RESEARCH ARTICLE

POST EMERGENCE HERBICIDES EFFECT ON YIELD ATTRIBUTING CHARACTERS AND YIELD OF FINGER MILLET

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Abstract: Finger millet (*Eleusine indica*) is an important small millet crop that is hardy and grows well in dry zones as rain-fed crops. There were thirteen treatments which comprised single application of different post-emergence herbicides either alone or in combination and hand weeding was conducted on Clayey *Vertisols* soil of College of Agriculture, Raipur during *kharif* season of 2012. The highest number number of fingers m^{-2}, finger length, number of fingerlet $finger^{-1}$, number of grains $finger^{-1}$ and test weight was observed in hand weeding twice which. Hand weeding twice at 20 and 40 DAS proved significantly superior to all other treatments. Among different herbicidal weed management practices, ethoxysulfuron recorded the highest grain yield. Straw yield of finger millet was the highest under hand weeding twice which was at par with that of metsulfuron methyl + chlorimuron ethyl and Hand weeding twice gave higher harvest index. 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, Herbicides, Poaceae

INTRODUCTION

Finger millet is a seeded annual cereal which belongs to the grass family, *Poaceae*. The height of a mature plant ranges from 30-150 cm in the cool, high-altitude regions of Africa and Asia, where it is grown for its seeds. The seeds, which may be white, light brown, or dark brown, are consumed in a variety of forms including as unleavened bread made from milled flour. Various types of porridge and alcoholic beverages are also prepared from the seeds. Weeds are the major biotic stresses for finger millet cultivation. Its seeds are very small, which leads to a relatively slow development in early growing stages. This makes finger millet a weak competitor for light, water and nutrients compared with weeds. Finger millet is especially valuable as it contains the amino acid methionine, which is lacking in the diets of hundreds of millions of the poor who live on starchy staples such ascassava, plantain, polished rice, or maize meal. Finger millet can be ground and cooked into cakes, puddings or porridge. The grain is made into a fermented drink (or beer) in Nepal and in many parts of Africa. The straw from finger millet is used as animal fodder. It is also used for a flavored drink in festivals. Nutritional value of finger millet per 100g Protein 7.6g, Fat 1.5g, Carbohydrate 88g, Calcium 370mg, Vitamins - A: 0.48mg, Thiamine (B1): 0.33mg, Riboflavin (B2): 0.11mg, Niacin: (B3) 1.2mg. It is used both as medicinal and traditional purposes. 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). 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

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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 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 were recorded on the yield attributing characters and yield of crop to study the effect of weed management on productivity of Finger millet. Post harvest observations were recorded from net plot area under each treatment. Five fingers of the tagged plants were harvested separately and the length was measured in cm with the help of scale. Number of fingers was recorded from one m^{-2} area of each plot and used for statistical analysis. Number of total fingerlets $finger^{-1}$ was recorded from five randomly tagged plants and mean was worked out by dividing the total number of fingerlets by five and used for statistical analysis. Five panicles of the tagged plant were harvested separately and grains were manually removed from the panicle. The number of filled grains $finger^{-1}$ was counted and the mean was calculated. 1000 seeds from the winnowed produce of each plot were counted and same were oven dried till constant weight and then weight was recorded in gram by using an electronic digital balance. Grain yield of the net plot was noted after threshing, winnowing and drying, and then calculated in kilogram $hectare^{-1}$ with appropriate multiplication factor. The harvested produce from each net plot was tied in bundles separately. Straw yield of plot was noted down after subtraction of grain yield from bundle weight. Bundle weight was recorded in kilogram $hectare^{-1}$ with the help of spring balance. Harvest index was computed as the ratio of economic yield *i.e.* grain yield ha^{-1} to the total biomass *i.e.* biological yield ha^{-1} (grain and straw) and expressed in per cent, using formula given by Donald (1962) -

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

RESULT AND DISCUSSION

Hand weeding twice at 20 and 40 DAS proved significantly superior over all the treatments (Table 1). The lowest number of finger was recorded in fenoxaprop-p-ethyl (45.0 g ha^{-1}). The highest finger length was observed in hand weeding twice which was at par with ethoxysulfuron, metsulfuron methyl + chlorimuron ethyl, fenoxaprop-p-ethyl (45.0 g ha^{-1}) + ethoxysulfuron.

