

Integrated weed control in drill-sown rainfed finger millet (*Eleusine coracana*)

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ABSTRACT

Series of on-station field experiment and on-farm testing were conducted during 1994–99 on red sandy-loam soils of Gandhi Krishi Vignana Kendra, Bangalore, and on the farmers' fields of Bangalore, Kolar and Tumkur districts of Southern Karnataka, to evaluate the effects of herbicides, cultural and mechanical measures of weed control on yield of drill-sown rainfed finger millet [*Eleusine coracana* (L.) Gaertn.]. Out of 8 herbicides tested, pre-emergence application of isoproturon @ 0.75 kg a.i./ha gave comparable yield (2,907 kg/ha) to that of farmer's practice of 2 intercultivations and 1 hand-weeding (3,078 kg/ha) and weed-free check–1 intercultivation and 2 hand-weedings (3,177 kg/ha)—besides accounting for lower weed biomass (444, 125 and 59 kg/ha respectively) and higher weed-control efficiency (86.7, 96.2 and 98.2% respectively). Combinations of isoproturon @ 0.5 kg a.i./ha and cultural + mechanical measures of weed control have further enhanced the yield by 12.14% over no chemical. 2, 4-D sodium salt @ 0.75 kg a.i./ha as post-emergence spray 15–20 days after sowing was next best alternative herbicide. On farm trials confirmed the superiority of isoproturon to farmer's practice of weed control to an extent of 6.4% yield increase besides being less labour-intensive and providing effective weed control.

Key words : Weed control, Isoproturon, 2, 4-D sodium salt, Finger millet

Finger millet is an important staple food crop grown mostly under rainfed conditions during the rainy season in Southern parts of Karnataka, occupying more than 1 million ha in the state. It is grown mostly on red sandy-loam soils, which are poor in their productivity and low in moisture retention.

Prevalence of weeds in red soils is more as compared to black soils, since secondary tillage operations before sowing cannot be done frequently due to lack of moisture. Therefore, weed infestation would be very much higher during the initial stages of the crop growth and hence needs weed-free condition for the first 5–6 weeks from sowing. Though cultural and mechanical measures of weed control are still superior to chemical control measures, there are situations where these measures cannot be undertaken timely due to continuous wet spells, costly and lack of availability of labour on time and laborious. Thus the weeds compete with the crops and there is reduction in yield to an extent of 55–61%, depending on the intensity of weeds, type of weeds and time of competition (Ramachandra Prasad *et al.*, 1991). Hence present study was undertaken to know the effectiveness of many herbicides and later to select the promising herbicides in the first instance and followed by testing the efficacy of combination of chemical and cultural methods of weed con-

trol under rainfed conditions. Further, large-scale testing on the research station and farmer's field was taken up to confirm the findings.

MATERIALS AND METHODS

During 1994, screening of herbicides (8) was carried out at Gandhi Krishi Vignana Kendra, Bangalore, in finger millet-based cropping systems, viz. sole crop of finger millet and farmer's practice of *akkadi* along with standard cultural and mechanical measures, viz. 2 intercultivations 25 and 45 days after sowing (DAS) and 1 hand-weeding at 40 DAS (farmer's practice); 1 intercultivation at 45 DAS and 2 hand-weedings at 20 and 40 DAS (weed-free check) and were compared with unweeded check (absolute control). Among the herbicides tested, Anilofos 30 EC @ 0.4 kg ai/ha; isoproturon 75 WP @ 0.75 kg ai/ha; fluchloralin 45 EC @ 0.75 kg ai/ha; metolachlor (Dual) 50 EC @ 1.0 kg ai/ha were used as pre-emergent and 2,4-D sodium salt 80 WP @ 0.75 kg ai/ha; chlorimuron ethyl (Classic) 25 WP @ 15 g ai/ha; oxadiazon 50 EC @ 0.75 kg ai/ha; ethoxy sulfuron WG 15 (HOE 95404) belongs to chemical family Sulfonyl urea @ 10 g ai/ha were tried as post-emergent herbicides. In all, there were 2 main plot treatments with 11 subplot treatments, replicated thrice laid out in split-plot design using 'Indaf 8' finger millet.

During 1995–97, two best herbicides, viz. isoproturon and 2,4-D sodium salt, were integrated with cultural and mechanical measures of weed control, viz. 2 intercultivations at 20 and 40 DAS; 2 hand-weedings and 2 intercultivations at 20 and 40 DAS + 1 hand-weeding at 35 DAS. The treatments were replicated thrice in factorial randomized block design using variety 'PR 2002'. Further, on-farm and on-station demonstrations were laid out during the rainy season 1997–99 at 11 different locations of Bangalore, Kolar and Tumkur districts of Southern Karnataka where isoproturon @ 0.5 ai/ha as pre-emergence herbicide along with 2 intercultivations were compared with farmer's practice.

Recommended management practices were adopted for raising the crop during the experimentation. Pre-emergence herbicides were sprayed on the day of sowing or on the next day after sowing as per the treatments, whereas post-emergence herbicides were applied 15–20 DAS.

