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

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A R T I C L E   I N F O

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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 T8 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 T9 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 T4 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 T1 i.e. two hand weeding and inter-culturing operation at 20 and 40 DAS followed by T4 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 T4 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 20°57’ N latitude and 72°54’ 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 (pH 7.7) with normal electric conductivity (0.36 dS/m). Ten treatments comprising of weed management practices viz., T₁: Un-weeded control, T₂: Two hand weeding (HW) and inter-culturing at 20 and 40 DAS, T₃: Atrazine @ 1.0 kg /ha as pre-emergence (PE), T₄: Atrazine @ 0.50 kg/ha as PE fb atrazine 0.50 kg/ha as post emergence (PoE) at 25 DAS, T₅: Atrazine @ 0.50 kg/ha as PE fb 2, 4-D @ 0.50 kg/ha as PoE at 25 DAS, T₆: Atrazine @ 0.50 kg/ha as PE fb metsulfuron methyl @ 6 g/ha as PoE, T₇: Atrazine @ 1 kg/ha as PE fb HW and IC at 40 DAS, T₈: Atrazine @ 0.50 kg /ha as PE fb Atrazine @ 0.50 kg/ha PoE 25 DAS fb HW and IC at 40 DAS, T₉: 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, T₁₀: 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 T₂ (2.60). While treatments T₈ (2.50), T₉ (2.40) and T₇ (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) | Straw yield (kg) |
|-----------|----------------------------|----------------|-----------------|
|           |                            | Per ha          | 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 (%) |
|---------------------------------------------------------------------------|-------------------|-----------------|---------------------|
| T1  Un weeded control                                                     | 26.65             | 21.73           | 9.94                |
| T2  Two hand weeding and inter-culturing (IC) at 20 and 40 DAS            | 30.20             | 24.28           | 10.63               |
| T3  Atrazine @ 1.0 kg /ha as pre-emergence (PE)                           | 28.21             | 23.45           | 10.19               |
| T4  Atrazine @ 0.50 kg /ha as PE fb atrazine 0.50 kg /ha as PoE at 25 DAS | 27.99             | 23.57           | 10.15               |
| T5  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               |
| T6  Atrazine @ 0.50 kg /ha as PE fb metsulfuron methyl @ 6 g /ha as PoE   | 26.93             | 22.95           | 10.25               |
| T7  Atrazine @ 1 kg /ha as PE fb HW and IC at 40 DAS                      | 27.01             | 23.85           | 10.35               |
| T8  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               |
| T9  Atrazine @ 0.50 kg /ha as PE fb 2, 4-D @ 0.50 kg /ha as PoE 25 DAS fb HW and IC at 40 DAS | 28.40             | 23.89           | 10.36               |
| T10 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 Description                                                                 | Gross Return (₹ per ha) | Net Return (₹ per ha) | B:C Ratio |
|----------------------------------------------------------------------------------------|--------------------------|-----------------------|-----------|
| T<sub>1</sub> Un weeded control                                                        | 61205                    | 35559                 | 2.39      |
| T<sub>2</sub> Two hand weeding and interculturing (IC) at 20 and 40 DAS                 | 88969                    | 54623                 | 2.59      |
| T<sub>3</sub> Atrazine @ 1.0 kg/ha as pre-emergence (PE)                                | 72342                    | 45761                 | 2.72      |
| T<sub>4</sub> Atrazine @ 0.50 kg/ha as PE fb atrazine 0.50 kg/ha as post emergence (PoE) | 76935                    | 50179                 | 2.88      |
| T<sub>5</sub> Atrazine @ 0.50 kg/ha as PE fb 2, 0 kg/ha as PoE at 25 DAS                  | 73317                    | 46741                 | 2.76      |
| T<sub>6</sub> Atrazine @ 0.50 kg/ha as PE fb metsulfuron methyl @ 6 g/ha as PoE          | 66055                    | 39229                 | 2.46      |
| T<sub>7</sub> Atrazine @ 1 kg/ha as PE fb HW and IC at 40 DAS                           | 77572                    | 46641                 | 2.51      |
| T<sub>8</sub> 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<sub>9</sub> 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<sub>10</sub> 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<sub>2</sub> (7638.67 kg/ha) (Table 1) and it was remain at par with treatments T<sub>8</sub> (7374 kg/ha), T<sub>9</sub> (7274 kg/ha), T<sub>7</sub> (7161.67 kg/ha), T<sub>4</sub> (7134 kg/ha), T<sub>5</sub> (7003.33 kg/ha) and T<sub>3</sub> (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<sub>2</sub> (30.20 %) had higher harvest index followed by treatments T<sub>8</sub> (28.53 %), T<sub>9</sub> (28.40 %) and T<sub>3</sub> (28.21 %).
Test weight

Treatment T₂ (24.28 g) recorded significantly higher test weight and noticed that most of treatments (Table 2) were at par with it except treatments T₁ (21.73 g) and T₆ (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 T₂ registered significantly higher protein content (10.63 %) which was at par with the treatments T₈ (10.44 %), T₉ (10.36 %), T₇ (10.35 %) and T₅ (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 T₂ recorded maximum gross return of (₹ 88,969 per ha) followed by treatments T₈ (₹ 80,855 per ha) T₉ (₹ 79,066 per ha) and T₇ (₹ 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 T₂ followed by treatment T₄ (₹ 50,179 per ha), T₈ (₹49,749 per ha). Treatment T₁ registered the lowest net return of (₹ 35,559 per ha) compare to these treatments, followed by treatments T₆ and T₁₀ 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 T₄ (2.88) followed by T₅ (2.76), T₃ (2.72) and T₈ (2.60). Higher gross returns along with the lowest cost under treatments T₁, T₃, T₄, T₅ and T₆ 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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