



## Herbicide tolerance of *Rabi* sorghum varieties and germplasm

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Sorghum (*Sorghum bicolor* (L.) Moench) is a staple cereal grown under moisture stress conditions with low inputs during rainy and post-rainy (*Rabi*) seasons. With the threat of climate change looming large on the crop productivity, sorghum being a drought hardy crop will play an important role in food, feed and fodder security in dry land economy. Weeds are a major deterrent in increasing the sorghum productivity as they compete with crop for soil moisture and nutrients, which are the major limiting factors in semi-arid areas. Therefore, efficient weed management becomes even more important under rainfed conditions. Atrazine (as pre-emergence) is the most widely used herbicide for weed control in grain sorghum. It has a low effectiveness on grasses (Dan *et al.* 2011) and its efficacy decreases under moisture stress conditions (Tapia *et al.* 1997). Atrazine may also cause carry over effects in subsequent sensitive crops under some conditions, so alternative treatments are needed (Ishaya *et al.* 2007, Keeling *et al.* 2013). Sensitivity of grain sorghum to currently available post-emergence herbicides is one of the major concerns to manage weeds that emerge after crop establishment (Archangelo *et al.* 2002). Presently, 2,4-D is the only post-emergence herbicide used to control broad-leaved weeds with varying degree of weed control and sensitivity in sorghum hybrids. Herbicide-tolerant crops make it possible to control weeds with non-selective herbicides. ALS-inhibitor herbicides *viz.*, nicosulfuron and nimsulfuron are widely used to control broad-leaf and grassy weeds in corn (*Zea mays*), but the sorghum is susceptible to these herbicides. However, by transferring a major resistance gene from wild sorghum relative, researchers at Kansas State University (KSU), USA developed a grain sorghum that is resistant to several ALS-inhibiting herbicides as Steadfast (nicosul-

furon), Accent (nicosulfuron), Resolve (rimsulfuron) and Ally (metsulfuron) (Tuinstra and Al-Khatib 2007, Tuinstra *et al.* 2009). Keeping these facts in view, the present experiment was conducted to evaluate the relative performance of *Rabi* sorghum germplasm and varieties to quizalofop ethyl, metsulfuron-methyl and carfentrazone-ethyl herbicides.

A field experiment was conducted during *Rabi* 2010-11 at the Indian Institute of Millets Research, Hyderabad (Telangana) to screen the *Rabi* sorghum germplasm and varieties tolerant to quizalofop-ethyl, metsulfuron-methyl and carfentrazone-ethyl herbicides. The climate of the area is semi-arid and tropical, with an average annual rainfall of 618 mm (75-80% of which is received during June-September), minimum temperature of 8-10 °C in December, and maximum temperature of 40-42 °C in May. The soil was an Alfisol, Udic Rhodustalf, sandy loam (66% sand, 13% silt and 21% clay), with 7.82 pH, 0.18 dS/m electrical conductivity, low in available N (143 kg/ha) and phosphorus (19 kg P<sub>2</sub>O<sub>5</sub>/ha) and medium in potassium (260 kg K<sub>2</sub>O/ha) content. Sixty three germplasm (*PEC 2, PEC 5, PEC 7, PEC 15, PEC 22, PEC 26, EP 1, EP 9, EP 11, EP 12, EP 13, EP 14, EP 16, EP 17, EP 22, EP 24, EP 37, EP 41, EP 42, EP 45, EP 46, EP 52, EP 54, EP 55, EP 57, EP 59, EP 64, EP 65, EP 68, EP 78, EP 80, EP 81, EP 82, EP 84, EP 91, EP 92, EP 93, EP 94, EP 95, EP 97, EP 102, EP 103, EP 104, EP 105, EP 106, EP 107, EP 114, EP 115, EP 117, EP 120, EP 124, EP 127, EP 138, SEVS 2, SEVS 3, SEVS 20, EA 10, EA 11, EC 11, EC 12, EC 21, EC 33, EC 34*) collected from different agro-ecological regions of the country along with five *Rabi* sorghum cultivars (*DSV 6, M 35-1, CSV 216 R, Phule Chitra* and *Phule Maulee*) were evaluated for their relative tolerance to quizalofop-ethyl (40 g/ha), metsulfuron-methyl (4 g/ha), and carfentrazone-ethyl (20 g/ha). A control plot was also kept to compare the yield loss and herbicide injury. The experiment was conducted in micro-plots (1 m<sup>2</sup>) and replicated thrice in a strip-plot design. The crop was sown in rows at 45 cm apart on 17<sup>th</sup>

