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Integrated weed management for rainfed groundnut

A. RAMAKRISHNA, C K ONG and S L N REDDY

International Crops Research Institute for the Semi Arid Tropics (ICRISAT), Patancheru 502324, A P, India

Abstract: Field experiments were conducted under rainfed conditions in 1987 and 1988 on groundnut (*Arachis hypogaea*) to test the comparative efficacy of pre-emergence herbicides metolachlor [2 chloro-N (2-ethyl 6 methylphenyl)-N (2-methoxy-1 methylethyl) acetamide] and pendimethalin [N (1-ethylpropyl)-3, 4-dimethyl-2,6 dinitrobenzanamine] applied separately, in mixture and in combination with hand weeding The density and dry mass of grass weeds were significantly reduced by herbicide and hand weeding treatments, at all stages of crop growth Integration of herbicides and hand weeding resulted in reduced density and dry mass of broadleaved weeds in comparison with herbicides applied alone Pre-emergence applications of pendimethalin (1 0 kg ha ^{1}) or metolachlor (1.0 kg ha ^{1}) were equivalent to a single hand weeding at 30 days after sowing (DAS) Integration of herbicide and hand weeding at 30 DAS gave consistent and effective weed control and higher pod yields over the two years

Key words: *Arachis hypogaea*, integrated weed control, handweeding, metolachlor, pendimethalin, groundnut

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INTRODUCTION

In groundnut, weeds not only compete for nutrients, light and moisture, but also interfere with farm operations including harvesting (Henning *et al.*, 1982). Being a short statured crop, it is heavily infested by weeds which can reduce crop yields by 25-80% (Naidu *et al.*, 1983). Weed infestation in the rainy season is twice as heavy as in post rainy season (Shanmugam, 1984). Hand weeding is not entirely satisfactory because of narrow row spacing and possible damage to pegs. In addition, with the increasing migration of villagers to urban areas farm labour is becoming expensive and scarce. Chemical weed control can be effective for groundnut if the correct herbicide is applied in appropriate dose, and time (Reddy *et al.*, 1980). However pre-emergence herbicides usually do not provide complete control of weeds since weed emergence does occur at later stages of crop growth and effectiveness is variable (Rathi *et al.*, 1986). Most weed control research has evaluated either chemical or mechanical methods alone. Neither chemical nor mechanical methods alone were adequate for consistent and acceptable weed control, groundnut yield or net returns (Bridges *et al.*, 1984). Hence, integration of chemical and mechanical methods of weed control may be more appropriate and requires further study. The present study was carried out to evaluate the effectiveness of metolachlor and pendimethalin separately, in mixtures, and in combination with manual methods for the control of weeds in groundnut.

MATERIALS AND METHODS

Bunch groundnut cv. Robout 33-1 was grown at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India (18°N, 78°E) during the rainy seasons of 1987 and 1988. The soil was an Alfisol (Udic Rhodostalf), sandy clay loam in texture, with a pH of 8.4 and an available water holding capacity of about 100 mm in the top 90 cm of the profile. It contained 19.2 kg ha^{-1} of available inorganic ($NH_4^+ + NO_3^-$) nitrogen (Bremner, 1965), 12.5 kg ha^{-1} of available phosphorus (Olsen and Sommers, 1982) and 158 kg ha^{-1} of potassium (Jackson, 1967). A fertilizer dressing of 18 kg N and 46 kg P_2O_5 ha^{-1} in the form of diammonium phosphate was applied at the time of discing after initial ploughing with a mould board plough. The field was subsequently rotovated and levelled.

The experiment was arranged in a randomized complete block design with three replications. Groundnut was sown in plots of 6.0 m x 9.0 m in rows 30 cm apart at a rate of 100 kg ha^{-1} seed on broad beds of 1.5 m on 26 June 1987 and 21 June 1988. An area of 3.0 m x 6.0 m from the centre of each plot was hand harvested on 28 October 1987 and 13 October 1988. The rainfall received during the crop growth period in 1987 (506 mm) was lower than 1988 (871 mm). The average seasonal rainfall for the location is 760 mm.

