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Long term herbicide usage on weed shift and productivity in transplanted finger millet – groundnut cropping system in southern Karnataka

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ABSTRACT

A field experiment was initiated during Kharif, 1999 with finger millet as first crop followed by groundnut in summer season at the Main Research Station, Hebbal, Bengaluru to know the long term effect of herbicide usage in the same piece of land on weed shift and yield of crops during 1999 to 2008. The pooled data of nine finger millet crops from 1999 to 2007 Kharif indicated that application of butachlor at 0.75 kg ai/ha more or less gave similar grain yield (3533 kg/ha) to hand weeding twice (3395 kg/ha), due to good control of weeds. Similarly over nine groundnut crops, pod yield obtained in plots applied with pendimethalin at 1.0 kg ai/ha (2160 kg/ha) was similar to hand weeding twice (2094 kg/ha). Continuous application of alachlor 1.0 kg ai/ha in groundnut and 2,4-D EE 0.75 kg ai/ha in finger millet paved way for dominance of grasses particularly Digitaria marginata, Dactyloctenium aegyptium and Echinochloa colona, while use of pendimethalin treated plot showed higher emergence of Commelina benghalensis. Further plot applied with FYM + fertilizer gave slightly higher yield as compared to plot applied with fertilizer alone in groundnut – finger millet cropping system. A saving of weeding cost to an extent of Rs. 6810 to 6980/ha in finger millet and Rs. 3018 to 3910/ha was observed in groundnut by using herbicides as compared to hand weeding. None of the herbicides affected the establishment, growth and yield of succeeding crops over past nine years, in spite of herbicides being applied continuously on the same piece of land.

Key words: Finger millet, groundnut, long term herbicide usage and weed shift

The Herculean task of achieving higher food production can be achieved through steep increase in the productivity of different cropping systems using improved technologies, increased cropping intensity and irrigation potential. Finger millet and groundnut are major cereal and oilseed crops of southern Karnataka. Weeds are one of the major constraints in the production of groundnut and finger millet. Weed management strategies have been adequately developed for individual crops, finger millet and groundnut. However, the weed management strategies for finger millet - groundnut cropping system are limited. The earlier studies have indicated that change in cropping system like transplanted finger millet followed by pulses lower the menace of *Cyperus rotundus* with concomitant increase in the density of *Portulaca oleracea* and *Digitaria marginata* (Anon., 1998). Similarly by adopting transplanted finger millet – groundnut system, the density of *Cyperus rotundus* was lowered in finger millet crop after the harvest of groundnut as a result of digging of plants at the time of harvest (Anon., 1998, Kumara, 2004). The usage of recommended herbicide(s) for the first crop in a sequence should not cause any residual effect on the succeeding crop or vice-versa. Continuous application of same herbicide results in shift in weed flora as observed in transplanted rice – rice system in Southern Karnataka (Ramachandra Prasad *et al.*, 2008). There is a need to document the shift in weed flora in a cropping system involving cereals, pulse/oilseed. In addition, integration of FYM along with recommended fertilizer application appeared to sustain the productivity of crops. Therefore an investigation to study the effect of weed management practices along with fertility levels in cropping system of groundnut - finger millet on shifting of weed flora, yield and economics was undertaken.

MATERIALS AND METHODS

The field experiment was initiated during Kharif 1999 with finger millet as first crop followed by groundnut during summer as the second crop at the Main Research Station, Hebbal, Bengaluru, under the jurisdiction of the University of Agricultural Sciences, Bengaluru. The soil type of the experimental site was red sandy loam with average fertility level. The finger millet – groundnut cropping system was taken up from 1999 to 2008 on the same piece of land. In both finger millet and groundnut cropping system, three weed management practices were compared with two sources of fertility levels, *viz.*, F_1 – 75% NPK supplied through fertilizer + 25% N supplied through FYM, and F_2 – 100% NPK supplied through fertilizers only. In finger millet, three weed management practices tried were W_1 – Butachlor 0.75 kg ai/ha (pre- emergence, within 3 days after planting {DAP}), W_2 – 2, 4-D EE 0.75 kg ai/ha (post-

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emergence, 15 DAP) and W_3 – Hand weeding twice (20 and 45 DAP). While in groundnut, three weed management practices namely W_1 – Pendimethalin 1.0 kg ai/ha (pre- emergence, within 3 days after sowing {DAS}, W_2 – Alachlor 1.0 kg ai/ha (pre-emergence) and W_3 – Hand weeding twice (20 and 40 DAS). The gross and net plot sizes were 9.0 m x 4.5 m and 8.4 m x 3.9 m, respectively.

