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Weed Management Effects on Growth and Yield of *kharif* Grain Sorghum (*Sorghum bicolor* L.)

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A B S T R A C T

A field experiment was conducted during the *Kharif* seasons of 2017 to 2019 in heavy black soils of Main Sorghum Research Station, Navsari Agricultural University, Surat (Gujarat), to evaluate the effect of different weed management practices in rainfed *kharif* grain sorghum (*Sorghum bicolor* L.) with pre and post emergence herbicides (Atrazine, Halosulphuron methyl and 2, 4-D) alone or combination of these herbicide followed by hand weeding and interculturing. Weed-free treatment (T_2 : Two HW at 25 and 50 DAS + 1 IC at 50 DAS) recorded the highest plant height (233.9 cm) at harvest, highest panicle length (33.3 cm), maximum grain (3627 kg/ha) and stover (13910 kg/ha) yields in pooled results of three years which were followed by treatment T_8 (1.5 kg/ha (PE) + one HW at 40 DAS) and totally chemical control treatment T_6 (Atrazine 1.5 kg/ha (PE) + 2 4 D 1.0 kg/ha (amine) at 40 DAS). Among the weed control treatments, maximum net returns of ` 81,855/ha was recorded under weed free treatment followed by ` 79,520/ha with treatment atrazine 1.5 kg/ha (PE) + one HW at 40 DAS) while the highest B: C ratio 2.35 was obtained from the treatment T_6 (Atrazine 1.5 kg/ha (PE) + 2 4 D 1.0 kg/ha (amine) at 40 DAS).

Introduction

Grain sorghum [*Sorghum bicolor* (L.) Moench], an important cereal crop of semi-arid tropical regions of India is traditionally grown for food, animal feed and fodder; but is also used as an industrial feedstock, and for bio fuels. In Gujarat, sorghum occupies about 0.14 million ha area and annual production of 0.19 million tonnes with the productivity of 1.35 t/ha (Anon. 2016). Weeds are a major deterrent in increasing the sorghum productivity, especially during rainy season. It was reported that yield loss of sorghum due to weeds ranges from 15-97%, depending on the nature and density of weeds (Thakur *et al.*, 2016).

Chemical method of weed control has become efficient, time saving and cheaper with the introduction of herbicides. Use of pre-emergence herbicides assumes greater

importance in the view of their effectiveness from initial stages, while post emergence herbicides may help in avoiding the problem of weeds at later stages. Chemical weed control is a better supplement to conventional method however the weed emergence pattern, application timing and stage of crop are important in chemical control. Continuous use of herbicides over a prolonged time leads to development of resistance in weeds making them difficult to control. Traditional hand weeding is the most efficient and widely adopted practice of weed management but it is labour intensive, time consuming and not economical due to high wage rates. Mechanical equipment can be time saving during peak operation, resulting in higher output per worker and reduction in the cost of weeding. However, neither herbicides nor mechanical methods are adequate for consistent and acceptable weed control. The integration of herbicide with some cultural operations or use of pre-emergence and post emergence herbicides in combination with mechanical methods can be more successful (Ishya *et al.,* 2007). The integration of herbicides with some cultural and mechanical methods can provide effective weed control. The integrated weed management is gaining importance for preventing yield losses and achieving higher input use efficiency (Ishaya *et al.,* 2007). Hence, present experiment was carried out to study the effect of integrated weed management practices on growth, yield and economics of *kharif* grain sorghum.

