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Effect of Chemical Weed Management on Growth and Yield Attributes of *Kharif* Sorghum (*Sorghum bicolor* L.)

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A B S T R A C T

Effect of chemical weed management on growth and yield of *kharif* sorghum was studied in sandy soil in the experimental farm of Lovely Professional University, Phagwara during 2017. The experiment was laid out in Randomized Complete Block Design with seven treatments and three replications. Among the all treatments one is control, one treatment comprises of pre- emergence herbicide only (Pendimethalin), one treatment comprises of post-emergence herbicides only with the combination of Atrazine and Tembotrione, the rest four treatments comprise of herbicides (both pre and post-emergence) combination of 2,4-D, Atrazine, Pendimathalin, Tembotrione in different doses. The treatment in which Pendimethalin @ 1L a.i. per ha (PRE) fb 2,4-D @ 0.87 L a.i. per ha (POST) + Atrazine @ 0.63 kg per ha (POST) were used, showed the significant impact on the growth and yield attributes of sorghum. The plants of this treatment showed significantly higher plant height, leaf area index, panicle length and grain yield as compared to the other treatments of the experiment.

Introduction

Sorghum (*Sorghum bicolor* L.) is the most important cereal crop in world after wheat (*Triticum aestivum*), rice (*Oryza sativa*), maize (*Zea mays*) and barley (*Hordeum vulgare* (L). Sorghum has multiple uses as grain, fodder and bio energy crop. Sorghum is also known as Jowar, Indian millet or Great millet. Sorghum plants can grow under low water conditions and high temperature (Laidlaw *et al.*, 2009). One of major problems in limiting the production of kharif sorghum are weeds. Weed competition in grain sorghum reduces yields, causes harvesting losses and increases seed content of the soil seed bank. Weed infestations in the early growing season will reduce yields significantly. Loss of yield due to weeds depends upon weed infestation, intensity of weeds and environmental conditions (Knezevic *et al.*, 2002; Tomado *et al.*, 2002).

There are various methods to control the weeds i.e. cultural, mechanical, chemical, biological and others. The method is adopted according to effectiveness and economics.

Application of method over a given area is based upon its effectiveness, economics and climatic conditions of that area. Sometimes if one method is not effective, another can. Hand weeding is most effective and widely adopted practice but it is labour and time consuming. In condition when labour is not available, it will not be effective. Mechanical equipment can be time saving during peak operation. Cultural practices are more effective before sowing of crop. In standing crop, these are difficult to perform. The use of herbicides lead to quick result and time consuming. Chemical method can be better supplement to conventional method however the weed emergence pattern and application time is important. As traditional methods may sometimes uneconomical, labourious and impossible. Hence chemicals can be used, but continous use of herbicides over a prolonged time lead to development of resistance in weeds making them difficult to control and also toxic for soil having residual effect also. Control of weeds with chemical method is an important factor because sorghum grow slowly in early stages. Yield losses can be minimum if weeds are controlled within first four weeks after crop emergence (Moore *et al.,* 2004). At present, high yielding agriculture greatly depends on a range of herbicides as they play a vital role in weed management practices (Rao 2000; Baghestani 2005). Weed management stands out as one of the limiting production factor due to slow initial growth of sorghum and scarcity of herbicides registered for use (Silva *et al.,* 2014a). In world's agriculture Atrazine is the most widely used herbicide (Alvi *et al.,* 2003). The active ingredient atrazine is one of the few herbicides registered for use in sorghum (Almeida 2011).

Materials and Methods

Location of experimental site

Field experiment was carried out in 2017. The experiment conducted on agriculture research farm, Lovely Professional University, Phagwara (Punjab). 252 metres from sea level located at Jalandhar-Delhi GT road. Latitude of site is 31° 15' N with longitude of 75° 41' E.

The soil was sandy loam with pH 7.25. The available N, P and K content of soil were 276, 18.4 and 290 kg ha- 1, respectively with Electrical conductivity 0.31 (dSm- 1).

Experimental details

Seven treatments were used and each treatment replicates three times**.** The design used was Randomized Complete Block Design (RCBD) and the herbicides used were – Atrazine (PRE & POST), Pendimethalin (PRE), 2,4-D (POST), Tembotrione (POST). Table 1 show the detail of treatments.

Agronomic practices

Variety of sorghum named sugargraze was used for this experiment. Seeds were sown on 14th July, 2017 followed by seed rate @ 10-12 kg/ha and the sowing was done on the ridges.