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November 2010. The herbicides were applied as post-emergence at 30 days after sowing (DAS) with knapsack sprayer fitted with flat-fan nozzles using spray volume of 500 liter water/ha. Fertilizer (60 kg N, 30 kg P<sub>2</sub>O<sub>5</sub> and 20 kg K<sub>2</sub>O/ha) was applied as recommended for Rabi grain sorghum in the area. All the phosphorus as single super phosphate and potassium as muriate of potash were applied as basal on the day of planting. Nitrogen as urea was applied in 2 splits, 50% at sowing and remaining at 35 DAS. The crop was raised under irrigated conditions and total three irrigations were applied during crop season. Sorghum panicles were manually harvested from 5 randomly selected plants in each plot, threshed, sun dried, weighed, and grain yield was adjusted to 14% moisture content. Weed count, for estimating weed density was recorded 20 days after herbicide application (50 DAS) with the help of a quadrat (0.50 x 0.50 m) placed in the centre of each plot. All the data were subjected to analysis of variance (ANOVA) by 'STATISTICS 8.1' software and the main effects and interactions were tested for significance. Treatment means obtained by ANOVA were compared using critical difference (LSD) at P=0.05 level of significance.

#### Effect on weeds

The field was infested mainly with *Parthenium hysterophorus* (43.36%), *Cyperus rotundus* (19.91%), *Celosia argentea* (20.38%), *Euphorbia geniculata* (12.42%) and others (*E. hirta* and *Digitaria sanguinalis*) (3.93%). Application of quizalofop-ethyl (40 g/ha) was found to be highly phytotoxic to the sorghum crop and resulted in to complete mortality of all the test genotypes and germplasm. None of the herbicides controlled *C. rotundus* (Table 1). Application of carfentrazone-ethyl (20 g/ha) being at par with metsulfuron-methyl (4 g/ha) significantly reduced the population of *E. geniculata* as compared to control. But carfentrazone-ethyl was less effective on *P. hysterophorus*. Application of metsulfuron-methyl at 4 g/ha significantly reduced the density of *P. hysterophorus* compared to control. Both the herbicides caused significant reduction in the population of *Celosia argentea*. Application of herbicides significantly brought down the population of total weeds as compared to control, but metsulfuron was superior in its efficacy than carfentrazone. Weed dry weight recorded at the harvest was however, not affected due to application of these herbicides. Different genotypes and germplasm had variable effects on various weeds. The lowest total weed density (23.56/m<sup>2</sup>) was recorded with 'EP 11' and the highest (62.44/m<sup>2</sup>)

with 'DSV 6'. Weed dry weight differed significantly with genotypes. Maximum weed dry weight at harvest (92.67 g/m<sup>2</sup>) was recorded with 'CSV 216R' and minimum (48.0 g/m<sup>2</sup>) with 'PEC 15'.

