Indian Journal of Agronomy **60** (1): 116–120 (March 2015)

Research Paper

Weed management in *rabi* groundnut (*Arachis hypogaea*) for *Konkan* region of Maharashtra

V.V. SAGVEKAR[1], B.D. WAGHMODE[2], A.P. CHAVAN[3] AND U.V. MAHADKAR[4]

Dr B.S. Konkan Krishi Vidyapeeth, Agricultural Research Station, Shirgaon, Ratnagiri, Maharashtra 415 629

Received : May 2014; Revised accepted : March 2015

ABSTRACT

A field experiment was conducted at Agricultural Research Station, Shirgaon, Tal. Dist. Ratnagiri (MS) on the lateritic soil during *rabi* 2009-12 to evaluate post emergence herbicides in *rabi* groundnut (*Arachis hypogaea* L.). The experiment comprised of twelve treatments of weed control replicated thrice in Randomized Block Design (RBD). The various weeds observed in groundnut field during *rabi* season were *Digitaria sanguinalis* (L.) Scoup, *Eleusine indica* (L.) Gaertn., *Echinochloa crusgalli (*L.) Beauv. and *Cyperus difformis* (L.) among the narrow leaved weeds were more rampart. The broad leaved weeds like *Leucas aspera* Spreng., *Cleome viscose* (L.), *Amaranthus viridis* (L.), *Euphorbia hirta* (L.), *Eclipta prostrate* (L.), *Physalis minima* (L.), *Alternenthera sessils* (L.), *and Convolvulus arvensis* (L.) marked their presence in good numbers. Post emergence application of quizalofop-p-ethyl @ 50 g a.i./ha along with pre emergence pendimethalin @ 1.0 kg a.i./ha gave significantly lower total weed density (52.1/m^2), weed dry weight (12.1g/m^2) and higher weed control efficiency (91.3%), which was at par with post emergence application of imazethapyr @ 75 g a.i./ha along with pre emergence application of pendimethalin @ 1.0 kg a.i./ha. Application of quizalofop-p-ethyl @ 50 g a.i./ha as a post emergence along with pre emergence application of pendimethalin @ 1 kg a.i./ha significantly increased the pod yield, haulm yield and kernel yields (2.57, 2.83 and 1.90 t/ha, respectively) and was at par with post-emergence application of imazethapyr @ 75 g a.i./ha in groundnut. Highest net returns (₹29,700/ha) and benefit: cost ratio (1:1.68) were obtained with application of pre-emergence application of pendimethalin @ 1 kg a.i./ha along with one hand weeding at 30 to 35 DAS followed by combination of pre-emergence application of pendimethalin with quizalofop-p-ethyl @ 50 g a.i./ha (₹26,551/ha and 1:1.55, respectively) and with imazethapyr @75g a.i./ ha (₹23,499/ha and 1:1.47, respectively).

Key words : Economics, Groundnut, Imazethapyr, Pendimethalin, Pod yield, Quizalofop-p-ethyl, Weed control efficiency

Groundnut is considered to be the one of the most important food legume and oilseed crops of India, which is cultivated in 5.31 million ha area with the production of 6.96 million tonnes and average productivity of 1.31 t/ha. (DES, 2013)

Weed infestation is one of the major constraints that limit the productivity of groundnut. Critical period of crop-weed competition for groundnut crop is ranged between 40 to 60 days after sowing. Crop is highly susceptible to weed infestation because of its slow growth in the initial stages up to 40 days, short plant height and underground pod bearing habit. Groundnut weeds comprise diverse plant species from grasses to broad-leaf weeds and sedges, and cause substantial yield losses which are more in rainfed spanish bunch type than in irrigated virginia type groundnut. In India, yield losses of groundnut due to weeds ranged from 24-70 per cent (Jhala *et. al.* 2005).

Besides this, weeds are preferred host of several insect-pests, and the vectors of many important organisms causing diseases in groundnut. Weeds also affect groundnut through the production of harmful allelochemicals. Thus, weed control is the foremost critical production factor in groundnut cultivation.