Depth of sowing was approximately 4-6 cm. Full dose of P_2O_5 and K_2O with half dose of N were applied as a basal dose and the remaining dose of N was applied in split doses at different critical stages of growth.

Data collection

The growth attributes (plant height & leaf area index) and yield attributes (panicle length & grain yield) were taken at 90 days after sowing.

Statistical analysis

Data were analyzed by Duncan's Multiple Range Tests (DMRT) for separation of means with a probability p< 0.05. Difference between mean values were evaluated by Analysis of Variance (ANOVA) using the software SPSS 16.

Results and Discussion

Growth attributes

Plant height (cm)

The range of plant height at 90 DAS varied from194.90 to 261.74cm. The highest plant height was recorded 261.74cm for T4 (Pendimethalin @1L a.i. per ha (PRE) fb 2,4-D @0.87 L a.i. per ha (POST)+ Atrazine @0.63 kg a.i. per ha (POST) at 35 DAS) followed by T2 (Atrazine @0.93kg a.i. per ha (PRE) fb Atrazine @0.63kg a.i. per ha (POST) at 35 DAS) i.e. 261.46cm and lowest value was recorded for T0 (control) as compared T0, T4 showed 34.29% increase in plant height. This may be due to that atrazine and pendimethalin when used in combination lower the population of broad leaf weeds and grasses, application of these herbicides improve growth parameters of crops.

Hence, plant height was highest. The result is similar with Kaushik *et al.*, (2005).

Leaf Area Index

The range of leaf area index at 90 DAS varied from 220.70 to 255.10. The highest value was recorded for leaf area index was for T4 (Pendimethalin @1L a.i. per ha (PRE) fb 2,4-D @0.87 L a.i. per ha (POST) + Atrazine @0.63 kg a.i. per ha (POST) at 35 DAS) followed by T2 (Atrazine @0.93kg a.i. per ha (PRE) fb Atrazine @0.63kg a.i. per ha (POST) at 35 DAS) and lowest value was recorded for T0 (control), as compared with T0, T4 showed 15.59% increase in leaf area index. This may be due to better control of weeds in early as well as later growth stages by using pre and post emergence herbicides. This result is similar with the findings of Kannur (2008).

Table.1 Treatments detail

T0: Control
T1: Atrazine @0.63kg a.i. per ha (PRE) fb 2,4-D @0.87 L a.i. per ha (POST) at 35 DAS.
T2: Atrazine @0.93kg a.i. per ha (PRE) fb Atrazine @0.63kg a.i. per ha (POST) at 35 DAS.
T3: Pendimethalin @2 L a.i. per ha (PRE) only
T4: Pendimethalin @1L a.i. per ha (PRE) fb 2,4-D @0.87 L a.i. per ha (POST)+ Atrazine @0.63 kg a.i. per ha (POST) at 35 DAS.
T5: Pendimethalin @1.5 L a.i. per ha (PRE) fb Tembotrione @0.63 L a.i. per ha (POST) + 2,4-D @0.87 L a.i. per ha (POST) at 35 DAS.
T6: Tembotrione @1.25 L a.i. per ha (POST) + Atrazine @0.63 kg a.i. per ha (POST) only at 35 DAS

Note: (PRE = Pre emergence herbicide, POST = Post emergence herbicide, DAS = Days after sowing, fb = followed by, a.i = active ingredient)

Table.2 Effect of chemical weed management on growth attributes of sorghum

Treatments	Plant height (cm)	Leaf area index
T0	$194.90^{c} \pm 2.96$	$220.70^{e} \pm 1.15$
T1	$257.86^{ab} \pm 13.77$	$230.43^{cd} \pm 0.93$
T2	$261.46^{a} \pm 0.95$	$242.27^{b} \pm 0.96$
T3	$239.37^{b} \pm 3.32$	$222.23^{e} \pm 0.77$
T4	$261.74^{a} \pm 0.96$	$255.10^{a} \pm 1.71$
T5	$255.99^{ab} \pm 2.10$	$232.93^{c} \pm 1.39$
T6	$255.86^{ab} \pm 5.94$	$228.27^{d} \pm 1.54$

The mean followed by different letters are significantly different at p < 0.05, according to DMRT (Dun can's Multiple Range Test) for separation of means.