#### Effect on crop

Plant population did not vary significantly with application of herbicides (Table 2). Application of metsulfuron-methyl at 4 g/ha caused significant reduction in plant height (24.3 cm) as compared to carfentrazone-ethyl at 20 g/ha (38.42 cm) and control (39.08 cm). Similar trend in plant height was observed at harvest. Panicle length increased significantly due to metsulfuron-methyl (14.51 cm) as compared to control (14.0 cm), but 100-seed weight decreased. Stover yield decreased significantly due to application of metsulfuron-methyl as compared to control. Reduction in plant height and stover yield due to metsulfuron-methyl indicates its toxicity on sorghum germplasm/genotypes. Harvest index also decreased due to metsulfuron, but the differences were not significant. Among genotypes, significantly the highest plant population/m row length (9.0) was recorded with 'EP 14' and the lowest (3.22) with 'EC 33'. Plant height at 25 days after herbicide spray varied significantly and ranged from 16.28 cm with 'DSV 6' to 49.84 cm with 'EP 80'. However, at harvest, 'EA 11' recorded the maximum plant height (221 cm). Panicle length ranged from 8.73 cm with 'EC 34' to 26.47 cm with 'EA 11'. The other genotype with longer panicle length was 'EA 10' (24.11 cm). The 100-seed weight of 'EP 105', 'EA 11' and 'CSV 216 R' was quite low (1.87-1.97 g), whereas it was as high as 4.03 to 4.08 g in 'EP 93', 'EP 91', 'PEC 7', 'PEC 15', 'EP 117'. The lowest stover yield (76 g/m<sup>2</sup>) was recorded with 'DSV 6' mainly due to shorter plant height. The highest stover yield (461 g/m<sup>2</sup>) was recorded with 'EA 13' followed by 'EP 45' (437 g/m<sup>2</sup>). The harvest index varied from 7.38% with 'EP 45' to 38.4% with 'EC 11'.

Post-emergence application of metsulfuron-methyl at 4 g/ha caused significant reduction (32.77%) in grain yield of sorghum (67.36 g/m<sup>2</sup>) as compared to control (100.2 g/m<sup>2</sup>). This might be due to significant reduction in 100-seed weight (4.94%) and plant dry biomass (15.03%). The grain yield with carfentrazone-ethyl (95.51g/m<sup>2</sup>) was at par with control (Table 3). Among genotypes, 'EP 52' produced the highest (163.60 g/m<sup>2</sup>) and 'EP 107' the lowest (21.53 g/m<sup>2</sup>) grain yield. The herbicide tolerance of genotypes in terms of increased grain yield over control varied with different herbicides. Of the 68 genotypes evaluated, Phule Maulee, 'PEC 22',