The treatments were (i) metolachlor or pendimenthalin at 1.0 and 1.5 kg a.i. ha^{-1}, (ii) a combination of metolachlor and pendimethalin at 1.0 kg a.i. ha^{-1} each; (iii) pre-emergent application of pendimethalin or metolachlor at 1.0 kg a.i. ha^{-1} followed by hand weeding at 30 days after sowing (DAS); and (iv) hand weeding at 30 DAS or at 30 and 45 DAS. A non-weeded control was included. All the herbicides were applied one day after sowing with a knapsack sprayer fitted with a flat fan-type nozzle, using water as a carrier at a volume of 600 l ha^{-1}. Weeds were sampled at 30 and 60 DAS and at harvest within a 1.0 m^2 quadrat and separated into grasses and broadleaves. They were counted, washed and oven dried to estimate the density and dry mass. The data on weed density and dry mass was transformed into $\sqrt{x + 0.5}$ for statistical analysis. Groundnut plant height at 30 and 60 DAS, and pod yields ha^{-1} at maturity were recorded.

The major grass weeds were *Echinochloa colona* (L.) Link., *Urochloa panicoides* Beauv., *Digitaria ciliaris* (Retz.) Koeler. and *Dactyloctenium aegyptium* (L.) P. Beauv. The broadleaved weeds were *Amaranthus viridis* L., *Digera muricata* (L.) Mart., *Celosia argentea* L., *Portulaca oleracea* L., *Lagascea mollis* Cav., *Indigofera glandulosa* Willd., *Trianthema portulacastrum* L., *Eclipta alba* (L.) Hassk. and *Cucumis* sp.

RESULTS AND DISCUSSION

Effect on weeds

The herbicides applied alone and in combination with hand weeding significantly reduced the grass weed density at all stages of crop growth in both years in comparison with the weedy check (Table 1). No differences in grass suppression were observed between various weed management

Table 1. Influence of herbicides and herbicide/manual weeding combinations on total weed density (g m^2).

Treatment	Rate of application (kg a.i ha^{-1})	30 DAS				60 DAS				At harvest			
		1987		1988		1987		1988		1987		1988	
		G	B	G	B	G	B	G	B	G	B	G	B
Metolachlor	1.0	0.0b	5.3c	0.3b	4.0b	20.3b	29.7a	1.3b	4.7b	4 0b	14.0a	5.0bc	18.7b
Metolachlor	1.5	0.7b	7.0c	0.0b	4.3b	2.0c	10.3b	1.7b	2.7b	3.3b	17.3a	3.3bc	13.3bc
Pendimethalin	1.0	3.3b	6.3c	0.0b	9.0b	8.0bc	11.3b	1.3b	6.3b	3.3b	11.7a	3.3bc	12.0bcd
Pendimethalin	1.5	1.0b	5.0c	0.0b	6.3b	5.3c	9.0b	1.3b	5.0b	4.0b	12.7a	3.0bc	11.0bcd
Metolachlor + pendimethalin	1.0 + 1.0	0.3b	2.0c	0.0b	4.7b	4.0c	9.3b	0.7b	6.7b	5.3b	12.7a	2.0c	10.7bcd
Metolachlor + manual weeding at 30 DAS	1.0	0.7b	6.3c	0.0b	6.0b	5.7c	7.7b	0.3b	3.7b	5.0b	9.0a	1.7c	12.0bcd
Pendimethalin + manual weeding at 30 DAS	1.0	1.3b	4.0c	0.3b	7.3b	0.0c	3.0b	0.0b	2.7b	6.0b	10.0a	2.3c	7.3cd
Manual weeding at 30 DAS*	–	96.0a	54.9ab	91.0a	83.0a	8.3bc	9.0b	6.7b	11.7b	14.0b	11.3a	6.3b	18.0bc
Manual weeding at 30 and 45 DAS*	–	82.7a	60.0a	94.7a	75.3a	2.7c	4.0b	2.3b	5.7b	6.7b	13.0a	4.0bc	10.0cd
Weedy check	–	83.3a	46.0b	104.0a	78.3a	52.3a	18.3ab	62.3a	57.3a	146.7a	9.7a	70.7a	48.3a

DAS = Days after sowing; G = Grasses; B = Broadleaved weeds.

Means followed by the same letter within a column are not significantly different at the 5% level using Duncan's multiple range test.

*Treatment imposed after taking the observations, hence similar to weedy check at 30 DAS.

practices at 30 DAS. During 1987, an increase in grass density was observed at 60 DAS with metolachlor at 1.0 kg treatment in comparison with all other weed management practices. However, in 1987 grass densities at harvest were similar regardless of weed management practices, except with hand weeding at 30 DAS. In 1988, there was no difference between the various weed management practices at 60 DAS, except with handweeding given at 30 DAS and grass densities for all treatments were less than the weedy check. However, at harvest significant decreases in grass densities were noted in the treatments with mixture of metolachlor and pendimethalin, metolachlor or pendimethalin in combination with a hand weeding at 30 DAS in comparison with hand weeding alone at 30 DAS.