Note-T0: Control, T1: Atrazine @0.63kg a.i. per ha (PRE) fb 2,4-D @0.87 L a.i. per ha (POST) at 35 DAS, T2: Atrazine @0.93kg a.i. per ha (PRE)fb Atrazine @0.63kg a.i. per ha (POST) at 35 DAS, T3: Pendimethalin @2 L a.i. per ha (PRE) only,T4: Pendimethalin @1L a.i. per ha (PRE) fb 2,4-D @0.87 L a.i. per ha (POST)+ Atrazine @0.63 kg a.i. per ha (POST) at 35 DAS, T5: Pendimethalin @1.5 L a.i. per ha (PRE) fb Tembotrione @0.63 L a.i. per ha (POST) + 2,4-D @0.87 L a.i. per ha (POST) at 35 DAS,T6: Tembotrione @1.25 L a.i. per ha (POST) + Atrazine @0.63 kg a.i.per ha (POST) only at 35 DAS

Table.3 Effect of chemical weed management on yield attributes of sorghum

Treatments	Panicle length (cm)	Grain yield (q ha^{-1})
T0	$23.83^{d} \pm 1.44$	$21.06^{e} \pm 0.25$
T1	$33.11^{bc} \pm 0.43$	$45.16^{c} \pm 0.84$
T2	$35.53^{b} \pm 1.38$	$53.50^{b} \pm 0.76$
T3	$31.10^{c} \pm 0.37$	$45.33^{c} \pm 1.06$
T4	$39.99^{a} \pm 0.60$	$59.35^{a} \pm 1.09$
T5	$32.28^{bc} \pm 0.73$	$41.76^{d} \pm 0.32$
T6	$33.48^{bc} \pm 0.76$	$44.91^{c} \pm 0.96$

The mean followed by different letters are significantly different at p < 0.05, according to DMRT (Dun can's Multiple Range Test) for separation of means.

NOTE-T0: Control, T1: Atrazine @0.63kg a.i. per ha (PRE) fb 2,4-D @0.87 L a.i. per ha (POST) at 35 DAS, T2: Atrazine @0.93kg a.i. per ha (PRE)fb Atrazine @0.63kg a.i. per ha (POST) at 35 DAS, T3: Pendimethalin @2 L a.i. per ha (PRE) only,T4: Pendimethalin @1L a.i. per ha (PRE) fb 2,4-D @0.87 L a.i. per ha (POST)+ Atrazine @0.63 kg a.i. per ha (POST) at 35 DAS, T5: Pendimethalin @1.5 L a.i. per ha (PRE) fb Tembotrione @0.63 L a.i. per ha (POST) + 2,4-D @0.87 L a.i. per ha (POST) at 35 DAS,T6: Tembotrione @1.25 L a.i. per ha (POST) + Atrazine @0.63 kg a.i.per ha (POST) only at 35 DAS

Yield attributes

Panicle length (cm)

The range of panicle length varied from 23.83 to 39.99 cm. The highest value for panicle length was 39.99 cm was recorded for T4 (Pendimethalin @1L a.i. per ha (PRE) fb 2,4-D @0.87 L a.i. per ha (POST)+ Atrazine @0.63 kg a.i. per ha (POST) at 35 DAS) followed by T2 (Atrazine @0.93kg a.i. per ha (PRE) fb Atrazine @0.63kg a.i. per ha (POST) at 35 DAS) i.e. 35.53 cm and the lowest value for panicle length was recorded for T0 (control) as compared to T0, T4 showed 67.81% increase in panicle length. This is may be due to this treatment has better growth characters due to controlled weeds at early as well as later stages i.e. less competition of crop and weeds for space, sunlight and nutrients. The result is similar with findings of Kolage *et al.,* (2004).

Grain yield (q ha^{-1})

The range of grain weight varied from 21.06 to 59.35 kg/ha. The highest value for grain yield was 59.35 kg/ha was recorded for T4 (Pendimethalin @1L a.i. per ha (PRE) fb 2,4-D @0.87 L a.i. per ha (POST)+ Atrazine @0.63 kg a.i. per ha (POST) at 35 DAS) followed by T2 (Atrazine @0.93kg a.i. per ha (PRE) fb Atrazine @0.63kg a.i. per ha (POST) at 35 DAS) i.e. 53.50 kg/ha and the lowest value was recorded for T0 (control) as compared to T0, T4 showed 181.81% increase in grain yield. This might be due to its better parameters of growth and yield. The result is conformity with the findings of Kannur (2008).

Based on present study it was concluded that the weed management with the use of herbicides significantly improves the growth of sorghum plants as well as yield of the crop. It plays a key role in sustainable agriculture. Its result is quick and can be easily performed in standing crop.

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