Finger millet cv. GPU – 28 was taken up as transplanted crop with 25 days old seedlings during Kharif 1999 to 2007 with recommended fertilizer dose (RDF) of 100 kg N, 50 kg P_2O_5 and 50 kg K_2O per ha and common spacing of 22.5 cm x 15 cm, while groundnut Cv. TMV-2 was taken up during summer 2000 to 2008 (9 crops) with RDF of 25 kg N, 75 kg P_2O_5 and 38 kg K_2O/ha and common spacing of 30 cm x 15 cm.

In both the crops, species wise weed density was taken up at 30, 60 DAS/P and at harvest in 50 cm x 50 cm quadrant at two spots per treatment, apart from taking dry weight of weeds' category – sedge, grasses and broad leaf weeds. The overall grain yield of finger millet and pod yields of groundnut obtained during 1999/ 2000 to 2007 have been presented in the Table 1.In this paper, changes in the weed flora due to continuous use of herbicides in finger millet and groundnut separately has been documented and presented (Table 2).

RESULTS AND DISCUSSION

a) Yield:

i) Finger millet: Over nine years (1999 to 2007), the grain yield obtained in finger millet applied with fertilizer only gave yield (3263 kg/ha) similar to finger millet receiving both fertilizer and FYM (3216 kg/ha). Among weed control treatments, grain yield obtained in plot treated with butachlor (3533 kg/ha) was similar to hand weeding twice (3395 kg/ha) and these were significantly superior to 2,4-D EE (2791 kg/ha) owing to good control of grasses, as the latter treatment was effective on broad leaf weeds (Table 1). The interaction effect was significant. Butachlor and hand weeding treatments gave higher grain yield at both sources of fertility than 2,4-D EE treatment (Table 1). Similar indications of weed control by using herbicides have been observed by Kumara (2004) earlier.

ii) Groundnut: Over nine seasons, the pod yield was significantly higher in plot treated with pendimethalin (2160 kg/ha) as compared to alachlor (1865 kg/ha), but comparable with hand weeded plots (2094 kg/ha), as result of good control of weeds particularly grasses. Where as alachlor was not that effective against grasses and consequently resulted in lower pod yield. Nevertheless, pendimethalin treated plots over years paved way for dominance of sedges (nearly seven fold increase) and also broad leaf weeds (three fold increase) with considerable reduction in the density of grasses (two fold) and consequently gave higher yield than alachlor treated plots. This clearly envisaged that grasses offered greater competition than sedge or broad leaf weeds in groundnut, by virtue of tall stature and higher receipt of sunlight (Table1).

