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Short communication

Pre- and post-emergence herbicides for weed management in finger millet

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Finger millet (*Eleusine coracana* Gaertn.) commonly known as (*ragi*), is one of the important staple food crops of South India. It is drought tolerant crop and widely grown in rainfed and dry land conditions in red soil area. In India, the crop occupies an area of 1.31 million hectares with a production of 1.93 million tonnes and productivity of 1.64 t/ha. Among finger millet growing states, Karnataka stands first with an area of 0.79 million hectares, with an annual production of 1.27 million tonnes and productivity of 1.87 t/ha (Anonymous 2014). The finger millet crop is slow growing during initial stages due to which weeds pose severe problem. If weeds are not controlled in early period up to four weeks after transplanting, yield is reduced drastically by 34 to 61% (Nanjappa and Hosmani 1985). Delayed weeding will be less effective because sufficient damage would have occurred at the critical period. In present days, apart from expensive labour charges, timely availability of labour is a limitation for undertaking cultural operations like hand weeding. In such situations, suitable technology with less labour requirement will be most helpful to farmers for controlling weeds effectively and chemical weed control is one of such measures. However, environmental pollution due to application of higher doses of herbicides is a concern. Some low dose herbicides have emerged. Further, broad spectrum weed control is another limitation in finger millet crop. Hence it is needed to test the available pre-mix formulation of herbicides to control diversified weed flora in finger millet.

A field experiment was conducted at College of Agriculture, V.C. Farm, Mandya, during *Rabi*, 2013. The soil texture of the experimental site was red sandy loam with a neutral pH (7.1) and was medium in organic carbon content (0.53%). The available nitrogen, phosphorus and potassium status in soil was 282.24, 29.77 and 243.6 kg/ha, respectively.

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The experiment was laid out in a randomized block design with three replications consisting of 10 treatments, *viz.* butachlor 50 EC 0.75 kg/ha as pre-emergence at 2 days after transplanting (DAT), oxyfluorfen 23.5 EC at 80 g/ha as pre-emergence application (2 DAT), oxadiargyl 80 WP at 60 g/ha as early post-emergence application (8 DAT), oxadiargyl 80 g/ha as early post-emergence application (8 DAT), bensulfuron-methyl 45 g + pretilachlor 450 g/ha (6.6% G pre-mix formulations) as pre-emergence application (2 DAT), bensulfuron-methyl at 60 g + pretilachlor at 600 g/ha (6.6% G pre-mix formulations) as pre-emergence application (2 DAT), bispyribac-sodium 10% SC at 20 g/ha as a post-emergence application (13 DAT), bispyribac sodium 10% SC at 25 g/ha as a post-emergence application (13 DAT), one intercultivation at 20 DAT followed by one hand weeding at 30 DAT and un-weeded check

The variety used was '*Indaf-7*', developed by Zonal Agricultural Research Station, Mandya, University of Agricultural Sciences, Bangaluru, suitable for winter season. The variety is having medium plant height, ear head is semi compacted cox comb type and comes to maturity in 115 to 120 days. Variety is having moderate resistance to pest and diseases. It is having higher grain yield potential of 5 to 6 t/ha. The 22 days old seedlings were transplanted in the main field at 22.5 x 15 cm spacing at 2-3 seedlings per hill. Equal quantity of farm yard manure at the rate of 7.5 t/ha was applied to each plot three weeks prior to sowing. The fertilizer nitrogen, phosphorus and potassium were applied as per recommended dose 100:50:50 N, P_2O_5 and K_2O kg/ha through urea, single super phosphate and muriate of potash. Fifty per cent of nitrogen and entire dose of P and K were applied at the time of planting. Remaining half nitrogen was top-dressed at 30 days after transplanting. Butachlor, oxyfluorfen and bensulfuron-methyl + pretilachlor were applied as pre-emergence herbicides as per the respective treatments at 2 DAT. Whereas, oxadiargyl was applied as early post-emergence at 8 DAT and bispyribac-sodium was applied as post-emergence at

13 DAT. The visual toxicity ratings were recorded at 5, 10, and 14 days after spraying of herbicides. The scores were given from 0 to 10 scales by comparing crop tolerance to a particular herbicide treatment and weedy check plot as outlined by Gupta (2010). The visual weed control ratings were recorded at 14, 28 and 35 DAT and scores were given from 0 to 10 scales. Statistical analysis was done as per the procedure outlined by Gomez and Gomez (1984). Weed control efficiency and weed index were calculated using standard formulae as quoted by Sunil *et al.* (2010).

