RESEARCH ARTICLE

EFFECT OF POST EMERGENCE HERBICIDE ON WEEDS AND ECONOMICS OF FINGER MILLET

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Abstract: Weeds are the major biotic stresses for finger millet cultivation. Initial slow growth of the finger millet favours weed growth. *Echinochloa colona* among grasses, *Cyperus iria* among sedges and *Alternanthera triandra, Eclipta alba* and *Phyllanthus urinaria* among broad leaf weeds were dominant. Weed index (loss of yield due to weeds) was found to be minimum with application of ethoxysulfuron (34.37 %). The maximum weed index was found with application of fenoxaprop-p- ethyl (93.62 %) at higher level (45.0 g ha^{-1}). In the experimental field, the most dominant species was *Echinochloa colona* which ranged between 24-46 per cent at all the growth stages. It was followed by *Phyllanthus urinaria* (13-18 %), *Eclipta alba (5-26 %), Cyperus iria* (3-23%) and *Alternanthera triandra* (5-12 %).There was complete control of broad leaf weeds *viz. Alternanthera triandra, Eclipta alba* and *Phyllanthus urinaria* and sedges *i.e. Cyperus iria* by the application of metsulfuron methyl + chlorimuron ethyl and ethoxysulfuron, where as grassy weed *i.e. Echinochloa colona* was completely killed by the application of fenoxaprop-p-ethyl and showed 100% weed control efficiency, respectively. Hand weeding twice recorded the highest grain yield and net return. Application of ethoxysulfuron registered the highest B:C ratio which was at par with metsulfuron methyl + chlorimuron ethyl and hand weeding twice.

Keywords: Weed management, Finger millet, Herbicide, Weed

INTRODUCTION

Finger millet is grown in *kharif* for grain purpose and it is the only millet, which is consumes directly after threshing as whole grain. It is a tetraploid and self-pollinating species probably evolved from its wild relative *Eleusine africana*. Interesting crop characteristics of finger millet are the ability to withstand cultivation at altitudes over 2000 meters above sea level, its favorable micronutrient contents (high iron and methionine content in particular), its high drought tolerance and the very long storage time of the grains. Finger millet is a high statue crop with slower initial growth which remains under smothering due to the infestation of weeds at early stages of growth. This situation causes higher competition and may result in drastic reduction in yield (Kushwaha *et al*. 2002). Finger millet (*Eleusine indica*) is an important small millet crop that is hardy and grows well in dry zones as rain-fed crops. It is used both as medicinal and traditional purposes.The production and productivity of the country is lower because of weeds pose one of the major constraints in the production of finger millet. Owing to initial slow growth of the finger millet favours weed growth, which cause more competition for sunlight, nutrient and water in early stages of growth lead in lowering productivity (Kumara *et al*. 2007). The critical period of crop weed competition for the finger millet varies from 25-45 days after sowing (Lall and Yadav, 1982). Weeds compete with crop plants for water, nutrients, space and solar radiations by reduction of yield upto 20 to 50 per cent. (Kushwaha *et al*. 2002) reported that weeds caused an appreciable reduction in density, dry weight and depletion of nutrients. Manual weed management, which is the most prevalent method for weed management in finger millet, requires a lot of labour. Now a day, due to the scarcity of labours, chemical weed management is considered as better option than the hand weeding. Chemical weed management practices might be an answer to achieve greater weed control efficiency, which in turn, may increase over all benefit of finger millet cultivation. The work on effect of post emergence herbicides in weed management of finger millet is very limited; therefore, keeping these points in view the present investigation was carried out to evaluation of post-emergence herbicides for weed management in direct sown finger millet.