RESULTS AND DISCUSSION

Major weeds observed in drilled-finger millet included *Cyperus rotundus* L., *Digitaria marginata* Link, *Dactyloctenium aegyptium* Picht, *Digitaria sanguinalis*, *Eragrostis pilosa* Beauv and *Cynodon dactylon* Pers. among grasses; *Acanthospermum hispidum* DC., *Argemone mexicana* L., *Borreria stricta* L., *Ageratum conizoides* L., *Portulaca quadrifolia*, *Amaranthus viridis* L., *Euphorbia hirta* Linn., *Leucas aspera* Sprang, *Celosia argentea*, *Tridax procumbens* L. and *Digera arvensis* among dicot weeds.

During 1994 between the cropping systems, there was non-significant difference in yield (Table 1). However, sole crop gave higher grain yield than mixed crop. This confirms the findings of Nanjappa and Hosmani (1986). Among the cultural and mechanical methods of weed control, weed-free check recorded significantly higher grain yield than other treatments, but it was on a par with

Table 1. Effect of pre- and post-emergence herbicides on finger millet-based cropping system (1994)

Treatment	Finger millet equivalent yield (kg/ha)	Dry weight of weeds (kg/ha)	Weed index (%)	Weed-control efficiency	Increase (%) over control
Cropping system (main plot)					
C ₁ , Sole crop	37 (1,865)	2,016	41.3	39.5	
C ₂ , Mixed crop (farmer's practice, <i>akkadi</i>)*	40 (1,818)	1,465	42.8	56.0	
CD (P=0.05)	NS	190			
Weed-control measure (subplot)					
<i>Pre-emergence spray</i>					
T ₁ , Anilophos @ 0.4 kg ai/ha	9 (163)	2,379	94.9	28.3	
T ₂ , Isoproturon @ 0.75 kg ai/ha	54 (2,907)	444	8.4	86.7	75.3
T ₃ , Fluchloralin @ 0.75 kg ai/ha	10 (168)	2,267	94.7	32.0	
T ₄ , Metalochlor @ 1.0 kg ai/ha	10 (196)	2,768	93.8	16.9	
<i>Post-emergence spray</i>					
T ₅ , 2, 4-D Na salt @ 0.75 kg ai/ha	50 (2,496)	1,532	21.4	54.0	
T ₆ , Oxadiazon @ 0.75 kg ai/ha	48 (2,293)	1,299	27.8	61.0	
T ₇ , Chlorimuron ethyl (Classic) @ 15 g ai/ha	47 (2,185)	1,997	31.2	40.1	
T ₈ , Ethoxy sulfuron (HOE 95404) @ 10 g ai/ha	44 (1,940)	2,954	38.9	11.3	
Cultural and mechanical measures					
T ₉ , 2 intercultivation operations (25, 45 DAS)+ 1 hand-weeding (40 DAS-farmer's practice)	55 (3,078)	125	3.1	96.2	85.6
T ₁₀ , 1 intercultivation (45 DAS) + 2 hand-weedings (20, 40 DAS)	56 (3,177)	59		98.2	91.6
weed-free check					
T ₁₁ , Control or unweeded check	41 (1,658)	3,322	47.8		
CD (P=0.05)	3.540				
Interaction [CD (P=0.05)]					
Weed-control measures at same level of cropping systems	5.007				
Cropping system at the same level of weed control measures	5.112				

Figures outside parentheses are square-root transformed values; figures in the parentheses are original values

*Several crops (sorghum, field bean, pigeonpea, Indian mustard and niger) were mixed and sown after every 8 rows

farmer's practice, and isoproturon-sprayed plots as pre-emergence. The other pre-emergent herbicides, viz. anilofos, fluchloralin and metolachlor, caused phytotoxicity to finger millet. Among the post-emergence herbicides tried, 2,4-D Na salt recorded significantly higher grain yield than ethoxy sulfuron and unweeded check, but was on a par with oxadiazon and chlorimuron ethyl. Among cultural and mechanical methods of weed control, weed-free check and farmer's practice along with pre-

emergence application of isoproturon at 0.75 kg ai/ha gave excellent weed control by registering lower weed biomass (59, 125 and 444 kg/ha respectively) and higher weed-control efficiency.

In the second phase of experimentation during 1995, higher grain yield was obtained owing to pre-emergence application of isoproturon @ 0.375 kg ai/ha over 2,4-D Na salt and the control. Among the cultural and mechanical measures of weed control, 2 weedings (4,949 kg/ha) re-

Table 2. Effect of integrated weed-control measures on yield of finger millet

Treatment	1995	1996	1997	Mean	Increase % over control
<i>Chemical (C)</i>					
C ₁ , No chemical	4,286	1,560	1,492	2,446	
C ₂ , Isoproturon @ 0.50 kg ai/ha as pre-emergence	4,549*	1,757	1,924	2,743	12.14
C ₃ , Isoproturon @ 0.50 kg ai/ha + 1% CaO as ameliorative			1,907	1,907	
C ₄ , 2,4-D Na salt @ 0.75 kg ai/ha as post-emergence	4,150	1,668	1,573	2,470	0.98
C ₅ , 2,4-D Na salt @ 0.75 kg ai/ha + 1% CaO as ameliorative		1,730	1,359	1,545	
CD (P=0.05)	NS	NS	356		
<i>Cultural and mechanical measure (M)</i>					
M ₁ , 2 hand-weedings at 20–25 and 35–40 DAS	4,949	1,857	1,869	2,892	34.76
M ₂ , 2 intercultivations (20, 40 DAS) + 1 hand-weeding (35 DAS) farmer's practice	4,214	1,775	1,845	2,611	21.66
M ₃ , Control	3,778	1,420	1,240	2,146	
CD (P=0.05)	282	202	278		
C × M interaction CD (P=0.05)	NS	NS	NS		