**Table 1. Effect of herbicides and genotypes on weeds**

Treatment	Weed density (no./m <sup>2</sup> )					Total	Total weed dry weight (g/m <sup>2</sup> )
	<i>Cyperus rotundus</i>	<i>Euphorbia geniculata</i>	<i>Parthenium hysterophorus</i>	<i>Celosia argentea</i>	Others		
<i>Herbicide</i>							
Metsulfuron-methyl 4 g/ha	10.32	2.08	5.55	1.04	2.31	21.30	64.65
Carfentrazone-ethyl 20 g/ha	12.25	1.49	22.00	4.70	1.31	41.75	70.02
Control	8.75	5.22	27.43	13.06	4.85	59.31	65.14
LSD (P=0.05)	NS	3.54	9.67	3.50	NS	16.15	NS
<i>Genotypes</i>							
DSV 6	28.67	1.78	24.00	5.78	2.22	62.44	77.33
M 35-1	21.33	1.33	19.11	8.89	2.22	52.89	86.17
CSV 216R	18.22	1.33	16.44	3.11	2.67	41.78	92.67
Phule Chitra	10.67	3.56	27.56	6.67	4.44	52.89	74.33
P. Maulee	15.11	3.56	19.56	4.00	3.56	45.78	68.33
PEC 26	29.33	1.78	16.89	2.67	1.33	52.00	72.33
PEC 22	19.11	1.33	21.33	2.22	2.67	46.67	71.33
EP 95	20.00	4.44	28.00	8.00	1.78	62.22	66.67
EP 94	9.33	2.22	24.89	7.11	3.11	46.67	55.00
EP 93	5.33	2.67	26.67	7.56	1.78	44.00	59.33
EP 92	1.78	4.00	23.11	3.56	1.78	34.22	79.83
EP 91	4.44	1.78	23.56	7.56	2.67	40.00	73.67
SEVS 3	2.67	2.67	22.22	4.44	2.22	34.22	64.67
SEVS 2	10.22	1.78	30.67	5.33	2.22	50.22	77.67
EA 11	14.67	3.11	22.67	4.89	3.11	48.44	68.00
EA 10	12.44	3.56	25.33	7.56	4.00	52.89	75.00
SEVS 20	8.44	4.44	20.00	5.78	5.33	44.00	72.00
PEC 2	2.67	4.89	16.00	4.89	2.67	31.11	83.00
PEC 5	1.78	4.44	17.33	6.67	3.11	33.33	57.33
PEC 7	0.89	3.56	17.78	5.33	2.67	30.22	61.67
PEC 15	3.11	5.33	14.22	5.33	1.78	29.78	48.00
EP 97	0.00	7.56	16.44	3.11	0.89	28.00	64.33
EP 102	9.33	1.33	14.22	7.11	4.00	36.00	68.67
EP 105	6.67	3.56	18.67	4.00	2.22	35.11	69.17
EP 103	12.89	3.56	15.11	4.89	1.78	38.22	57.00
EP 104	13.33	3.11	12.22	2.22	1.33	34.22	68.00
EC 11	18.22	0.89	13.78	5.78	1.33	40.00	58.33
EC 12	12.00	1.78	12.44	6.22	2.22	34.67	63.67