Generally weeds are controlled through hand weeding in groundnut, which is very expensive, laborious and sometimes damaging to the crop plants. It is, therefore, important to find out suitable herbicides that would control the weeds economically and safely. Herbicides were

[1]**Corresponding author Email:** arsshirgaon@rediffmail.com; bharat_breed@yahoo.co.in

[1]Principal, ATS, Lanja, Maharashtra 416 712; [2]Officer Incharge, ARS, Shirgaon, Maharashtra 415 609; [3]Agronomist, ARS, Phondaghat, Maharashtra 416 601 and Head, Department of Agronomy, College of Agriculture, Dapoli, Maharashtra 415 712

found to be selective in controlling many weeds in monocropping as well as in cropping systems. Herbicides, though, selective, efficient and cost effective weed control measure in controlling weeds in groundnut, the maximum benefit can be achieved by combining herbicides with manual, cultural and mechanical weed control methods.

Thus looking to the confectionary need, which requires high quality and well filled pods, it is essential that these aspects to be looked carefully. Thus the present study was undertaken to assess the post emergence herbicides in *rabi* groundnut for Konkan region of Maharashtra.

MATERIALS AND METHODS

The field experiments were conducted at Research Farm of Agricultural Research Station, Dr. B.S. Konkan Krishi Vidyapeeth, Shirgaon, Dist. Ratnagiri (MS) during the *rabi* season 2009-12. The experiment was laid out in randomised block design with twelve treatments viz. Un weeded control (T_1), Weed free (T_2), pendimethalin @ 1.0 kg a.i./ha (Pre emergence PE) + 1 Hand Weeding (HW) 30 days after sowing (DAS) (T_3), quizalofop-p-ethyl @ 50 g a.i./ha at 20 DAS (PoE) (T_4), quizalofop-p-ethyl @ 75 g a.i./ha at 20 DAS PoE (T_5), quizalofop-p-ethyl @ 100 g a.i./ha at 20 DAS PoE (T_6), imazethapyr @ 50 g a.i./ha at 20 DAS PoE (T_7), imazethapyr @ 75 g a.i./ha at 20 DAS PoE (T_8), imazethapyr @ 100 g a.i./ha at 20 DAS PoE (T_9), pendimethalin @ 1.0 kg a.i./ha PE + quizalofop-p-ethyl @ 50 g a.i./ha at 20 DAS PoE (T_{10}), pendimethalin @ 1.0 kg a.i./ha PE + imazethapyr @ 75 g a.i./ha at 20 DAS PoE (T_{11}) and Farmer's practice (one hand weeding + one inter-cultivation at 30 DAS) (T_{12}) and replicated three times. The crop was irrigated as per the requirement with recommended plant protection measures. Post emergence application done at 20 days after sowing, inter cultivation was done at 30 days after sowing as per different treatments. The experimental soil was lateritic with slightly acidic in reaction (6.80 pH), 0.050 dS/m electrical conductivity, high in organic carbon (1.49 %), medium in available nitrogen (278 kg/ha), low in available phosphorus (13.0 kg/ ha) and high in available potassium (376.3 kg/ha). The gross plot was 4.50 m × 1.80 m and crop was fertilized with 25 kg N and 50 kg P_2O_5 /ha through urea and single super phosphate. The N and P were applied through urea and single super phosphate, respectively. The FYM and RDF were mixed in soil at the time of field preparation. Herbicides were applied with manually operated knapsack sprayer delivering a spray volume of 600 lit/ha through flat-fan nozzle. Groundnut variety '*Trombay Konkan Groundnut-Bold' (TG 19A)* was sown at 30 cm × 15 cm spacing using a seed rate of 125 kg/ha.

Weed density and weed growth at 45 and 80 days after sowing were recorded from pre-marked quadrants of 1 m^2 area. The weed count data were subjected to square root transformation ($\sqrt{x+1}$) to normalize the distribution. Weed control efficiency and weed index were worked out to assess the efficiency of different weed control treatments. The economics was calculated based on prevailing market prices of inputs such as pendimethalin @ 380/lit, quizalofop-p-ethyl @ 300/lit, imazethapyr @ 1,670/lit., labour charges 120/per man day and out puts viz. groundnut pods @ 30/kg and haulm @ 1/kg. The pod and haulm yields of groundnut was recorded separately for each net plot and converted into kg/ha. The data were analysed following Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Weed flora

The major weed flora observed in the experimental field included *Digitaria sanguinalis (*L.) Scop.*, Eleusine indica (*L.) Gaertn.*, Echinochloa crusgalli (*L.) Beauv.*, Cyperus difformis (*L.)*,* and *Cynodon dactylon* (L.) Pers. as narrow leaf weeds while *Leucas aspera* Spreng.*, Cleome viscose (*L.)*, Amaranthus viridis* (L.), *Euphorbia hirta* (L.), *Eclipta prostrate* (L.), *Physalis minima* (L.), *Alternenthera sessils* (L.) and *Convolvulus arvensis (*L.) were broad leaf weeds.