The lowest finger length was observed in weedy check which was statistically similar with cyhalofop-butyl, cyhalofop-butyl + metsulfuron methyl + chlorimuron ethyl and fenoxaprop-p-ethyl (45.0 g ha^{-1}).

Maximum number of fingerlet $finger^{-1}$ was recorded under hand weeding twice which was at par with ethoxysulfuron and metsulfuron methyl + chlorimuron ethyl and both were significantly superior over rest of the treatments. The lowest number of fingerlet $finger^{-1}$ was found in weedy check.

The highest number of grains $finger^{-1}$ was recorded under hand weeding twice which was at par with ethoxysulfuron, metsulfuron methyl + chlorimuron ethyl and fenoxaprop-p-ethyl (45.0 g ha^{-1}) + ethoxysulfuron and significantly superior over rest of the treatments. The lowest number of grains $finger^{-1}$ was found in weedy check which was at par with cyhalofop-butyl, cyhalofop-butyl + ethoxysulfuron, cyhalofop-butyl + metsulfuron methyl + chlorimuron ethyl and fenoxaprop-p-ethyl (37.5 g ha^{-1}).

The variation in test weight due to application of various weed management practices was observed. Lowest test weight was found in weedy check. Grain yield was significantly influenced by different weed management practices (Table 2). Hand weeding twice at 20 and 40 DAS proved significantly superior to all other treatments, which might be due to better weed control. The loss in grain yield due to weed competition was 55.4 per cent in weedy check. Singh and Arya (1999) also reported higher

grain yield with hand weeding twice. Per cent increase or decrease in grain yield of finger millet over weedy check is given in Fig.1 Among different herbicidal weed management practices, ethoxysulfuron recorded the highest grain yield which was at par with metsulfuron methyl + chlorimuron ethyl and significantly better than rest of the treatments including weedy check. The increase in grain yield was 47.0 and 42.8 per cent over weedy check, however, the yield was 34.4 and 36.3 per cent lesser compared to hand weeding twice with application of ethoxysulfuron and metsulfuron methyl + chlorimuron ethyl, respectively. These two herbicides controlled broad leaf weeds and sedges efficiently and were relatively non- phytotoxic to finger millet which might have resulted in higher grain yield than that of weedy check, however, the grasses were not controlled leading to poor grain yield compared to hand weeding twice. This is in confirmaly with Prasad *et al.* (2010) and Bhowmick and Ghosh (2002). The lowest grain yield was recorded under fenoxaprop-p-ethyl (45.0 g ha^{-1}). The data indicated that hand weeding twice at 20 and 40 DAS produced significantly higher straw yield which was at par with metsulfuron methyl + chlorimuron ethyl and ethoxysulfuron and significantly superior over rest of the treatments. The higher straw yield under hand weeding was also reported by Naik *et al.* (2001).

Hand weeding twice gave higher harvest index (13.77 %), which was at par with combined application of fenoxaprop-p-ethyl (37.5 g ha^{-1}) + ethoxysulfuron.The lowest harvest index was found with cyhalofop-butyl + ethoxysulfuron. In case of application of post emergence herbicide, the weed index (loss of yield due to weeds) ranged from 34.37 per cent to 93.62 per cent.

Gross returns, net returns and benefit: cost ratiowere worked out for different treatments (Table 3). Hand weeding twice gave maximum gross return which was due to higher grain and straw yield. Fenoxaprop-p-ethyl (45.0 g ha^{-1}) gave minimum gross return which was due to the lower yield. The maximum net return was observed in hand weeding twice which was at par with application of ethoxysulfuron and metsulfuron methyl + chlorimuron ethyl. All the other treatments recorded negative net return. The maximum B:C ratio was recorded with application of ethoxysulfuron which was at par with that of metsulfuron methyl + chlorimuron ethyl and hand weeding twice. Minimum B:C ratio was observed with application of fenoxaprop-p- ethyl (45.0 g ha^{-1}) which was at par with that of cyhalofop-butyl + ethoxysulfuro.

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.