EC 21	35.56	0.44	12.44	5.33	5.33	59.11	73.67
EC 33	31.11	3.11	8.00	6.22	3.11	51.56	62.67
EC 34	14.67	3.56	11.11	6.22	1.78	37.33	76.67
EP 120	12.89	1.33	19.56	4.89	1.78	40.44	88.67
EP 124	20.44	2.67	23.11	5.78	2.67	54.67	87.33
EP 127	24.44	0.89	20.89	5.78	2.67	54.67	74.33
EP 138	13.78	1.78	22.22	4.44	1.33	43.56	73.00
EP 117	11.56	2.22	27.11	6.67	2.67	50.22	67.00
EP 115	6.67	3.56	25.33	5.78	4.44	45.78	52.67
EP 114	6.22	5.33	21.78	8.89	2.67	44.89	65.33
EP 107	8.44	4.44	23.11	5.78	1.33	43.11	77.83
EP 106	12.44	3.56	22.67	4.89	3.56	47.11	77.67
EP 78	8.00	4.44	28.44	7.11	2.22	50.22	68.33
EP 68	5.33	2.67	25.78	4.89	2.22	40.89	79.50
EP 65	10.67	2.22	25.78	5.78	3.56	48.00	67.00
EP 64	9.78	6.22	26.22	5.78	4.89	52.89	82.17
EP 59	12.67	4.00	19.56	3.67	8.89	48.78	72.00
EP 84	1.33	3.56	19.56	3.56	4.00	32.00	64.33
EP 82	3.11	4.44	17.33	5.33	4.44	34.67	57.67
EP 81	3.56	8.89	18.67	8.44	4.44	44.00	57.67
EP 80	2.22	8.89	14.22	5.78	2.22	33.33	52.33
EP 52	2.67	6.22	15.56	5.33	2.67	32.44	49.33
EP 46	9.78	0.89	18.22	8.44	1.78	39.11	58.17
EP 57	6.22	3.11	15.11	7.11	2.22	33.78	55.00
EP 54	11.11	1.33	14.67	6.22	2.67	36.00	63.67
EP 55	10.67	1.33	10.22	4.00	1.33	27.56	59.33
EP 42	10.22	0.89	12.44	3.56	1.33	28.44	66.67
EP 24	7.11	0.44	14.22	4.89	0.44	27.11	56.00
EP 37	8.00	1.33	16.00	7.11	3.89	37.33	69.33
EP 41	4.89	3.11	15.11	8.89	2.67	34.67	56.33
EP 45	10.22	0.44	10.67	9.11	3.11	33.56	61.00
EP 1	6.89	1.33	10.67	6.67	1.78	27.33	66.00
EP 11	0.00	0.89	11.11	9.78	1.78	23.56	52.33
EP 12	20.22	0.00	12.00	6.67	2.67	41.56	59.00
EP 13	21.78	1.78	14.22	9.79	4.89	52.44	54.33
EP 9	1.33	2.67	13.33	12.44	5.33	35.11	62.00
EP 16	3.56	2.67	14.22	13.78	4.00	38.22	67.00
EP 17	1.78	4.89	13.33	8.00	2.67	30.67	79.33
EP 22	3.11	0.44	9.78	9.78	2.44	25.56	55.33
EP 14	2.67	1.78	10.22	12.89	2.22	29.78	50.00
LSD (P=0.05)	7.43	4.95	8.69	5.57	3.64	19.58	13.27