MATERIAL AND METHOD

The present investigation entitled "Evaluation of post-emergence herbicides for weed management in direct sown Finger millet." was carried out at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) India, during the *kharif* season (July-November) 2012. The soil of experimental field was Clayey *(Vertisols)*, which was low in nitrogen, medium in phosphorus and high in potassium contents with neutral in pH. The experiment was laid out in randomized block design (RBD) with three replications. There were thirteen treatments of post-emergence herbicides along with two hand weeding and untreated control. The finger millet cultivar "GPU-28" was sown and harvested on 11th July, 2012 and 20th November, 2012 respectively, using seed rate of 10 kg ha^{-1} at 25 cm distance and gaps were maintained by thinning to

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obtain proper plant population. Sowing was performed by manually and crop was fertilized with 60:40:40 N: P_2O_5:K_2O kg ha^{-1}. Half dose of nitrogen (30 kg/ha) and full dose of P and K (40 and 20 Kg/ha respectively) were applied as basal and remaining half of nitrogen (30 kg/ha) was top dressed one month later. Plant protection measures were followed as per recommendation. The treatments were *viz*. T_1- Fenoxaprop-p-ethyl (37.5 g ha^{-1}), T_2- Fenoxaprop-p-ethyl (45.0 g ha^{-1}), T_3- Metsulfuron methyl + Chlorimuron ethyl, T_4- Ethoxysulfuron, T_5 – Cyhalofop-butyl, T_6- Fenoxaprop-p-ethyl (37.5 g ha^{-1}) + metsulfuron methyl + chlorimuron ethyl, T_7- Fenoxaprop-p-ethyl (45.0 g ha^{-1}) + metsulfuron methyl + chlorimuron ethyl, T_8- Fenoxaprop-p-ethyl (37.5 g ha^{-1}) + ethoxysulfuron, T_9- Fenoxaprop-p-ethyl (45.0 g ha^{-1}) + ethoxysulfuron, T_{10}- Cyhalofop-butyl + metsulfuron methyl + chlorimuron ethyl, T_{11}- Cyhalofop-butyl + ethoxysulfuron, T_{12}- Hand weeding twice and T_{13}- Weedy check. The observations of weeds were recorded from the area left for distractive sampling and the net plot area was kept undisturbed. The important weed species associated with the Finger millet crop in the experimental field were observed at different intervals. The density of different weed species and dry weight of weeds was studied at 15, 30, 45, 60, 75 and 90 DAS and at harvest. The density of different weed species study in each plot was made from marked area outside the net plot area using a quadrate of 50 cm x 50 cm (0.25 m^2). Only green weeds sample were taken. Thedata were calculated for m^{-2} for statistical analysis. Weed density was subjected to square root transformation *i.e.*

$$X + 0.5$$

Weeds present in quadrate were uprooted carefully along with roots. The roots of the samples were cut and only aerial parts were cleaned, sun-dried and finally oven-dried at 60^{o}C for 48 hours. After complete oven drying, the dry weight was recorded species-wise and as well as total dry weight of weeds for different treatments. Weed dry weight was subjected to square root transformation *i.e.*

$$X + 0.5$$

The weed control efficiency was calculated at 15, 30, 45, 60, 75 and 90 DAS and at harvest on the basis of reduction in dry matter production of weeds in treated plots in comparison with weedy check and expressed in percentage as suggested by Mani *et al.* (1973).

$$WCE\ (\%) = \frac{DWC - DWT}{DWC} \times 100$$

Where,

WCE = Weed control efficiency (%)

DWC = Dry weight of weeds in weedy check plot (g) DWT = Dry weight of weeds in treated plot (g)

Weed Index is an index expressing the reduction in yield due to presence of weeds in comparison with weed free situation. It was expressed in per cent and calculated by using the formula given below as suggested by (Reddy 2007).

$$\text{Weed Index } (\%) = \frac{\text{Seed yield from weed free plot} - \text{Seed yield from treated plot}}{\text{Seed yield from weed free plot}} \times 100$$

RESULT AND DISCUSSION

The major weeds species were observed in weedy check plot of the experimental field which have been presented in Table1.