Weed flora

The predominant weed flora observed in the experimental field during investigation includes *Dactyloctenium aegyptium* L., *Cynodon dactylon* L., *Digitaria marginata* L., *Panicum miliacea* L., *Eleusine indica* L. and *Echinochloa colona* L., among grasses*; Portulaca oleracea* L., *Parthenium hysterophorus* L., *Ageratum conyzoides* L., *Commelina benghalensis* L., *Mollugo disticha* L., *Phyllanthus niruri* L., *Alternanthera spp, Sida acuta* L., *Sida cardifolia* L., *Amaranthus viridis* L., *Mimosa pudica* L., *Bidens pilosa* L. and *Achyranthes aspera* L. among broad-leaved weeds and *Cyperus rotundus* L. and *Cyperus esculentus* L. were major sedges in transplanted finger millet system. Similar weed flora was also observed by Kumar *et al.* (2013) and Sunil and Shankaralingappa (2014).

Weed control efficiency

At 5, 10 and 14 days after spraying of herbicides, oxadiargyl 60 g and 80 g/ha as early post-emergence application and bispyribac-sodium 20 g and 25 g/ha as post-emergence application showed slight to moderate crop toxicity. However, at later stages plant recovered from the effect. At 14, 28 and 35 DAT, the excellent control of weeds were noticed with pre-emergence application of bensulfuron-methyl at 60 g + pretilachlor 600 g/ha (6.6% G pre-mix formulations) as pre-emergence application (2 DAT), bensulfuron-methyl 45 g + pretilachlor 450 g/ha (6.6% G pre-mix formulations) as pre-emergence application (2 DAT), followed by oxyflurofen 80 g/ha as pre-emergence application. These results were comparable with one interculticvation at 20 DAT. The highest weed control efficiency and lowest weed index was recorded with pre-emergence application of bensulfuron-methyl at 60 g + pretilachlor 600 g/ha (6.6% G pre-mix formulations) as pre-emergence application (Table 1). These results were in conformity with the findings of Srivastava *et al.* (2008) and Patil *et.al.* (2013).

Weed attributes and yield

Among different weed management practices, bensulfuron-methyl at 60 g + pretilachlor at 600 g/ha (6.6% G pre-mix formulations) applied as pre-emergence herbicide recorded significantly higher growth and yield parameters, *viz.* plant height, leaf area (cm^2/hill), number of productive tillers/hill, and ear head weight, ear head length, and thousand grain weight and was followed by one intercultivation at 20 DAT and one hand weeding at 30 DAT and oxyfluorfen 80 g/ha as pre-emergence application (2 DAT). This increase in crop growth and yield parameters in these treatments were due to better control of weeds resulting in minimum competition of weeds with finger millet for resources during crop growth period and helped in better utilization of nutrients, moisture, space and light by the crop.

Table 1. Effect of weed control treatments on crop toxicity rating, weed control rating, WCE and weed index in transplanted finger millet

Treatment	Crop toxicity rating			Weed control ratings			WCE (%)	Weed index (%)
	5 DASp	10 DASp	14 DASp	14 DAT	28 DAT	35 DAT		
Butachlor 50 EC at 0.75 kg/ha as PE application (2 DAT)	0.50	0.40	0.40	9.00	6.80	6.00	66.54	23.65
Oxyfluorfen 23.5 EC at 80 g/ha as PE application (2 DAT)	0.10	0.20	0.10	9.80	9.40	9.40	87.67	1.82
Oxadiargyl 80 WP at 60 g/ha as early POE application (8 DAT)	2.00	2.00	3.00	9.00	8.20	8.00	75.99	6.56
Oxadiargyl 80 WP at 80 g/ha as early POE application (8 DAT)	3.00	3.00	4.00	9.10	8.50	8.90	80.04	8.44
Bensulfuron-methyl at 45 g + pretilachlor at 450 g/ha (6.6% G premix formulations) as PE application (2 DAT)	0.10	0.10	0.00	9.50	9.20	9.20	86.87	4.92
Bensulfuron-methyl at 60 g + pretilachlor at 600 g/ha (6.6% G premix formulations) as PE application (2 DAT)	0.10	0.10	0.00	9.80	9.70	9.80	91.57	-2.51
Bispyribac-sodium 10% SC at 20 g/ha as a POE application (13DAT)	2.00	2.50	4.00	0.00	7.90	8.60	74.71	5.74
Bispyribac-sodium 10% SC at 25 g/ha as a POE application (13 DAT)	2.00	2.60	4.50	0.00	8.50	8.80	80.26	7.38
One intercultivation at 20 DAT followed by one hand weeding at 30 DAT	0.00	0.00	0.00	0.00	9.00	9.90	84.26	0.00
Unweeded check	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.27