**Table 2. Effect of herbicides and genotypes on growth and yield attributes**

Treatment	Plant population/ m row	Plant height (cm)		Panicle length (cm)	100-seed weight (g)	Stover yield (g/m <sup>2</sup> )	Harvest index (%)
		25 days after herbicide spraying	At harvest				
<i>Herbicides</i>							
Metsulfuron-methyl 4 g/ha	6.43	24.30	155	14.51	3.08	226	22.96
Carfentrazone-ethyl 20 g/ha	6.69	38.42	171	14.31	3.21	255	27.25
Control	6.72	39.08	167	14.00	3.24	266	27.36
LSD (P=0.05)	NS	8.14	13	0.37	NS	30	NS
<i>Genotypes</i>							
DSV 6	5.33	16.28	118	16.90	2.73	76	35.45
M 35-1	6.11	29.09	150	14.70	3.28	192	25.62
CSV 216R	3.44	18.74	173	15.78	1.97	127	27.71
Phule Chitra	6.00	38.11	185	17.31	3.65	235	31.38
P. Maulee	7.22	30.91	164	14.48	3.53	201	22.23
PEC 26	5.33	24.68	161	15.66	3.11	193	18.00
PEC 22	5.33	37.51	171	10.17	3.01	337	20.61
EP 95	5.22	33.51	170	16.17	3.78	255	21.13
EP 94	4.78	28.28	163	15.99	3.42	140	26.32
EP 93	5.67	37.51	194	11.64	4.04	369	28.81
EP 92	3.00	26.56	181	13.65	3.00	232	15.61
EP 91	6.11	30.40	163	16.20	4.03	254	26.70
SEVS 3	8.33	48.91	187	9.38	2.93	291	27.38
SEVS 2	6.22	28.41	177	18.31	2.31	177	29.11
EA 11	5.44	27.24	221	26.47	1.96	194	23.78
EA 10	6.22	25.38	111	24.11	2.24	132	36.82
SEVS 20	6.11	37.41	185	11.62	2.91	257	25.31
PEC 2	5.44	32.49	167	15.44	3.32	298	18.01
PEC 5	5.44	40.02	164	11.40	3.47	283	27.26
PEC 7	7.11	47.32	184	15.62	4.08	302	33.08
PEC 15	5.00	35.53	182	14.16	4.05	277	32.06
EP 97	7.00	33.25	162	14.81	3.23	214	26.61
EP 102	6.44	38.66	164	14.70	3.45	163	36.86
EP 105	6.44	31.33	171	17.77	1.87	150	33.07
EP 103	7.44	31.04	145	14.11	2.35	160	32.17
EP 104	5.67	27.93	162	17.26	2.51	173	26.63
EC 11	5.89	27.47	131	9.14	2.06	142	38.40
EC 12	6.11	32.12	134	16.20	2.32	139	36.30
EC 21	6.00	24.97	186	8.34	2.56	103	30.87
EC 33	3.22	23.88	126	13.42	3.09	79	24.09
EC 34	6.67	31.87	148	8.73	2.37	218	28.88
EP 120	7.11	27.85	145	15.76	3.03	195	24.52
EP 124	7.22	49.06	136	11.91	2.23	137	25.73
EP 127	4.78	28.36	141	11.13	3.02	275	26.93
EP 138	5.56	35.19	217	16.76	3.29	338	24.15
EP 117	7.00	31.86	176	14.59	4.05	310	22.24
EP 115	7.22	41.88	170	17.78	2.07	331	20.39
EP 114	7.56	42.84	190	16.20	3.71	392	21.52
EP 107	5.67	27.88	113	12.24	3.16	96	18.32
EP 106	4.78	28.29	105	10.36	3.78	120	30.34
EP 78	8.22	40.76	170	14.71	3.58	341	26.65
EP 68	7.89	40.56	165	14.67	3.56	305	26.75
EP 65	8.33	38.31	186	15.71	3.76	323	27.29
EP 64	7.00	38.82	183	14.41	3.74	260	25.66
EP 59	7.33	40.16	167	14.62	3.51	248	27.09
EP 84	7.89	32.64	153	13.70	2.89	242	18.02
EP 82	7.56	46.40	185	13.24	3.64	291	31.81
EP 81	7.88	45.18	192	10.83	3.43	357	28.72
EP 80	7.44	49.84	178	14.47	3.83	348	28.11
EP 52	8.67	39.20	156	13.47	3.10	274	37.39
EP 46	7.67	33.02	159	12.33	3.51	324	27.92
EP 57	7.67	39.64	163	15.46	2.89	330	28.92
EP 54	8.78	33.60	154	16.67	2.55	233	32.75
EP 55	8.78	28.27	161	15.80	3.84	296	26.84
EP 42	8.11	28.44	150	14.82	3.14	300	26.54
EP 24	6.67	32.29	164	17.53	2.89	226	28.42
EP 37	5.78	33.93	178	15.92	3.77	291	18.81
EP 41	6.78	30.67	189	18.29	2.40	221	26.87
EP 45	5.56	25.99	175	15.09	3.05	437	7.38
EP 1	6.22	33.29	153	12.39	2.77	293	19.26
EP 11	6.89	35.21	160	11.32	3.98	301	22.76
EP 12	7.00	36.91	147	11.14	2.87	205	22.07
EP 13	8.44	40.82	167	11.62	3.78	461	19.43
EP 9	7.67	37.42	160	11.32	3.14	336	18.23
EP 16	7.89	37.89	169	9.35	3.55	274	27.54
EP 17	7.89	33.31	171	13.32	3.44	243	24.86
EP 22	8.11	31.82	161	11.24	3.59	267	27.33
EP 14	9.00	32.98	174	10.67	3.51	383	21.32
LSD (P=0.05)	1.64	8.14	20	2.44	1.86	83	7.06