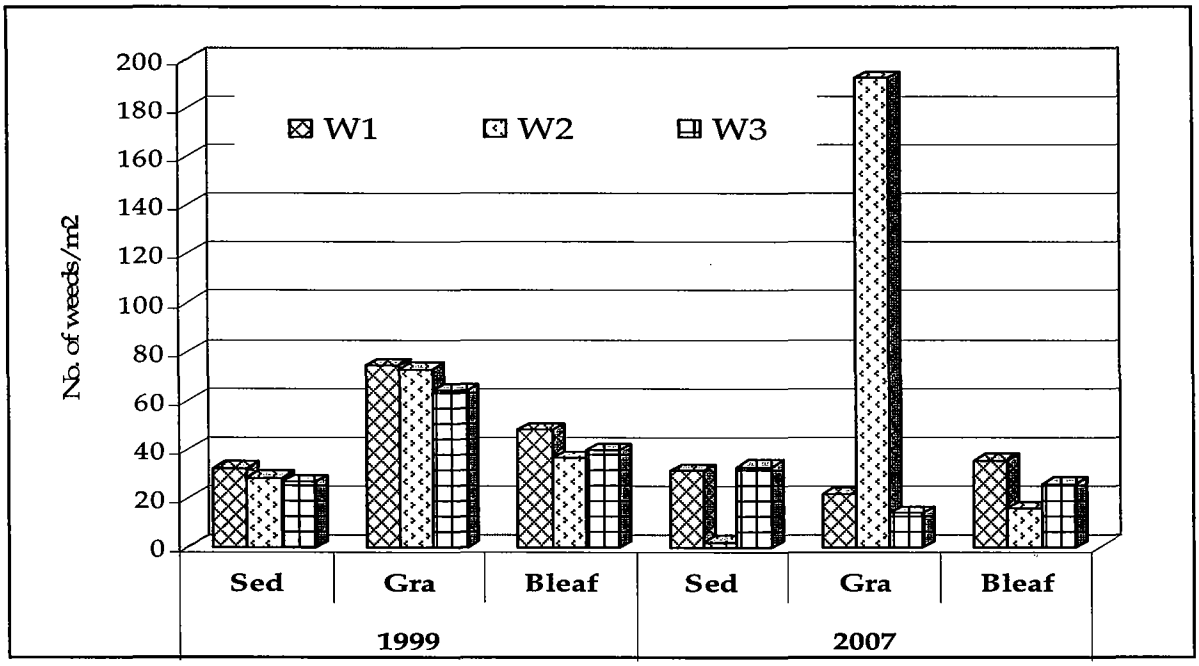
The beneficial effect of FYM on pod yield of groundnut was clearly visualized in the 5th crop cycle onwards in groundnut. However in the ninth season, application of FYM + fertilizer gave pod yield (1985 kg/ha) similar to mere fertilizer application only (1951 kg/ha) without affecting the weeds' growth/ density and subsequent weeds' emergence. Averaged over nine seasons, the integrated use of fertilizer and FYM gave slightly higher yield (2093 kg/ha) than the use of fertilizer alone (1986 kg/ha) (Table 1) perhaps due to improvement of soil physico-chemical properties, as also observed by Kachot *et al.* (2001) and Kumara (2004) in groundnut.

b) Shift in weed flora

i) Finger millet: At the beginning of the study in 1999, the density of sedge, grasses and broad leaf weeds was similar among weed management practices. The major weed flora in 1999 was *C. rotundus* (sedge), *D. marginata, D. aegyptium* (among grasses), *A. conyzoides* and *L. mollis* (among broad leaf weeds). Continuous application of butachlor in finger millet for almost nine years lowered the grasses' density (*D. marginata, E. colona*) considerably and paved way for increased sedge density. Further, *C. benghalensis* and *Lagascea mollis* were minor weed (less than 4.0/m^2 at harvest) in 1999 in butachlor sprayed plot and it increased its density to 13 to 20/m^2 (at 30 DAP) by 2007 owing to continuous application of butachlor. Continuous application of 2,4-D EE had no effect on grasses and their density increased from 72.8/m^2 in 1999 to 104.2/m^2 at 30 DAP by 9th crop cycle in 2007. This evidently indicates that continuous application of herbicides paved way for dominance of a particular weed in finger millet crop (Fig. 1), as also reported by Ramachandra Prasad (1993), Channa Naik *et al.* (2000) and Kumara (2004).

ii) Groundnut: Effort was made to know the change in weed flora due to weed management practices comparing the density of category of weeds/ m^2 at 60 DAS in 2000 summer crop and 2008 summer groundnut (Fig. 2). The build up of density of sedge was evident by 9th crop (2000 to 2008) in pendimethalin applied plots (16/m^2 at 2000 to 86/m^2 at 2008) owing to suppression of grasses (34.4/m^2 in 2000 to 19.9/m^2 in 2008), while in alachlor treated plots, there was increased density of grasses particularly *D. marginata, D. aegyptium* and *E. colona* after 30 days onwards by 9th crop (17.0/m^2 in 2000 to 54.1/m^2 in 2008). The density of broad leaf weeds also showed an increasing trend in pendimethalin applied plot (16.0/m^2 in 2000 to