The broadleaved weeds were effectively controlled up to 30 DAS by all herbicide and herbicide/hand weeding combinations which recorded significantly lower densities in comparison to the weedy check. In 1987, maximum density of broadleaved weeds was recorded with metolachlor (1.0 kg ha^{-1}) at 60 DAS, which was comparable to the weedy check. Broadleaved weed densities in all weed management treatments at harvest were comparable to the weedy check during 1987, but not in 1988. During 1988, all weed management treatments significantly reduced broadleaved weed density in comparison to the weedy check.

Weed species separated at various stages (data not given) indicated increased density of broad leaved weeds such as *E. alba, C. argentea, L. mollis,* and *D. muricata* in all the herbicide treated plots at 60 DAS. This may be attributed to reduced competition from grasses due to the herbicides being more effective on grassy weeds. Application of herbicides in combination with a single or two handweedings reduced broadleaved weed density compared to herbicides applied alone. Thus handweeding was beneficial in removal of herbicide tolerant weeds (*C. argentea, L. mollis, D. celiaris and D. aegyptium*).

The weedy check recorded a significantly higher dry mass of grasses at all the stages. There was no difference among various weed management practices during 1987 and all control treatments recorded significantly lower dry mass of grasses in comparison to the weedy check after first weeding at 30 DAS (Table 2). In 1988, although there was no difference among various weed control practices at 30 DAS, increased dry mass of grasses was observed at 60 DAS and at harvest with handweeding at 30 DAS. However, all the control treatments recorded significantly lower grass dry mass in comparison to the weedy check at all growth stages. There was a reduction in dry mass of broadleaved weeds during 1988 in comparison to 1987 in both herbicide alone and herbicide/handweeding treatments. In 1987, dry mass of broadleaved weeds with metolachlor at 1.0 kg at 60 DAS was as much as in the weedy check and was also comparable to treatments with pendimethalin alone or in mixtures with metolachlor. However, during 1988 all the weed management practices were similar and recorded a significantly lower broadleaved weed dry mass in com-

Table 2. Weed dry mass (g m^{-2}) as influenced by herbicide/manual weeding combinations.

Treatment	Rate of application (kg a.i. ha^{-1})	30 DAS				60 DAS				At harvest			
		1987		1988		1987		1988		1987		1988	
		G	B	G	B	G	B	G	B	G	B	G	B
Metolachlor	1.0	0.0b	1.3c	0.3c	6.7c	41.3b	138.1a	2.3b	5.3b	63.6b	125.5b	2.8b	42.3b
Metolachlor	1.5	0.1b	1.6c	0.4c	3.8c	2.3b	49.6b	1.3b	5.7b	43.3b	70.1b	11.0b	19.3b
Pendimethalin	1.0	0.5b	0.6c	0.0c	8.1c	27.5b	70.8ab	0.4b	8.1b	36.1b	129.0b	20.6b	28.3b
Pendimethalin	1.5	0.9b	0.4c	0.3c	5.1c	4.1b	67.0ab	0.0b	5.3b	44.2b	94.8b	3.8b	24.1b
Metolachlor + pendimethalin	1.0 + 1.0	0.3b	0.3c	0.0c	3.7c	0.7b	83.6ab	0.1b	4.3b	54.4b	81.9b	18.5b	12.8b
Metolachlor + manual weeding at 30 DAS	1.0	0.1b	1.3c	0.0c	8.6c	10.7b	7.7b	0.3b	6.4b	39.7b	45.1b	3.1b	25.5b
Pendimethalin + manual weeding at 30 DAS	1.0	0.2b	0.4c	2.3c	5.5c	0.0b	10.6b	1.1b	5.7b	52.6b	56.6b	2.5b	21.0b
Manual weeding at 30 DAS*	–	6.5b	16.3a	87.8a	84.8b	14.9b	35.5b	11.2b	22.0b	98.1b	76.5b	34.4b	41.7b
Manual weeding at 30 and 45 DAS	–	17.7a	8.3b	59.9b	107.4a	0.6b	3.7b	1.3b	7.2b	35.8b	44.1b	12.8b	24.6b
Weedy check	–	26.2a	9.3b	70.5b	107.9a	571.0a	80.3ab	140.6a	180.2a	304.4a	239.0a	227.4a	222.4a

DAS = Days after sowing; G = Grasses; B = Broadleaved weeds.
Means followed by the same letter within a column are not significantly different at the 5% level using Duncan's multiple range test.
*Treatment imposed after taking the observations, hence similar to weedy check at 30 DAS.