**Table 3. Interaction effect of herbicides x germplasm on grain yield (g/m<sup>2</sup>) of Rabi sorghum**

Genotypes	Herbicide			Mean	% change (-/+) over control	
	Control	Metsulfuron-methyl 4 g/ha	Carfentrazone-ethyl 20 g/ha		Metsulfuron-methyl	Carfentrazone-ethyl
DSV 6	58.0	20.0	47.2	41.73	-65.52	-18.62
M 35-1	93.6	40.4	64.4	66.13	-56.84	-31.20
CSV 216R	77.2	36.28	32.0	48.67	-53.01	-58.55
Phule Chitra	114.0	96.0	112.4	107.47	-15.79	-1.40
P. Maulee	51.6	54.8	66.0	57.47	<b>+6.20</b>	<b>+27.91</b>
PEC 26	48.0	32.4	46.73	42.38	-32.50	-2.65
PEC 22	78.4	105.6	78.4	87.47	+34.69	0.00
EP 95	96.0	47.2	61.7	68.30	-50.83	-35.73
EP 94	45.63	42.0	62.4	50.01	-7.96	+36.75
EP 93	172.0	113.0	163.0	149.33	-34.30	-5.23
EP 92	55.6	8.8	64.4	42.93	-84.17	+15.83
EP 91	98.4	64.8	114.4	92.53	-34.15	+16.26
SEVS 3	157.2	61.2	110.8	109.73	-61.07	29.52
SEVS 2	83.2	17.6	117.2	72.67	-78.85	+40.87
EA 11	82.8	35.6	63.2	60.53	-57.00	-23.67
EA 10	67.6	63.6	99.6	76.93	-5.92	+47.34
SEVS 20	101.6	41.2	118.4	87.07	-59.45	+16.54
PEC 2	47.6	70.6	78.13	65.44	<b>+48.32</b>	<b>+64.14</b>
PEC 5	90.2	122.0	106.0	106.07	<b>+35.25</b>	<b>+17.52</b>
PEC 7	164.0	129.8	154.0	149.27	-20.85	-6.10
PEC 15	131.3	135.6	125.2	130.70	+3.27	-4.65
EP 97	64.8	72.4	95.6	77.60	<b>+11.73</b>	<b>+47.53</b>
EP 102	113.2	81.2	91.1	95.17	-28.27	-19.52
EP 105	58.8	81.2	82.4	74.13	<b>+38.10</b>	<b>+40.14</b>
EP 103	114.8	5.6	107.2	75.87	-95.12	-6.62
EP 104	80.8	44.8	62.8	62.80	-44.55	-22.28
EC 11	101.2	29.2	135.2	88.53	-71.15	+33.60
EC 12	88.4	41.6	107.6	79.20	-52.94	+21.72
EC 21	63.2	30.4	44.4	46.00	-51.90	-29.75
EC 33	49.6	4.4	21.2	25.07	-91.13	-57.26
EC 34	66.0	94.0	105.6	88.53	<b>+42.42</b>	<b>+60.00</b>
EP 120	80.4	54.0	55.6	63.33	-32.84	-30.85
EP 124	60.4	32.8	49.2	47.47	-45.70	-18.54
EP 127	128.0	60.8	115.2	101.33	-52.50	-10.00
EP 138	150.4	97.2	75.2	107.60	-35.37	-50.00
EP 117	81.6	94.8	89.6	88.67	<b>+16.18</b>	<b>+9.80</b>
EP 115	86.4	72.7	95.2	84.77	-15.86	+10.19
EP 114	111.6	81.6	129.3	107.50	-26.88	+15.86
EP 107	28.2	15.6	20.8	21.53	-44.68	-26.24
EP 106	78.0	45.2	33.6	52.27	-42.05	-56.92
EP 78	111.2	150.8	109.6	123.87	+35.61	-1.44
EP 68	157.2	98.0	78.87	111.36	-37.66	-49.83
EP 65	141.2	96.8	125.6	121.20	-31.44	-11.05
EP 64	91.6	88.0	89.6	89.73	-3.93	-2.18
EP 59	83.6	90.8	102.0	92.13	<b>+8.61</b>	<b>+22.01</b>
EP 84	49.2	18.0	92.4	53.20	-63.41	+87.80
EP 82	63.4	171.6	172.2	135.73	<b>+5.02</b>	<b>+5.39</b>
EP 81	176.0	83.2	172.4	143.87	-52.73	-2.05
EP 80	179.0	125.6	103.6	136.07	-29.83	-42.12
EP 52	160.0	154.0	176.8	163.60	-3.75	+10.50
EP 46	146.8	122.4	107.2	125.47	-16.62	-26.98
EP 57	111.2	117.2	174.4	134.27	<b>+5.40</b>	<b>+56.83</b>
EP 54	132.4	75.2	132.8	113.47	-43.20	+0.30
EP 55	130.4	84.27	111.2	108.62	-35.38	-14.72
EP 42	100.8	89.2	135.2	108.40	-11.51	+34.13
EP 24	126.0	49.2	94.0	89.73	-60.95	-25.40
EP 37	82.4	36.4	83.4	67.40	-55.83	+1.21
EP 41	93.6	46.8	103.2	81.20	-50.00	+10.26
EP 45	44.4	14.4	45.6	34.80	-67.57	+2.70
EP 1	107.0	42.4	60.27	69.89	-60.37	-43.67
EP 11	104.4	76.0	85.6	88.67	-27.20	-18.01
EP 12	104.0	19.8	50.4	58.07	-80.96	-51.54
EP 13	87.6	60.0	186.0	111.20	-31.51	+112.33
EP 9	73.2	36.67	114.8	74.89	-49.90	+56.83
EP 16	137.7	70.8	104.0	104.16	-48.57	-24.46
EP 17	82.0	73.6	85.6	80.40	-10.24	+4.39
EP 22	140.8	68.0	92.4	100.40	-51.70	-34.38
EP 14	164.8	42.8	103.7	103.77	-74.03	-37.08
Mean	100.2	67.36	95.51			
	Germplasm (G)	Herbicide (H)	G x H			
LSD (P=0.05)	22.44	9.67	35.67			

