum. Similar results were also reported by Dhar *et al.,* (2006) and Rao *et al.,* (2007).

Effect on economics

Treatment T_2 recorded maximum gross return of (₹ 88,969 per ha) followed by treatments T_8 (₹ 80,855 per ha) T_9 (₹ 79,066 per ha) and T_7 (₹ 77,572 per ha) (Table 3). The higher grain yields (Table 2) recorded under these treatments might be responsible for higher gross return. Here the highest net return (₹ 54,623 per ha) was recorded in treatment T_2 followed by treatment T_4 (₹ 50,179 per ha), T_8 (₹49,749 per ha). Treatment T_1 registered the lowest net return of (₹ 35,559 per ha) compare to these treatments, followed by treatments T_6 and T_{10} may be due to phytotoxic effect of metsulfuron methyl on these treatments as well as more competitive effect on growth and yield resulted in poor return.

Whereas, the maximum B:C was accrued under the treatment T_4 (2.88) followed by T_5 (2.76), T_3 (2.72) and T_8 (2.60). Higher gross returns along with the lowest cost under treatments T_1, T_3, T_4, T_5 and T_6 might be responsible for higher net return and B: C ratio. This is in conformity with the findings of Kumar *et al.,* (2012), Mishra *et al.,* (2012), Priya and Kubsad (2013), Patel *et al.,* (2014) and Thakur *et al.,* (2016).

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