Table 1. Major weeds species observed in the experiment field

S. No.	Scientific name	Family	Common name	Group
1	*Echinochloa colona*	Poaceae	Sawan/Jungle rice	Grasses
2	*Cyperus iria*	Cyperaceae	Motha/Yellow nutsedge	Sedges
3	*Alternanthera triandra*	Compositae	Resham kanta	Broad leaf
4	*Eclipta alba*	compositeae	Bhringraj/False daisy	Broad leaf
5	*Phyllanthus urinaria*	Euphorbiaceae	Dodania	Broad leaf

Cyperus iria

Echinochloa colona

Eclipta alba

Phyllanthus urinaria

Alternanthera triandra

Plate 1. Major weed species observed in the field

The most dominant species was *Echinochloa colona* which ranged between 24-46 per cent at all the growth stages. It was followed by *Phyllanthus urinaria* (13-18 %), *Eclipta alba (5-26 %), Cyperus iria* (3-23 %) and *Alternanthera triandra* (5-12%). Other weed species like *Commelina benghalensis, Cynodon dactylon, Cynotis axillari, Fimbristylis miliacaea etc*. were also observed in the experiment field in negligible quantum.

Weed density at 30 DAS the minimum was observed with application of cyhalofop-butyl + metsulfuron methyl + chlorimuron ethyl (Table 2). The highest weed density was noticed in weedy check. At 60 DAS Weed density was recorded the lowest in fenoxaprop-p-ethyl (45.0 g ha^{-1}) + metsulfuron methyl + chlorimuron ethyl. The highest weed density was recorded in weedy check. At 90 DAS lowest weed density was observed with application of metsulfuron methyl + chlorimuron ethyl or ethoxysulfuron was applied in combination with cyhalofop-butyl or fenoxaprop-p-ethyl at both levels which was at par with each other. The highest weed density was recorded with application of metsulfuron methyl + chlorimuron ethyl. At harvest there was no plant alive in hand weeding twice which was at par with metsulfuron methyl + chlorimuron ethyl. The highest weed density was recorded in weedy check. In the present study, the individual herbicide killed some of the grasses, sedges and broad leaf weeds individually but the some of the other weeds were not controlled by this herbicide due to which the result exhibited variation in total weed density and complete controlled of weeds by any herbicide alone or in combination was not observed. However, the combined application of cyhalofop-butyl or fenoxaprop-p-ethyl with metsulfuron methyl + chlorimuron ethyl exhibited the appreciable lower total weed density.

Total dry weight of weed species at various stages as influenced different herbicidal treatments in finger millet are presented in Table 3. At 30 DAS the minimum total dry weight was recorded with application of fenoxaprop-p-ethyl (37.5 g ha^{-1}) + ethoxysulfuron (Table 4.19). The highest total weed dry weight was recorded in weedy check. At 60 DAS lowest total dry weight was recorded in hand weeding twice. The highest total dry weight was recorded in weedy check. At 90 DAS the lowest total dry weight was recorded in hand weeding twice. The highest total weed dry weight was recorded in weedy check. At harvest there was no plant alive so total dry weight was zero with application of metsulfuron methyl + chlorimuron ethyl or ethoxysulfuron alone or in combination with cyhalofop-butyl or fenoxaprop-p-ethyl at both levels and hand weeding twice.The highest total weed dry weight was recorded in weedy check which was at par with cyhalofop-butyl. In conclusion, the combined application of cyhalofop-butyl or fenoxaprop-p-ethyl with metsulfuron methyl + chlorimuron ethyl exhibited the appreciable lower total weed dry weight.

The weed control efficiency (WCE) of weeds of different species was noted at 30, 45, 60, 75 and 90 DAS and at harvest. Weed control efficiency (%) of total weed species is given in Fig. 1. Hand weeding twice recorded highest weed control efficiency followed by metsulfuron methyl + chlorimuron ethyl ethoxysulfuron, fenoxaprop-p- ethyl. Lowest weed control efficiency was exhibited with application of cyhalofop- butyl.