'PEC 2', 'PEC 5', 'PEC 15', 'EP 97', 'EP 105', 'EC 34', 'EP 117', 'EP 78', 'EP 59', 'EP 82', and 'EP 57' showed tolerance to metsulfuron-methyl (3.27 - 48.32% increase in grain yield over control). Maximum increase in grain yield (48.32%) was recorded with 'PEC 2' followed by 'EC 34' (42.42%), 'EP 105' (38.10%) and 'PEC 5' (35.25%). Carfentrazone-ethyl, however, showed initial leaf phytotoxicity after its spraying but recovered later within 15 days. The promising genotypes tolerant to carfentrazone were 'EP 13', 'EP 84', 'EP 9', 'PEC 2', 'EC 34', 'EP 57', 'EP 105', 'EP 97', 'EA 10' (40-112% increase in grain yield over control). Some of the promising genotypes showed tolerance to both metsulfuron and carfentrazone were 'PEC 2', 'PEC 5', 'EP 97', 'EP 105' and 'EC 34'.

It may be concluded that *Rabi* sorghum germplasm *PEC 2*, *PEC 5*, *EP 97*, *EP 105* and *EC 34* may be included in breeding programme for developing sorghum cultivars tolerant to metsulfuron-methyl and carfentrazone-ethyl.

#### SUMMARY

Field experiment was conducted during *Rabi* 2010-11 at the Indian Institute of Millets Research, Hyderabad (Telangana) to screen the *Rabi* sorghum germplasm and varieties tolerant to quizalofop-ethyl, metsulfuron-methyl and carfentrazone-ethyl herbicides. The crop was infested mainly with *Parthenium hysterophorus* (43.36%), *Cyperus rotundus* (19.91%), *Celosia argentea* (20.38%), *Euphorbia geniculata* (12.42%) and others (*E. hirta* and *Digitaria sanguinalis*) (3.93%). Of the 68 genotypes evaluated for herbicide tolerance, none was tolerant to quizalofop-ethyl. 'Phule Maulee', 'PEC 22', 'PEC 2', 'PEC 5', 'PEC 15', 'EP 97', 'EP 105', 'EC 34', 'EP 117', 'EP 78', 'EP 59', 'EP

82', and 'EP 57' showed tolerance to metsulfuron-methyl (3.27 - 48.32% increase in grain yield over control) with very good control of all broad-leaved weeds. The promising genotypes showed tolerance to both metsulfuron and carfentrazone were 'PEC 2', 'PEC 5', 'EP 97', 'EP 105' and 'EC 34'. Carfentrazone-ethyl, however, showed initial leaf phytotoxicity but crop recovered within 15 days of herbicide application.

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