Short communication

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Evaluation of new herbicides for weed control and crop safety in rainy season sorghum

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Sorghum (*Sorghum bicolor* (L.) Moench) is a staple cereal grown during both rainy (*Kharif*) and post-rainy (*Rabi*) seasons in the semi-arid and arid parts of India on marginal and least fertile soils where only few other crop can survive. Weeds are a major deterrent in increasing the sorghum productivity, especially during rainy season due to wider row spacing, slow initial crop growth rate, and congenial weather conditions for weed growth. Sorghum is mostly grown in rainfed areas, where soil moisture and nutrients are the most limiting factors. Weeds compete with sorghum for light, soil moisture and nutrients (Burnside and Wicks 1969, Smith *et al*. 1990) and reduce the grain yield by 15 to 83% depending on crop cultivars, nature and intensity of weeds, spacing, duration of weed infestation and environmental conditions (Mishra 1997, Stahlman and Wicks 2000). Therefore, appropriate weed management would help to improve sorghum productivity and input use-efficiency. Presently atrazine as pre-emergence is the most widely used herbicide for weed control in grain sorghum. However, as sorghum is grown in moisture stress conditions, lack of soil moisture may decrease the efficacy of pre-emergence herbicides. There is no effective post-emergence herbicide for broad-spectrum weed control in sorghum. The present experiment was therefore conducted to evaluate new herbicides for weed control and crop safety in grain sorghum.

A field experiment was conducted during rainy season of 2009 at the Directorate of Sorghum Research, Rajendranagar, Hyderabad (AP) consisting of ten treatments in a randomized block design with three replications (Table 1). The soil was sandy loam in texture, low in organic carbon, available nitrogen and phosphorus and medium in potassium content with pH 7.8. The crop (*cv. CSH 23*) was sown in rows at 60 x 15 cm apart on 8 July 2009. The crop was fertilized with 80 kg N and 40 kg P_2O_5 and 40 kg K_2O/ha. Entire dose of phosphorus and potassium and half dose of nitrogen were applied as basal and remaining half dose of nitrogen was side dressed at 30 days after sowing (DAS). Herbicides, as per treatments, were applied in 500 l/ha spray volume with Knapsack sprayer fitted with flat-fan nozzle. Pre-emergence herbicides were applied next day after sowing and post-emergence herbicides at 25 DAS. In weed free check, weeds were removed manually twice at 20 and 45 DAS. Weed density (species-wise) and total weed dry matter were recorded at harvest from $1m^2$ area by placing a 50- by 50-cm quadrate randomly at four places in each plot. The oven-dried samples of weeds at harvest were analysed for nutrient content. Nitrogen was estimated by Micro-kjeldahl method, phosphorus by vanado-molybdo phosphoric method in nitric acid system and potassium with flame photometry (Jackson 1967). The nutrient depletion was determined by multiplying the per cent nutrient content in the plant with their respective dry weights at harvest. The data on weeds were subjected to square root transformation before statistical analysis.

The field was infested mainly with broad-leaved weeds (66.6%) (*Parthenium hysterophorus* (24.7%), *Tribulus terrestris* (11.9%), *Euphorbia hirta* (8.77%), *Digera arvensis* (7.15%), *Corchorus olitorius* (6.1%), and others (*Amaranthus viridis, Ageratum conyzoides, Trianthema portulacastrum, Alternanthera sessilis, E. geniculata, Cleome viscosa, Achyrantheus aspera, Cyanotis axillaris,* (7.72%), followed by grasses (27.8%) (*Brachiaria ramosa, Chloris barbata, Dactyloctenium aegyptium* (15.07%), *Digitaria sanguinalis* (9.06%), and others (*Echinochloa colona, Dinebra retroflexa, Panicum repens* (3.57%) and sedges (5.6%) (*Cyperus rotundus*). Application of herbicides reduced the weed population but all the post-emergence herbicides and oxyfluorefen (pre-emergence) caused severe phytotoxicity on sorghum resulting in poor crop yields (Table 1). Post-emergence herbicides *viz.*, Atlantis (mesosulfuron+idosulfuron), Almix (chlorimuron+metsulfuron) and Total (sulfosulfuron + metsulfuron) caused complete mortality of sorghum plants. In absence of competition from crop, weeds grew profusely and accumulated higher dry matter even more than that of weedy check. Infestation of weeds throughout

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Table 1. Effect of herbicides on weeds, nutrient depletion and grain yield of sorghum