Table 2. Total weed density (m^{-2}) as influenced by different herbicidal treatments in finger millet

Treatment	Dose ($g\ ha^{-1}$)	Weed density (m^{-2})						
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	At harvest
T_1 : Fenox	37.5	8.16 (66.33)	9.80 (95.67)	11.93 (142.00)	13.33 (177.33)	10.97 (120.00)	8.58 (73.33)	4.71 (21.67)
T_2 : Fenox	45.0	7.86 (61.33)	9.17 (83.67)	11.61 (134.33)	12.82 (164.00)	11.77 (138.00)	8.57 (73.00)	4.18 (17.00)
T_3 : MSM+CME	2.0+2.0	7.84 (61.00)	7.07 (49.67)	7.59 (57.33)	8.56 (73.00)	7.42 (54.67)	6.41 (40.67)	0.71 (0.00)
T_4 : Ethox	15.0	7.61 (57.67)	8.37 (69.67)	8.76 (76.33)	9.47 (89.33)	8.74 (76.00)	7.62 (57.67)	0.71 (0.00)
T_5 : Cyhalo	62.5	7.40 (54.33)	8.95 (79.67)	10.42 (108.00)	12.26 (150.00)	10.63 (112.67)	8.53 (72.33)	3.08 (9.00)
T_6 : Fenox+MSM+ CME	37.5+2.0+2.0	7.66 (58.33)	4.81 (22.67)	3.96 (15.33)	2.81 (7.67)	2.17 (4.67)	1.83 (3.67)	0.71 (0.00)

T_7 : Fenox+MSM+ CME	45.0+2.0+2.0	7.58 (57.33)	2.76 (7.33)	2.19 (4.33)	1.81 (3.00)	1.72 (2.67)	1.27 (1.33)	0.71 (0.00)
T_8 : Fenox+Ethox	37.5+15.0	8.06 (64.67)	7.35 (53.67)	6.82 (46.00)	6.84 (46.33)	6.26 (38.67)	4.98 (24.33)	0.71 (0.00)
T_9 : Fenox+Ethox	45.0+15.0	7.98 (63.33)	6.35 (40.00)	6.36 (40.00)	6.53 (42.33)	5.48 (29.67)	4.67 (21.33)	0.71 (0.00)
T_{10} : Cyhalo+MSM+ CME	62.5+2.0+2.0	7.93 (62.33)	1.97 (3.67)	2.55 (6.00)	3.06 (9.00)	2.02 (3.67)	1.77 (2.67)	0.71 (0.00)
T_{11} : Cyhalo+Ethox	62.5+15.0	7.67 (58.33)	6.08 (36.67)	6.69 (44.33)	6.74 (45.00)	5.94 (35.00)	5.04 (25.00)	0.71 (0.00)
T_{12} : Weed free (HW at 20 and 40 DAS)		7.86 (61.33)	3.06 (9.00)	2.26 (4.67)	2.26 (4.67)	2.20 (4.33)	1.87 (3.00)	0.71 (0.00)
T_{13}: Weedy check		8.64 (74.34)	13.64 (185.67)	16.68 (277.67)	17.21 (296.33)	14.81 (219.00)	12.20 (148.33)	5.18 (26.33)
SEm ±		0.24	0.25	0.16	0.26	0.26	0.26	0.05
CD at 5 %		NS	0.75	0.48	0.78	0.77	6.76	0.16

The observations are square root transformed. Figures in parentheses indicate the original value. Fenox = Fenoxaprop-p-ethyl, MSM = Metsulfuron methyl,CME = Chlorimuron ethyl, Ethox = Ethoxysulfuron, Cyhalo = Cyhalofop–butyl, HW = Hand weeding.

Table 3. Total weed dry weight of weeds as influenced by different herbicidal treatments in finger millet