Weed growth

All the treatments were responsible for significant reduction in weed density and dry weight of weeds over control. Weed free check has recorded significantly lowest weed growth as compared to herbicides tried. Among the herbicides per emergence application of pendimethalin @ 1 kg a.i./ha + 1 HW at 30 DAS recorded lowest weed growth and weed index followed by pendimethalin @ 1 kg a.i./ha + quizalofop-p-ethyl @ 50 g a.i./ha at 20 DAS and pendimethalin @ 1 kg a.i./ha + imazethapyr @ 75 g a.i./ha at 20 DAS which were at par. Similarly, higher weed control efficiency at 45 and 80 DAS were recorded under pendimethalin @ 1.0 kg a.i./ha + 1HW at 30 DAS (69.6 and 92.0%) followed by combination of pendimethalin @ 1.0 kg a.i./ha and imazethapyr @ 75 g a.i./ha at 20 DAS (80.4 and 91.8%) and combination of pendimethalin @ 1.0 kg a.i./ha and quizalofop-p-ethyl @ 50 g a.i./ha at 20 DAS (76.9 and 91.3%). This might be due to pre emergence application of pendimethalin, which prevented emergence of grassy weeds by inhibiting root and shoot growth while post emergence weedicides were responsible for inhibition of acetolactate synthase (ALS) or acetohydroxyacid synthase (AHAS) in broad leaved weeds which caused destruction of these weeds at 3–4 leaf stage. Similar results were observed by Kalhapure *et al.* (2013). Dubey and Gangwar (2012) also found lower weed biomass, weed index and higher weed control effi-

Table 1. Effect of weed management treatments on weed growth (pooled data of 3 years)

Treatment	Weed population at (No./ m^2)				Total weed population (NLW + BLW) at (No./m^2)		Weed dry weight (g/m^2) (NLW+[1] BLW) at		Weed control efficiency at 45 DAS (%)	Weed control efficiency at 80 DAS (%)	Weed index
	45 DAS		80 DAS								
	NLW	BLW	NLW	BLW	45 DAS	80 DAS	45 DAS	80 DAS			
Un weeded control	191.9 (12.8)	59.9 (7.7)	132.1 (11.3)	125.9 (11.2)	251.7 (15.4)	257.9 (16.0)	93.6 (8.6)	142.8 (11.7)	0.0	0.0	60.2
Weed free	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	0.0 (0.7)	100.0	100.0	0.0
Pendimethalin @ 1.0 kg a.i./ha PE + 1HW 30 DAS	19.1 (4.1)	23.0 (4.2)	42.8 (6.2)	27.6 (4.8)	42.1 (6.0)	70.4 (8.2)	12.3 (3.2)	10.7 (3.1)	69.6	92.0	6.1
Quizalofop-e-ethyl @ 50 g a.i./ha at 20 DAS	58.4 (7.4)	32.0 (5.5)	66.3 (7.7)	51.3 (7.0)	90.4 (9.3)	117.7 (10.6)	64.6 (7.0)	58.1 (7.1)	35.0	55.3	48.3
Quizalofop-e-ethyl @ 75 g a.i./ha at 20 DAS	79.4 (8.5)	32.9 (5.7)	87.3 (8.8)	46.0 (6.6)	112.3 (10.4)	133.3 (11.3)	49.0 (6.2)	57.5 (6.9)	48.5	58.9	42.6
Quizalofop-e-ethyl @ 100 g a.i./ha at 20 DAS	75.7 (8.2)	31.1 (5.5)	84.6 (8.6)	52.4 (7.2)	106.8 (10.1)	137.0 (11.5)	47.8 (6.1)	53.1 (6.7)	50.0	61.9	40.2
Imazethapyr @ 50 g a.i./ha at 20 DAS	76.0 (8.2)	35.8 (5.9)	79.3 (8.3)	84.2 (9.1)	111.8 (10.3)	163.6 (12.5)	53.4 (6.5)	45.0 (6.4)	41.0	65.1	43.1
Imazethapyr @ 75 g a.i./ha at 20 DAS	71.1 (7.8)	29.7 (5.4)	71.9 (7.9)	58.7 (7.6)	100.77 (9.7)	130.5 (11.2)	59.7 (6.6)	45.1 (6.3)	43.6	66.3	38.7
Imazethapyr @ 100 g a.i./ha at 20 DAS	70.4 (7.8)	25.8 (5.0)	70.3 (7.8)	53.0 (7.2)	96.23 (9.5)	123.3 (10.9)	44.4 (5.7)	33.9 (5.4)	58.1	74.8	35.3
Pendimethalin @ 1.0 kg a.i./ha + Quizalofop-e-ethyl @ 50 g a.i./ha at 20 DAS	29.2 (5.1)	17.4 (4.0)	26.6 (4.8)	25.6 (5.0)	46.67 (6.5)	52.1 (7.0)	15.1 (3.7)	12.1 (3.4)	76.9	91.3	14.2
Pendimethalin @ 1.0 kg a.i./ha + Imazethapyr @ 75 g a.i./ha at 20 DAS	28.2 (5.0)	11.0 (3.3)	31.2 (5.3)	23.1 (4.7)	39.23 (6.1)	54.3 (7.2)	13.5(3.5)	10.2(3.2)	80.4	91.8	16.2
Farmer's practice (1 hand-weeding + one intercultivation)	33.3 (5.7)	45.3 (6.6)	68.2 (7.4)	62.3 (7.5)	78.67 (8.7)	130.6 (10.6)	19.1(4.8)	33.1(5.4)	55.0	74.1	32.1
SEm±	(0.4)	(0.3)	(0.5)	(0.5)	(0.4)	(0.5)	(0.3)	(0.2)	–	–	–
CD (P=0.05)	(1.1)	(1.0)	(1.3)	(1.4)	(1.1)	(1.4)	(0.8)	(0.6)	–	–	–