Treatment	Dose (g/ha)	Time of application	Weed population at harvest (no./m^2)*				Total weed dry weight (g/m^2)	Grain yield (kg/ha)	Nutrients depletion by weeds (kg/ha)		
			Broad-leaf	Grasses	Sedges	Total			N	P	K
Atrazine	500	Pre-em.	7.24 (51.9)	5.82 (33.4)	1.29 (1.16)	9.24 (85)	123	2390	15.13	3.08	15.72
Pendimethalin	500	Pre-em.	8.24 (67.4)	1.47 (1.7)	2.64 (6.5)	8.72 (76)	192	2053	29.57	6.14	29.11
Oxyfluorefen	200	Pre-em.	4.80 (22.5)	1.18 (0.89)	6.84 (46.3)	8.06 (64)	77	521	10.55	2.31	9.67
Metsulfuron methyl	4	Post-em.	3.72 (13.6)	8.22 (67.1)	1.29 (1.2)	9.18 (84)	405	834	71.28	15.79	64.31
Carfentrazone	20	Post-em.	4.27 (17.7)	8.07 (64.6)	1.65 (2.2)	9.28 (80)	349	764	53.75	12.56	57.01
Atlantis (mesulfuron + idosulfuron)	400	Post-em.	5.44 (29.1)	7.59 (57.1)	0.71 (0)	9.36 (87)	320	0	33.28	9.92	46.98
Almix (chlorimuron + metsulfuron)	20	Post-em.	2.18 (4.2)	8.83 (75.5)	1.00 (0.5)	9.23 (85)	349	0	53.75	11.17	52.63
Sulfosulfuron + metsulfuron	40	Post-em.	1.44 (1.6)	8.29(68.2)	1.58 (2.0)	8.55 (73)	184	0	22.63	4.60	19.54
Weed free check	-	-	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0	2924	0	0	0
Weedy check	-	-	7.57 (57.1)	6.95 (47.8)	1.65 (2.2)	10.35(107)	243	1458	31.59	6.56	30.38
LSD (P=0.05)			1.66	1.46	1.03	2.29	83	683	6.3	3.8	8.4

*Data subjected to square root transformation ($\sqrt{x+0.5}$). Values in parentheses are original
Pre-em.=Pre-emergence (1 DAS); Post-em.=Post-emergence (25 DAS); DAS=Days after sowing

the crop growth period caused 50% reduction in grain yield of sorghum. Atrazine and pendimethalin each at 0.50 kg/ha applied as pre-emergence were found safe to crop and resulted in good weed control and higher grain yield (2390 and 2053 kg/ha, respectively). Pendimethalin was very effective against grassy weeds, resulting in dominance of broad-leaved weeds like *P. hysterophorus, T. terrestris, Euphorbia* spp. and *C. olitorius*. Metsulfuron methyl, Almix (chlorimuron+metsulfuron) and Total (sulfosulfuron+metsulfuron) provided good control of broad-leaved weeds but these herbicides were not effective against grasses. Vigorous growth of *D. aegyptitium* and *D. sanguinalis* suppressed other weeds in weedy check. Application of herbicides significantly influenced the nutrient removal by weeds. Pre-emergence application of atrazine, pendimethalin and oxyfluorfen significantly reduced the nutrient depletion by weeds as compared to weedy check (Table 1), mainly due to reduction in weed dry matter accumulation of weeds. Application of post-emergence herbicides caused greater depletion of nutrients from soil due to vigorous weed growth in absence of crop. Satao and Nalamwar (1993) also reported that uncontrolled weeds in sorghum depleted 29.94-51.05, 5.03-11.58 and 48.74-74.34 kg/ha NPK, respectively from soil. The findings gave an indication that newly developed post-emergence herbicides recommended in other cereal crops are not safe for sorghum crop and hence screening of more new herbicides is required.

SUMMARY

A field experiment was conducted during rainy season of 2009 at the Directorate of Sorghum Research, Hyderabad to evaluate the efficacy of new herbicide molecules in grain sorghum. The experimental field was dominated with broad-leaved weeds (66.6%) followed by grasses (27.8%) and sedges (5.6%). Infestation of weeds caused 50% reduction in grain yield of sorghum. Application of oxyfluorefen as pre-emergence, and metsulfuron methyl, carfentrazone, atlantis (mesosulfuron+idosulfuron), almix (chlorimuron+metsulfuron) and total (sulfosulfuron +metsulfuron) as post-emergence caused mild to severe phytotoxicity on grain sorghum resulting in poor yields. This showed that newly developed post-emergence herbicides recommended in other grain crops are not safe for sorghum and therefore, screening of more number of new herbicides is required.

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