Treatment	Dose ($g\ ha^{-1}$)	Dry weight ($g\ m^{-2}$)						
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	At harvest
T_1 : Fenox	37.5	1.42 (1.53)	4.74 (22.06)	7.16 (50.74)	8.48 (71.37)	9.82 (96.23)	10.89 (118.47)	6.15 (37.49)
T_2 : Fenox	45.0	1.42 (1.52)	4.29 (17.91)	6.26 (38.88)	8.42 (70.37)	10.15 (102.53)	11.34 (128.20)	6.96 (48.04)
T_3 : MSM+CME	2.0+2.0	1.58 (2.02)	2.99 (8.47)	4.27 (17.77)	5.46 (29.30)	5.57 (30.60)	6.45 (41.25)	0.71 (0.00)
T_4 : Ethox	15.0	1.48 (1.69)	3.01 (8.60)	4.93 (23.90)	5.60 (30.86)	6.37 (40.26)	8.27 (68.03)	0.71 (0.00)
T_5 : Cyhalo	62.5	1.45 (1.62)	3.65 (12.83)	8.27 (68.01)	9.40 (87.94)	13.03 (169.22)	13.61 (184.93)	9.42 (88.3)
T_6 : Fenox+MSM+ CME	37.5+2.0+2.0	1.44 (1.57)	2.58 (6.19)	4.47 (19.50)	5.11 (25.67)	5.45 (29.23)	6.34 (39.71)	0.71 (0.00)
T_7 : Fenox+MSM+ CME	45.0+2.0+2.0	1.48 (1.71)	2.95 (8.22)	4.54 (20.20)	4.66 (21.26)	5.17 (26.46)	5.79 (33.06)	0.71 (0.00)
T_8 : Fenox+Ethox	37.5+15.0	1.46 (1.64)	2.07 (3.80)	4.93 (23.87)	5.20 (26.75)	6.48 (41.52)	6.92 (47.48)	0.71 (0.00)
T_9 : Fenox+Ethox	45.0+15.0	1.46 (1.65)	3.21 (9.83)	3.55 (12.11)	3.90 (14.70)	5.91 (34.58)	6.24 (38.48)	0.71 (0.00)
T_{10} : Cyhalo+MSM+ CME	62.5+2.0+2.0	1.49 (1.73)	2.90 (7.97)	4.25 (17.70)	4.55 (20.23)	4.84 (23.10)	5.88 (34.61)	0.71 (0.00)
T_{11} : Cyhalo+Ethox	62.5+15.0	1.55 (1.91)	3.36 (10.80)	5.65 (31.51)	6.46 (41.35)	7.77 (59.83)	8.44 (70.80)	0.71 (0.00)
T_{12} : Weed free (HW at 20 and 40 DAS)		1.54 (1.91)	2.62 (6.42)	3.19 (9.66)	3.29 (10.37)	3.51 (11.89)	3.52 (11.89)	0.71 (0.00)

T_{13}: Weedy check		1.65 (2.24)	5.98 (35.22)	10.16 (102.67)	12.06 (145.21)	15.12 (228.02)	15.99 (255.51)	9.77 (95.17)
SEm ±		0.05	0.10	0.16	0.17	0.20	0.29	0.15
CD at 5 %		NS	0.30	0.49	0.51	0.60	0.86	0.43

The observations are square root transformed. Figures in parentheses indicate the original value. Fenox = Fenoxaprop-p-ethyl, MSM = Metsulfuron methyl, CME = Chlorimuron ethyl, Ethox = Ethoxysulfuron, Cyhalo = Cyhalofop–butyl, HW = Hand weeding

Table 4. Weed control efficiency (%) of total weeds at different stages of finger millet as influenced by different herbicidal treatments

Treatment	**Dose ($g\ ha^{-1}$)**	**Weed control efficiency of total weeds (%)**					
		30 DAS	**45 DAS**	**60 DAS**	**75 DAS**	**90 DAS**	**At harvest**
T_1 : Fenox	37.5	37.37	50.58	50.85	57.80	53.63	60.61
T_2 : Fenox	45.0	49.15	62.13	51.54	55.03	49.83	49.52
T_3 : MSM+CME	2.0+2.0	75.95	82.69	79.82	86.58	83.86	100.00
T_4 : Ethox	15.0	75.58	76.72	78.75	82.34	73.37	100.00
T_5 : Cyhalo	62.5	63.57	33.76	39.44	25.79	27.62	7 .
T_6 : Fenox+MSM+ CME	37.5+2.0+2.0	82.42	81.01	82.32	87.18	84.46	100.00
T_7 : Fenox+MSM+ CME	45.0+2.0+2.0	76.66	80.33	85.36	88.40	87.06	100.00
T_8 : Fenox+Ethox	37.5+15.0	89.21	76.75	81.57	81.79	81.42	100.00
T_9 : Fenox+Ethox	45.0+15.0	72.09	88.20	89.88	84.83	84.94	100.00
T_{10} : Cyhalo+MSM+ CME	62.5+2.0+2.0	77.37	82.76	86.07	89.87	86.45	100.00
T_{11} : Cyhalo+Ethox	62.5+15.0	69.34	69.31	71.52	73.76	72.29	100.00
T_{12} : Weed free (HW at 20 and 40 DAS)		81.77	90.59	92.86	94.79	95.35	100.00
T_{13}: Weedy check		–	–	–	–	–	–