ciency with post emergence application of imazethapyr and 2 hand-weeding in groundnut. Application of any of these 2 post-emergence herbicide alone without any pre-emergence herbicide or hand weeding would not result in significant weed control in *rabi* groundnut.

Growth and yield attributes

Pooled mean value of plant height was statistically non significant due to different treatments under study. However number of branches per plant was found to be statistically significant. Highest number of branches/plant was observed with pendimethalin @ 1 kg a.i./ha + one hand weeding at 30 DAS which was at par with rest of the treatments except unweeded control and quizalofop-p-ethyl @100 g a.i./ha and imazethapyr @ 75 g a.i./ha at 20 DAS.

Highest number of pods/plant was observed with pendimethalin @ 1 kg a.i./ha + quizalofop-p-ethyl @ 50 g a.i./ha at 20 DAS, which was statistically at par with weed free treatment followed by pendimethalin @ 1 kg a.i./ha + 1 HW at 30 DAS and pendimethalin @ 1 kg a.i./ha + imazethapyr @ 75 g a.i./ha at 20 DAS while statistically highest dry pod weight /plant was noticed with weed free treatment which was at par with pendimethalin @ 1 kg a.i./ha + 1 HW at 30 DAS followed by pendimethalin @ 1 kg a.i./ha + quizalofop-p-ethyl @ 50 g a.i./ha at 20 DAS. Similarly shelling per cent, sound mature kernels and 100 kernel weight was significantly higher in weed free treatment. Dutta *et al.* (2005) have also concluded that proper weed control was responsible for enhancing the yield attributing characters and yield in groundnut. Weed free environment in crop also facilitated better peg initiation and development at the critical growth stages of groundnut which tends to increase in number of pods per plant and pod yield.

Yield

Significantly higher dry pod (2.95 t/ha), kernel (2.23 t/ha) and haulm yields (3.11 t/ha) were recorded under weed free treatment followed by pre emergence application of pendimethalin @ 1 kg a.i./ha + 1 HW (2.76, 2.07 and 2.79 t/ha, respectively) and combination of pendimethalin @ 1 kg a.i./ha (PE) with quizalofop-p-ethyl @ 50 g a.i./ha (PoE) (2.57, 1.90 and 2.63 t/ha, respectively) (Table 3). This might be due to minimizing the competition of weeds with main crop for resources, viz. space, light, nutrients and moisture with adaption of effective weed control methods. Higher profitable pod yield of summer groundnut was also reported by Raj *et al.* (2008) with keeping the crop in weed free condition. Harvest index was minimum under weedy check because of poor partitioning of photosynthates from source to sink, whereas, application of pendimethalin @ 1 kg a.i./ha + 1 HW attained the maxi-

mum value of harvest index followed by weed free treatment (Table 3). The findings are in close conformation to that of Dubey *et al.* (2010).