*0.375 kg isoproturon a.i./ha

Table 3. Results of farm trials on the use of isoproturon for weed control in rainfed finger millet conducted by State Department of Agriculture in Bangalore, Kolar and Tumkur

Name of taluk and village	Grain yield (kg/ha)		Increase (%) over check	Labour for weeding (No./ha)		Labour cost for weeding	
	T ₁	T ₂		T ₁	T ₂	T ₁	T ₂
Anekal	3,215	3,000	4.2		40		1,000
Bangalore North (Challahalli)	2,625	2,500	5.0	10	50	300	1,500
Bangalore South (Chikkaverappanapalya)	2,200	1,900	15.8		50		2,000
Chikkabalapura (Reddigollavarahalli)	2,200	2,000	10.0	10	60	250	1,500
Hosakote (Tavatahalli)	2,850	2,700	5.6	8	38	280	1,330
Doddaballapura (Maralenahalli)	2,150	2,075	3.6	25	65	750	1,950
Devanahalli (Gobaragunte)	1,625	1,500	8.3	12	45	360	1,350
Kolar (Anakathatti)	2,700	2,600	1.9	2	45	50	1,125
Malur (Gerapura)	1,800	1,650	9.1	2	20	80	800
Madugiri (Sammerehalli)	1,575	1,500	5	10	52	250	1,300
Nelamangala (Kodappanahalli)	3,500	3,300	6.1	10	58	300	1,740
Mean	2,395	2,252	6.4	8	48	238	1,418

*Gross plot size 0.05 ha each treatment

T₁, Application of isoproturon; T₂, farmer's practice (hand-weeding)

Table 4. Economics of chemical weed-control measures in rainfed finger millet (1995–97)

Treatment	Gross returns (Rs/ha)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	Added cost (Rs/ha)	Benefit : cost ratio
Isoproturon @ 0.5 kg ai/ha as pre-emergence	13,081	7,287	5,794	360	1.80
2,4-D Na salt @ 0.75 kg ai/ha as post-emergence	11,232	7,217	4,015	290	1.56
Hand-weeding	14,296	7,802	6,494	875	1.83
Unweeded control	7,461	6,537	924		1.14

sulted significantly higher grain yield over other cultural and mechanical measures tested (Table 2).

However, in 1996 though there was non-significant differences in yields between the herbicides tested, isoproturon @ 0.5 ai/ha as pre-emergence application resulted higher yield than 2,4-D sodium salt @ 0.75 kg ai/ha as post-emergence spray. Among the cultural and mechanical measures, 2 hand-weedings at 20–25 and 35–40 DAS and farmer's practice gave comparable yields and both were significantly superior to the control. However, the interaction between chemical and cultural or mechanical measures of weed control were non-significant for yield (Table 2).

On the contrary, during 1997 isoproturon-treated plots as pre-emergence @ 0.5 kg ai/ha gave significantly higher grain yield than 2,4-D and no chemical spray. Among the cultural and mechanical measures, 2 hand-weedings at 20–25 and 35–40 DAS and farmer's practice gave comparable yields and were significantly superior to the control (Table 2).

The increase in yield over the control by the herbicides and cultural and mechanical measures of weed control was owing to effective weed control, resulting in good stand of the crop. Between the herbicides, isoproturon gave higher yield than 2,4-D owing to better weed control in the beginning of the crop-growth period (30–35 DAS), which coincides, with the critical period of weed competition (Sundaresh *et al.*, 1975).

Further, on-farm demonstrations conducted at Bangalore, Kolar and Tumkur districts (Table 3) indicated that isoproturon @ 0.5 kg ai/ha as pre-emergence spray enhanced yield by 6.4% over farmer's practice besides being less labour-intensive (8 labourers/ha) and less added cost on labour having a benefit : cost ratio of 1:1.80 (Table 4).

In areas of labour scarcity, costly and non-availability on time, where extensive areas have to be weeded in short time, and in situations where wet conditions prevail and weed control through cultural and mechanical measures are not possible, use of isoproturon @ 0.50 ai/ha for controlling the weeds in drilled rainfed finger millet is a better choice or integrated with cultural and mechanical measures of 2 intercultivations and 1 hand-weeding can further enhance yield besides giving good weed control.

The next alternative herbicide is 2,4-D Na salt @ 0.75 kg ai/ha applied as post-emergence 15–20 DAS along with 2 intercultivation is ideal for providing good weed control and to maintain higher yield levels of rainfed drilled finger millet.

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