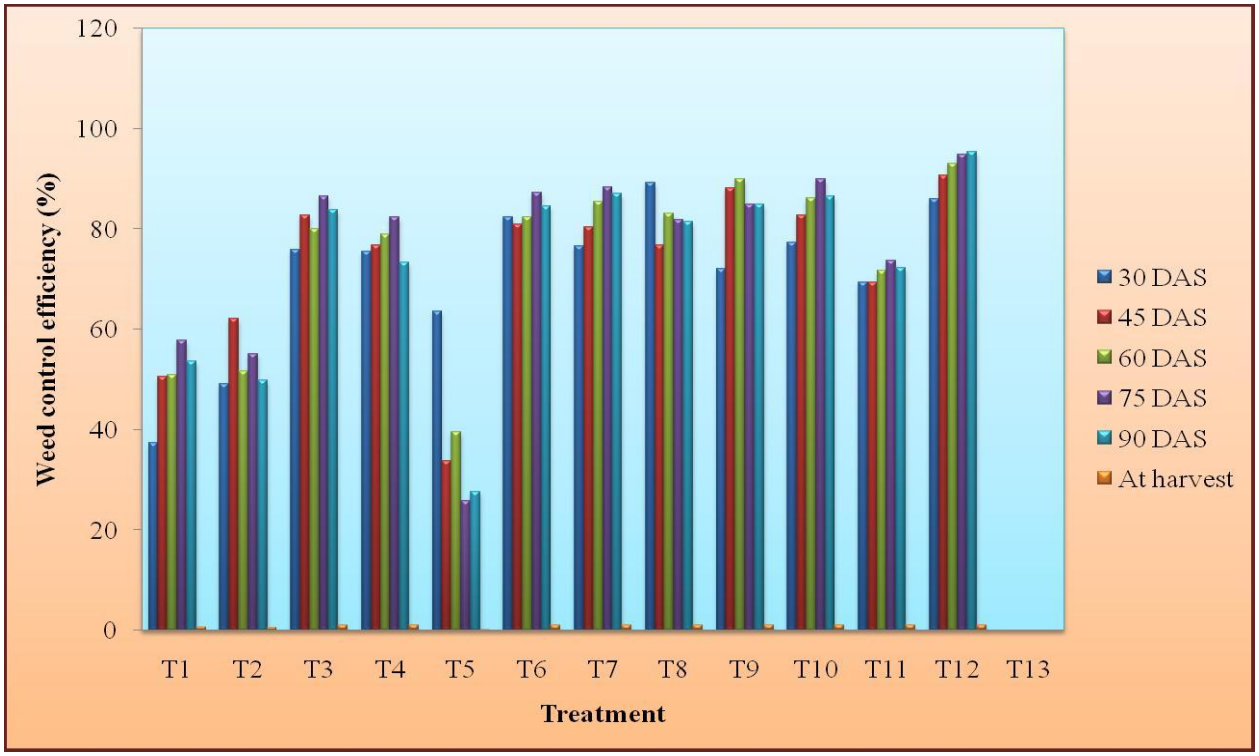

Fig. 4.3. Weed control efficiency (%) of total at different stages of finger millet as influenced by different herbicidal treatments

Economics

Hand weeding twice recorded the highest gross return. Among herbicides ethoxysulfuron gave maximum gross return which was at par with that of metsulfuron methyl + chlorimuron ethyl. Fenoxaprop-p-ethyl (45.0 g ha^{-1}) gave minimum gross return. The maximum net return was observed in hand weeding twice which was at par with application of ethoxysulfuron and metsulfuron methyl + chlorimuron ethyl and B:C ratio was observed with ethoxysulfuron which was at par with that of metsulfuron methyl + chlorimuron ethyl and hand weeding twice.

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