WCE- Weed control efficiency; DAT- Days after transplanting; PE- Pre-emergence; POE- Post-emergence; DAT- Days after spraying

Scale of crop toxicity (0.0 = None, 1.0-3.0 = Slight, 4.0 – 6.0 = Moderate, 7.0 – 9.0 = Severe, 10.0 = Complete)

Scale of weed control rating (0.0 = No control, 1.0-3.0 = Poor controlt, 4.0 – 6.0 = Fair control, 7.0 – 9.0 = Good control, 10.0 = Excellent control)

Table 2. Effect of weed control treatments on growth, yield parameters and yield of transplanted finger millet

Treatment	Plant height (cm) at harvest	Leaf area at 60 DAT (cm^2/hill)	Productive tillers (no./hill)	Ear head length (cm)	Ear head weight (g/hill)	1000 grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
Butachlor 50 EC at 0.75 kg/ha as PE application (2 DAT)	74.10	538	2.6	12.2	20.01	2.85	3.19	4.63
Oxyfluorfen 23.5 EC at 80 g/ha as PE application (2 DAT)	82.13	1034	4.2	15.3	49.54	2.95	4.11	6.15
Oxadiargyl 80 WP at 60 g/ha as early POE application (8 DAT)	77.00	849	3.3	13.6	40.27	2.91	3.91	5.89
Oxadiargyl 80 WP at 80 g/ha as early POE application (8 DAT)	78.47	807	2.8	12.6	37.17	2.88	3.83	5.60
Bensulfuron-methyl at 45 g + pretilachlor at 450 g/ha (6.6% G premix formulations) as PE application (2 DAT)	80.04	949	4.2	14.0	48.46	2.95	3.98	5.86
Bensulfuron-methyl at 60 g + pretilachlor at 600 g/ha (6.6% G premix formulations) as PE application (2 DAT)	86.80	1432	4.5	16.6	54.73	3.02	4.29	6.45
Bispyribac-sodium 10% SC at 20 g/ha as a POE application (13DAT)	79.13	804	3.2	13.9	38.70	2.93	3.94	6.03
Bispyribac-sodium 10% SC at 25 g/ha as a POE application (13 DAT)	79.17	773	2.9	12.6	30.48	2.87	3.87	5.93
One intercultivation at 20 DAT followed by one hand weeding at 30 DAT	85.90	1251	4.3	15.5	51.74	2.99	4.18	6.13
Unweeded check	67.07	424	1.9	08.5	7.82	2.53	1.54	2.24
LSD (P=0.05)	7.13	137	0.4	3.2	7.13	0.25	0.88	1.09

However, un-weeded check recorded significantly lower plant height (cm), number of tillers/hill, leaf area (cm^2/hill) and dry matter production (g/hill) (Table 2). This might be due to severe crop weed competition for the same growth resources. These results were in line with the findings of Saha (2009) and Kumar *et al*. (2013).

The grain and straw yield of transplanted finger millet also followed the similar trend as above. The better yield and yield components was due to reduced crop weed competition for nutrients, light, moisture and space and provided better environment for crop growth and development (Singh and Singh 2010).

SUMMARY

Significantly higher grain yield and straw yield (4.29 and 6.45 t/ha, respectively), was recorded with pre-emergence application of bensulfuron-methyl (0.6% G) + pretilachlor (6.0% G) at 1.0 kg/ha as compared to pre-emergence application of butachlor 50 EC at 0.75 kg/ha (3.19 and 4.63 t/ha, respectively) and un-weeded check (1.54 and 2.24 t/ha, respectively). Similar trend was also observed with respect to the growth and yield parameters of fingermillet.

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