45.0/m^2 in 2008) owing to increase in the density of *Commelina benghalensis*, as the herbicide is not effective on this weed from initial stages itself. While in alachlor treated plot, there was considerable increase in the density of grasses particularly *D. marginata* and *D. aegyptium* in 2008 as compared to density of grasses in 2000 summer. In addition, there was also increase in the density of sedge, as the herbicide, alachlor is not effective. In hand weeded plot, increase in the density of sedge, *C. rotundus* was observed from 11.2/m^2 in 2000 to 36.9/m^2 in 2008 (Fig. 2). Thus, it was clear that continuous application of pendimethalin and alachlor over 9 year's period favoured dominance of sedge and grasses, respectively, while hand weeding did not favour the dominance of weeds' category. However, the density of sedge, *C. rotundus* showed an increasing trend over years owing to non-effectiveness of the method and effective control of other category of weeds – grasses and or broad leaf weeds (Table 2). As observed in the present study, shift in weed flora due to herbicides' usage in groundnut is also reported by Ramachandra Prasad (1993) and Kumara (2004).

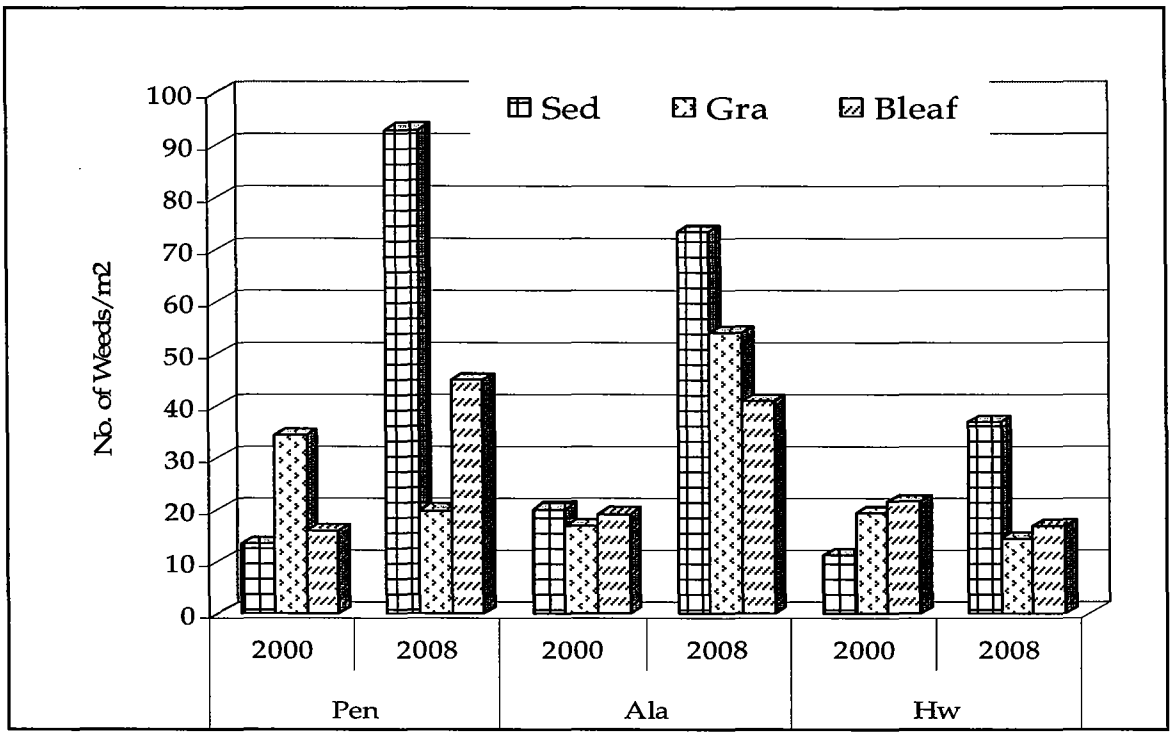


Note: Sed- sedges, Gra- grasses,

Fig. 1. Shift in weed flora due to continuous use of weed management practices in transplanted finger millet.

c) Economics of weed management: In finger millet, use of herbicides – butachlor 0.75 kg ai/ha – 3 DAP (Rs. 670/ha) and 2,4-D EE 0.75 kg ai/ha – 15 DAP (Rs. 840/ha) was cheaper than two hand weeding, amounting to Rs. 7650/ha. Thus, a saving of weeding cost to an extent of Rs. 6810 to 6980/ha was observed by using herbicides as compared to hand weeding, though it gave comparable yield to butachlor (Table 2). Regarding the cost spent on weed management in groundnut by using herbicides was lower (Rs. 1040 in alachlor to Rs. 1932/ha in pendimethalin) as compared to hand weeding (Rs 4950/ha). The saving in weeding cost through herbicides amounted to Rs. 3018 to 3910/ha, as compared to hand weeding (Table 2). This suggested that herbicides are economical and cost effective in managing weeds right from the initial stages as compared to hand weeding as also observed by Raj Singh *et al.* (1996), Gnanamurthy and Balasubramaniyan (1998), Sukhadia *et al.* (2000) and Kumar (2004).