Economics

Pre emergence application of pendimethalin @ 1 kg a.i. /ha + 1 HW was most effective in controlling weeds with higher net returns (32,188/ha) and benefit: cost ratio (1:1.68) followed by combination of pre-emergence application of pendimethalin with quizalofop-p-ethyl @ 50 g a.i./ha (26,551/ha and 1:1.55, respectively) and with imazethapyr @ 75 g a.i./ha (23,499/ha and 1:1.47, respectively) (Table 3). This might be due to the cost of cultivation of groundnut crop was increased in treatment weed free check due to the higher need of human labours and their higher wages. This cost was reduced in treatment pendimethalin @ 1 kg a.i./ha + 1 HW and application of pendimethalin @ 1 kg a.i./ha + quizalofop-p-ethyl @ 50 g a.i. or imazethapyr @ 75 g a.i./ha by using herbicides to effective control of weeds with minimizing human

Table 2. Growth and yield attributes of groundnut as influenced by different weed management treatments (pooled data of 3 years)

Treatment	Plant height (cm)	Branches/ plant (No.)	Pods/ plant (No.)	Dry pod weight (g/plant)	Shelling per cent (%)	Sound mature kernels(%)	100 kernel weight (g)
Un weeded control	38.9	5.0	9.8	13.2	72.1	81.4	62.1
Weed free	38.4	6.1	17.0	25.2	75.5	86.9	66.9
Pendimethalin @ 1.0 kg a.i./ha PE + 1HW at 30 DAS	44.0	6.2	16.9	23.5	74.8	85.0	65.8
Quizalofop-e-ethyl @ 50 g a.i./ha at 20 DAS	41.2	4.7	10.7	13.2	74.1	84.2	63.8
Quizalofop-e-ethyl @ 75 g a.i./ha at 20 DAS	40.7	5.4	11.3	15.7	74.2	85.2	60.1
Quizalofop-e-ethyl @ 100 g a.i./ha at 20 DAS	38.9	4.7	10.7	17.4	74.3	85.7	65.3
Imazethapyr @ 50 g a.i./ha at 20 DAS	40.3	5.2	12.3	18.3	74.0	84.0	61.0
Imazethapyr @ 75 g a.i./ha at 20 DAS	39.0	5.0	11.6	16.2	73.1	85.0	61.0
Imazethapyr @ 100 g a.i./ha at 20 DAS	36.9	5.6	12.0	17.0	74.2	83.9	59.8
Pendimethalin @ 1.0 kg a.i./ha + Quizalofop-e-ethyl @ 50 g a.i./ha at 20 DAS	43.0	6.0	18.0	22.9	73.7	85.4	62.4
Pendimethalin @ 1.0 kg a.i./ha + Imazethapyr @ 75 g a.i./ha at 20 DAS	39.7	5.7	15.7	21.8	74.8	85.1	64.1
Farmer's practice (1 hand-weeding + one intercultivation)	39.8	5.9	14.4	21.6	73.7	84.3	63.5
SEm±	2.52	0.40	1.01	1.08	0.48	1.3	1.3
CD (P=0.05)	NS	1.13	2.84	3.04	1.34	3.7	3.6

Table 3. Yield and economics of groundnut as influenced by different weed management treatments (Pooled data of 3 years)

Treatment	Pod yield (t/ha)	Kernel yield (t/ha)	Haulm yield (t/ha)	Harvest index	Gross returns (×10³ /ha)	Cost of cultivation (×10³/ha)	Net returns (×10³ /ha)	Benefit cost ratio
Un weeded control	1.18	0.85	1.77	0.33	33.8	43.2	-9.4	0.78
Weed free	2.95	2.23	3.11	0.42	83.9	54.1	29.7	1.53
Pendimethalin @ 1.0 kg a.i./ha PE + 1 HW 30 DAS	2.76	2.07	2.79	0.43	78.4	46.2	32.2	1.68
Quizalofop-e-ethyl @ 50 g a.i./ha at 20 DAS	1.56	1.16	1.87	0.39	44.4	44.1	0.2	1.00
Quizalofop-e-ethyl @ 75 g a.i./ha at 20 DAS	1.72	1.28	1.99	0.40	48.6	45.3	3.3	1.07
Quizalofop-e-ethyl @ 100 g a.i./ha at 20 DAS	1.77	1.32	2.14	0.39	50.0	45.4	4.6	1.10
Imazethapyr @ 50 g a.i./ha at 20 DAS	1.71	1.27	2.07	0.39	48.8	45.7	3.0	1.05
Imazethapyr @ 75 g a.i./ha at 20 DAS	1.84	1.35	2.04	0.42	52.4	46.2	6.1	1.12
Imazethapyr @ 100 g a.i./ha at 20 DAS	1.90	1.41	2.21	0.40	53.9	46.7	7.2	1.15
Pendimethalin @ 1.0 kg a.i./ha + Quizalofop-e-ethyl @ 50 g a.i./ha at 20 DAS	2.57	1.90	2.83	0.40	73.3	46.8	26.6	1.55
Pendimethalin @ 1.0 kg a.i./ha + Imazethapyr @ 75 g a.i./ha at 20 DAS	2.50	1.87	2.87	0.39	71.4	47.9	23.5	1.47
Farmer's practice (1 hand-weeding + 1 intercultivation)	2.00	1.47	2.61	0.36	57.3	55.1	2.2	1.03
SEm±	0.13	0.09	0.13	–	–	–	–	–
CD (P=0.05)	0.35	0.26	0.36	–	–	–	–	–