Materials and Methods

The experiment was conducted at Main Sorghum Research Station, Navsari Agricultural University, Surat during *kharif* seasons of the year 2017, 2018 and 2019 under South Gujarat Agro climatic zone - II. Main Sorghum Research Station is located on southern part of Gujarat state and geographically located 20^{o}-12' N latitude and 72^{o}-52' E longitude with an altitude of 12.0 meters above mean sea level. The soil of the experimental field was heavy black which represents the typical black cotton soils of South Gujarat and medium in organic carbon (0.36 to 0.40%) and available nitrogen (159 kg/ha), medium in available phosphorus (31-35 kg/ha) and high in available potash (550-650 kg/ha). The soil has flat topography and characterized by medium to poor drainage with good water holding capacity. The soil was slightly alkaline (pH 7.7) with normal electric conductivity (0.34 dS/m). Ten treatments comprising of weed management practices *viz.,* T_1: Weedy check; T_2: Weed free (HW at 25 and 50 DAS + one interculturing at 50 DAS); $T_{3:}$ Atrazine 1.5 kg/ha (PE); T_4: 2,4-D 1.0 kg/ha (amine) at 20 DAS; T_5: Halosulphuron methyl 100 g at 20 DAS; T_6: Atrazine 1.5 kg/ha (PE) + 2, 4 D 1.0 kg/ha (amine) at 40 DAS; $T_{7:}$ Atrazine 1.5 kg/ha (PE) + Halosulphuron methyl 100gm/ha at 40 DAS; T_8: Atrazine 1.5 kg/ha (PE) + one HW at 40 DAS; T_9: 2,4-D 1.0 kg/ha (amine) 20 DAS + one HW at 40 DAS and T_{10}: Halosulphuron methyl 100g/ha at 20 DAS + one HW at 40 DAS were evaluated in randomized block design with three replications. The improved and popular cultivar *i.e.* GJN 1 of sorghum was used for cultivation. The crop was harvested manually with the help of sickle when seed almost matured and stover had turned yellow. The sun dried bundles were threshed and winnowed and seed so obtained were weighed and data on seed and stover yields were recorded. The economics of the treatments was carried out on the basis of prevailing market prices of inputs and outputs. The benefit: cost ratio was calculated by dividing the net returns with cost of cultivation. The statistical analysis of data was done using analysis of variance (ANOVA) technique at 0.05 probability level (Gomez and Gomez, 2010).

Results and Discussion

The major weed species observed in the experimental plot were monocot weeds like *Echinocloa colonum, Dactyloctenium aegyptium, Commelina benghalensis;* dicot weeds like *Alternanthera sessilis Hibiscus spp., Digera arvensis, Abutilon indicum, Physalis minima, Portulaca oleracea*

Amaranthus spinosus, Phyllanthus niruri, Trianthema portulacastrum, Euphorbia hirta, Eclipta alba; and sedges *Cyperus rotundus.*

Effect on crop

A perusal of data presented in Table- 1 indicated that plant population after thinning and at harvest were not affected significantly due to various weed management treatments in pooled results. The minimum number of days to 50% flowering and days to maturity were registered under treatment (T_1) weedy check while Weed-free treatment (T_2: HW 25 and 50 DAS + 1 IC 50 DAS) recorded the highest plant height (233.9 cm) at harvest and highest panicle length (33.3 cm) in pooled results of three years.

Table.1 Effect of different weed management practices on growth and yield attributes of *kharif* grain Sorghum (Pooled of three years)

Treatments	Plant population		Days to 50% flowering	Days to maturity	Plant height at harvest (cm)	Panicle length (cm)
	Initial	Final				
T_1: Weedy check	147393	146570	73	113	193.7	27.6
T_2: Weed free (HW 25 and 50 DAS + 1 IC 50 DAS)	146981	146501	75	115	233.9	33.3
T_3: Atrazine (PE)	146913	147530	74	114	216.4	30.6
T_4: 2,4-D (amine) at 20 DAS	145815	144581	81	121	221.8	29.3
T_5: Halosulphuron methyl 100 g at 20 DAS	148284	146089	76	116	216.4	28.6
T_6: Atrazine (PE) + 2, 4- D 1.0 kg/ha 40 DAS	147461	146775	76	116	221.8	31.4
T_7: Atrazine (PE) + Halosulphuron 100g/ha 40 DAS	146912	145541	74	114	217.7	30.2
T_8: Atrazine (PE) + one HW at 40 DAS	148147	147393	74	114	224.3	31.4
T_9: 2,4-D (amine) 20 DAS + one HW at 40 DAS	146844	146090	79	119	214.6	29.8
T_{10}: Halosulphuron methyl at 20 DAS + 1 HW at 40 DAS	147461	146227	76	116	213.2	29.4
S.Em.±	1130	1044	1.0	0.71	2.79	0.71
CD @ 5%	NS	NS	2.0	1.99	7.86	1.99