Table 1. Yield attributes at harvesting stage of finger millet as influenced by different herbicidal treatments

Treatment	Dose (g ha^{-1})	Number of finger (m^{-2})	Finger length (cm)	No. of fingerlets $finger^{-1}$	No. of grains $finger^{-1}$	Test weight (g)
T_1 : Fenox		26.67	7.49	5.05	1588	2.88
T_2 : Fenox	45.0	12.00	7.19	5.69	2060	2.85
T_3 : MSM+CME	2.0+2.0	85.33	8.23	6.74	2652	3.19
T_4 : Ethox	15.0	81.33	8.31	6.89	2712	3.20
T_5 : Cyhalo	62.5	46.67	6.97	5.13	1510	2.99
T_6 : Fenox+MSM+ CME	37.5+2.0+2.0	46.00	7.40	6.18	2207	2.73
T_7 : Fenox+MSM+ CME	45.0+2.0+2.0	48.00	7.46	6.13	2229	2.79
T_8 : Fenox+Ethox	37.5+15.0	52.67	7.71	6.13	2193	2.97
T_9 : Fenox+Ethox	45.0+15.0	38.67	7.95	6.20	2507	2.77
T_{10} : Cyhalo+MSM+ CME	62.5+2.0+2.0	38.00	7.16	5.16	1532	2.87
T_{11} : Cyhalo+Ethox	62.5+15.0	28.00	7.56	5.07	1584	2.97

T_{12} : Weed free (HW at 20 and		104.00	8.43	6.96	2890	3.21
T_{13}: Weedy check		78.67	6.24	4.47	1317	2.33
SEm ±		3.84	0.33	0.36	163.76	0.11
CD at 5 %		11.2	0.97	1.06	478.07	0.34

Fenox = Fenoxaprop-p-ethyl, MSM = Metsulfuron methyl, CME = Chlorimuron ethyl, Ethox = Ethoxysulfuron, Cyhalo = Cyhalofop butyl, HW = Hand weeding

Table 2. Grain yield, Straw yield, Harvest Index and Weed Index of finger millet as influenced by different herbicidal treatments

Treatment	Dose ($g\ ha^{-1}$)	Grain yield ($Kg\ ha^{-1}$)	Straw yield ($Kg\ ha^{-1}$)	Harvest index (%)	Weed index (%)
T_1 : Fenox		140	1395	9.11	88.47
T_2 : Fenox	45.0	77	637	11.11	93.62
T_3 : MSM+CME	2.0+2.0	771	6155	11.34	36.23
T_4 : Ethox	15.0	794	5479	13.00	34.37
T_5 : Cyhalo	62.5	188	1217	13.39	84.53
T_6 : Fenox+MSM+ CME	37.5+2.0+2.0	191	1427	12.44	84.23
T_7 : Fenox+MSM+ CME	45.0+2.0+2.0	188	1219	13.44	84.52
T_8 : Fenox+Ethox	37.5+15.0	180	966	15.67	85.15
T_9 : Fenox+Ethox	45.0+15.0	165	819	15.56	86.37
T_{10} : Cyhalo+MSM+ CME	62.5+2.0+2.0	163	1328	11.00	86.53
T_{11} : Cyhalo+Ethox	62.5+15.0	119	1276	8.44	90.22
T_{12} : Weed free (HW at 20 and 40 DAS)		1210	6363	16.00	-
T_{13}: Weedy check		540	3737	12.64	55.40
SEm ±		21.58	310.86	0.76	-
CD at 5 %		63.00	907.34	2.23	-

Fenox = Fenoxaprop-p-ethyl, MSM = Metsulfuron methyl, CME = Chlorimuron ethyl, Ethox = Ethoxysulfuron, Cyhalo = Cyhalofop–butyl, HW = Hand weeding