Cost of nutrients (N and P_2O_5), 12.54 and 21.00, respectively; Cost of FYM, 1000/t; Groundnut seed, 50/kg; Sale rate of groundnut pod, 30000/t; Sale rate of haulm, 1000/t

labours. Sasikala *et al.* (2004) and Rao *et al.* (2011) also reported higher net returns and benefit: cost ratio with integration of pre and post emergence application of herbicides with hand weeding in groundnut. Weedy check (control) recorded lowest gross monetary returns (33,825/ha), net monetary returns ((-)9,397/ha) and benefit: cost ratio (0.78).

Pre emergence application of pendimethalin @ 1.0 kg a.i./ha + one hand weeding at 30 DAS proved practically more convenient and economically best feasible integrated weed management practice for groundnut considering the present condition of scarcity and high cost of labours, quality of weed control, yield and B:C ratio of cultivation of groundnut. If hand weeding is not possible, pre emergence application of pendimethalin @ 1 kg a.i./ha combined with post emergence application of either quizalofop-p-ethyl @ 50 g a.i./ha or imazethapyr @ 75 g a.i./ha could be alternative method of weed control in *rabi* groundnut.

REFERENCES

DES. 2013. *Agriculture at a glance.* Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi.

Dubey, Megha, Singh, Smita, Kewat, M.L. and Sharma, J.K. 2010. Efficacy of imazethapyr against monocot weeds in groundnut. *Indian Journal of Weed Science* **42**(1 and 2): 27–30.

Dubey, Megha and Gangwar Suchi. 2012. Effect of chemical weed control of imazethapyr (Pursuit) in groundnut var, *'TG–24'*. *Plant Archives* **12**(2):675–77.

Dutta, D., Bandyopadhyay, P. and Banerjee, P. 2005. Integrated weed management in *rainfed* groundnut (*Arachis hypogaea*) in acid lateritic soils of West Bengal. *Journal of Crop and Weed* **2**(1): 47–51.

Jhala, A., Rathod, P.H., Patel, K.C. and Van Damme, P. 2005. Growth and yield of groundnut (*Arachis hypogaea* L.) as influenced by weed management practices and rhizobium inoculation. *Communications in Agricultural and Applied Biological Sciences* **70**(3): 493–500.

Kalhapure, A.H., Shete, B.T. and Bodake, P.S. 2013. Integration of chemical and cultural methods for weed management in groundnut. *Indian Journal of W*eed *Science* **45**(2): 116-119.

Panse, V.G. and Sukhatme, P.V. 1985. Statistical Methods for Agricultural Workers, 359 pp. ICAR, New Delhi.

Raj, V.C., Damame, H.S., Patel, Ah. M. and Arvadia, M.K. 2008. Integrated weed management in summer groundnut (*Aracis hypogaea* L.). (In:) *Proceedings of Biennial Conference on Weed Management in Modern Agriculture: Emerging Challenges and Opportunities,* at Patna, Bihar during 27–28 February 2008. p. 127.

Rao, S.S., Madhavi, M. and Reddy, C.R. 2011. Integrated approach for weed contol in *Rabi* groundnut (*Arachis hypogaea* L.). *Journal of Research ANGRAU* **39**(1): 60–63.

Sasikala, B., Reddy, Y. and Raghava Reddy, C. 2004. Pre and post emergence herbicides on weed control and yield of groundnut (*Arachis hypogaea). Indian Journal of Dry land Agriculture Research and Development* **19**(1): 78–80.