DAS- Days after sowing, HW- Hand weeding; IC – Interculturing; PE- Pre-emergence; PoE- Post-emergence
Rate of application: Atrazine 1.5 kg/ha; Halosulphuron methyl 100gm/ha; 2,4-D (amine) 1.0 kg/ha

Table.2 Effect of different weed management practices on growth attributes of *kharif* grain Sorghum (Pooled of three years)

Treatments	Grain yield (Kg/ha)	Stover yield (Kg/ha)	Harvest index (%)	Net Return (Rs./ha)	B:C ratio
T_1: Weedy check	1486	6296	18	21,491	0.72
T_2: Weed free (HW 25 and 50 DAS + 1 IC 50 DAS)	3627	13910	22	81,855	2.20
T_3: Atrazine (PE)	2865	11111	21	63,984	2.09
T_4: 2,4-D (amine) at 20 DAS	2680	10370	21	57,932	1.90
T_5: Halosulphuron methyl 100 g at 20 DAS	2439	9198	22	43,777	1.23
T_6: Atrazine (PE) + 2, 4- D 1.0 kg/ha 40 DAS	3174	12387	21	73,745	2.35
T_7: Atrazine (PE) + Halosulphuron 100g/ha 40 DAS	2677	10597	21	49,038	1.22
T_8: Atrazine (PE) + one HW at 40 DAS	3441	13375	21	79,520	2.33
T_9: 2,4-D (amine) 20 DAS + one HW at 40 DAS	2748	10720	21	56,922	1.67
T_{10}: Halosulphuron methyl at 20 DAS + 1 HW at 40 DAS	2727	10844	21	51,801	1.32
S.Em.±	56	307	0.3	-	-
CD @ 5%	159	866	0.9	-	-

DAS- Days after sowing, HW- Hand weeding; IC – Interculturing; PE- Pre-emergence; PoE- Post-emergence
Rate of application: Atrazine 1.5 kg/ha; Halosulphuron methyl 100gm/ha; 2,4-D (amine) 1.0 kg/ha

The data furnished in Table-2 indicated that significantly the maximum grain yield, stover yield and harvest index were recorded with the treatment T_2 (two HW at 25 and 50 DAS + one interculturing at 50 DAS) in pooled results which were followed by treatment T_8 (1.5 kg/ha (PE) + one HW at 40 DAS) and totally chemical control treatment T_6 (Atrazine 1.5 kg/ha (PE) + 2 4 D 1.0 kg/ha (amine) at 40 DAS). All weed management practices significantly enhanced seed yield over weedy check. The lowest values of growth and yield attributes and yield were recorded in weedy check. These results were in close conformity with those reported by Singh *et al.,* (1994), Yadav *et al.,* (2014) and Tiwari *et al.,* (2014).

This might be due to minimizing the competition of weeds with crop for resources, *viz*. space, light, nutrients and moisture with adoption of effective weed control methods. Thus, reduced crop-weed competition resulted in overall improvement in crop growth as reflected by increase in plant height, panicle length, grain and stover yield. Increase in seed yield might be due to the direct influence of various weed management treatments on the suppression of weeds.

Economics

Maximum net returns of ` 81,855/ha were obtained with weed-free treatment, followed by ` 79,520/ha with treatment atrazine 1.5 kg/ha (PE) + one HW at 40 DAS) while the highest B:C ratio 2.35 was obtained from the treatment T_6 (Atrazine 1.5 kg/ha (PE) + 2 4 D 1.0 kg/ha (amine) at 40 DAS) followed by T_8 (Atrazine 1.5 kg/ha (PE) + one HW at 40 DAS) with the B:C ratio of 2.33.

It was concluded that pre-emergence application of atrazine @ 1.5 kg/ha followed by one hand weeding at 40 DAS appeared to be the best integrated weed management practice for *kharif* grain sorghum sown in heavy black soils of south Gujarat region but

in case of availability of plenty labour two hand weeding at 25 and 50 DAS followed by one interculturing at 50 DAS should be adopted for better weed management in *kharif* grain sorghum.

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