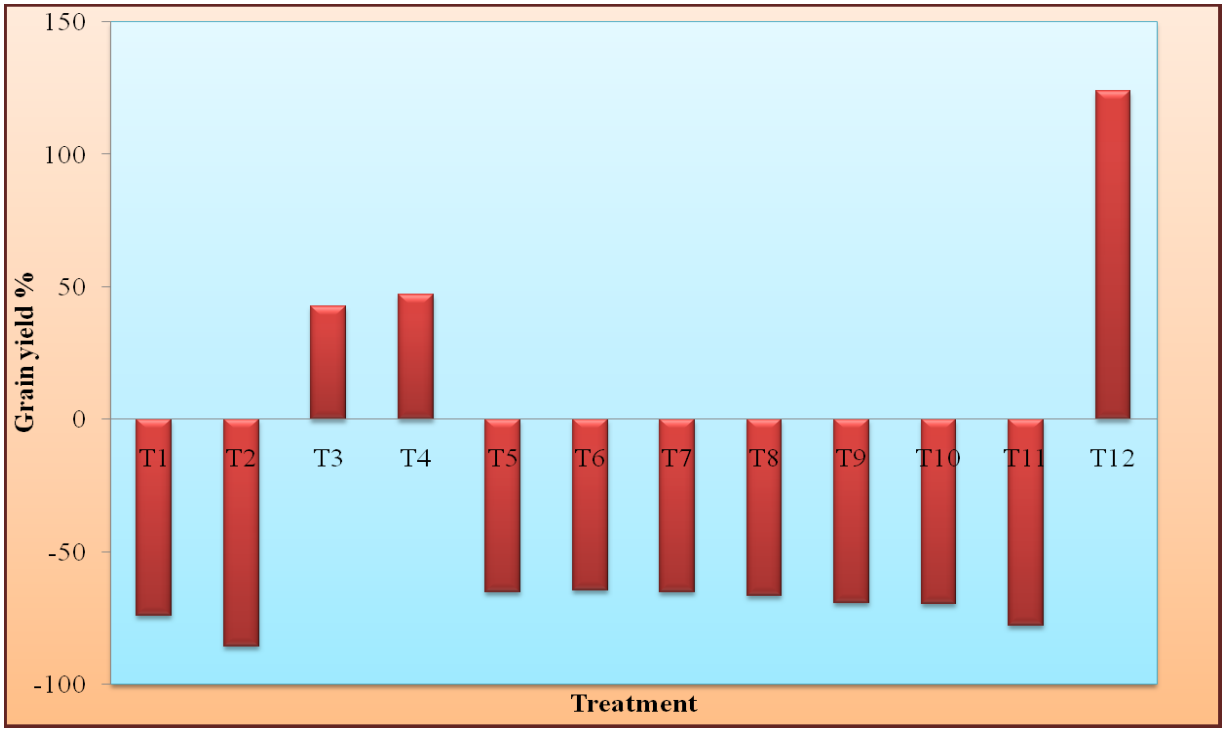

Fig 1: Per cent increase or decrease in grain yield of finger millet over weedy check as influenced by influenced different herbicidal treatments.

Table 3. Economics of different post emergence herbicides for weed management in finger millet

Treatments	Total Cost of Cultivation (Rs ha^{-1})	Gross Return (Rs ha^{-1})	Net Return (Rs ha^{-1})	B:C Ratio
T_1 : Fenox	12028	2863	-9165	0.24
T_2 : Fenox	12162	1551	-10611	0.13
T_3 : MSM+CME	11662	15417	3755	1.32
T_4 : Ethox	11795	15662	3867	1.33
T_5 : Cyhalo	12706	3682	-9023	0.29
T_6 : Fenox+MSM+ CME	12328	3801	-8527	0.31
T_7 : Fenox+MSM+ CME	12462	3689	-8773	0.30
T_8 : Fenox+Ethox	12548	3488	-9060	0.28
T_9 : Fenox+Ethox	12682	3199	-9483	0.25
T_{10} : Cyhalo+MSM+ CME	13006	3260	-9746	0.25
T_{11} : Cyhalo+Ethox	13226	2467	-10759	0.19
T_{12} : Weed free (HW at 20 and 40 DAS)	18370	23377	5007	1.27
T_{13}: Weedy check	11070	10648	-422	0.96
SEm ± CD at 5 %		451.39 1317.5	451.39 1317.5	0.03 0.10

Fenox = Fenoxaprop-p-ethyl, MSM = Metsulfuron methyl, CME = Chlorimuron ethyl, Ethox = Ethoxysulfuron, Cyhalo = Cyhalofop–butyl, HW = Hand weeding

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