None of the herbicides affected the establishment, growth and yield of succeeding crops over past nine years, in spite of herbicides being applied continuously on the same piece of land, owing to degradation of applied herbicides in the soil by 120 days after application as observed by Kumara (2004) earlier on red sandy loam soil at Hebbal condition.



Note : Pen-Pendimethalin, Ala- Alachlor, Hw- Hand weeding

Fig. 2. Effect of continuous use of weed management practices on the shift in weed flora at 60 DAS in groundnut.

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Table 1. Effect of weed management practices on pod / grain yield of finger millet – groundnut system with and with out FYM

Treatment	Ground nut [Summer] (kg/ha)				Treatments	Finger millet [Kharif] (kg/ha)			
	2000	2003	2008	Mean		1999	2004	2007	Mean
Pendimethalin + FYM	1481	2182	1985	2196	Butachlor + FYM	3755	2690	3123	3497
Alachlor + FYM	1541	1949	1725	1888	2,4-D + FYM	3149	2139	1841	2801
HW + FYM	1630	2131	2244	2194	HW + FYM	3805	3157	3157	3156
Pendimethalin	1512	1943	1942	2124	Butachlor	3699	3264	2976	3570
Alachlor	1930	1810	1786	1841	2,4-D EE	3028	2755	2235	2781
HW	1867	2165	2125	1993	HW	3796	3293	3254	3439
LSD (0.05)	**347**	**312**	**NS**	**253**		**NS**	**833**	**760**	**660**
Averaged over weed management practices									
NPK 75% (fert.)+25% (FYM)	1551	2087	1985	2093		3570	2662	2707	3216
NPK 100% (fert.)	1770	1973	1951	1986		3508	3104	2823	3263
LSD (0.05)	**124**	**NS**	**38**	**NS**		**NS**	**152**	**NS**	**NS**
Averaged over FYM/ Fertilizer									
Pendimethalin	1497	2062	1964	2160	Butachlor	3727	2977	3051	3533
Alachlor	1736	1880	1756	1865	2,4-D	3089	2447	2038	2791
Hand weeding	1749	2148	2185	2094	Hand weeding	3801	3225	3205	3395
LSD (0.05)	**167**	**225**	**142**	**182**		**355**	**286**	**439**	**320**

Note:

Butachlor 0.75 kg a.i.ha^{-1}(pre-em.), 2,4-D EE 0.75 kg a.i.ha^{-1} (post-em.);
Pendimethalin 1.0 kg a.i.ha^{-1}(pre – em.), Alachlor 1.0 kg a.i.ha^{-1}(pre – em.),;
HW = Hand weeding (20 and 40/45 DAS/DAP);.

Table 2 : Economics of weed management practices in finger millet - groundnut cropping system.

Finger millet (1999 – 2007, Kharif)			Groundnut (2000 - 2008, Summer)		
Management practices	Cost Rs./ha)	Savings over HW (Rs./ha)	Management practices	Cost (Rs./ha)	Savings over HW (Rs./ha)
Butachlor 50	670	6980	Pendimethalin	1932	3018
2,4-D	840	6810	Alachlor	1040	3910
HW (20 & 45 DAP)	7650	--	HW (20 & 40 DAS)	4950	--

Cost of herbicides :

i) Pendimethalin 30 EC Rs. 460/liter, ii) Alachlor 50 EC = Rs. 320/liter,
iii) Butachlor 50 EC Rs. 180/liter, iv) 2, 4-D EE 38 EC Rs. 220/liter;
v) Application cost – Rs. 400/- per ha, vi) cost of labour – Rs. 90/- per day of eight hours work