

## Integrating herbicidal and conventional approach for profitable weed management in groundnut (*Arachis hypogaea*)

PARVENDER SHEORAN<sup>1</sup>, VIRENDER SARDANA<sup>2</sup>, ASHWANI KUMAR<sup>3</sup>, ANITA MANN<sup>4</sup> AND SUKHVINDER SINGH<sup>5</sup>

Punjab Agricultural University, Ludhiana, Punjab 141 004

Received : June 2015; Revised accepted : December 2015

### ABSTRACT

A field experiment was conducted during the rainy seasons of 2009 and 2010 at Ludhiana, Punjab in the Indo-Gangetic alluvial plains, to work out an effective weed-management strategy in groundnut (*Arachis hypogaea* L.). Almost two-thirds of the weed infestation was dominated by sedges, followed by broad-leaf (26.3%) and grassy (9.3%) weeds. Season long weed competition reduced the mean seed yield of groundnut by 60.9%. Alone application of herbicides either through pendimethalin or imazethapyr provided effective weed control (43.5–53.3% weed-control efficiency) but the late flushes and escaped/ regenerated weeds at later stages hampered the crop yield significantly. Integrated approach involving sequential application of pendimethalin 0.75 kg/ha pre-emergence (PE) and imazethapyr 0.05 kg/ha post-emergence (PoE) supplemented with 1 hand-weeding 45 days after sowing (DAS) provided 83.7% weed-control efficiency, 2.11 t/ha pod yield, ₹4.3 × 10<sup>3</sup>/ha net returns with benefit: cost ratio of 2.99 which was as good as implying 2 hand-weedings 3 and 6 weeks after sowing.

**Key words :** Economics, Groundnut, Pod yield, Weed-management

Groundnut is an important oilseed and supplementary food crop of India which is cultivated on nearly 4.19 million ha area with 6.68 million tonnes production and average productivity of 1.59 t/ha (DGR, Junagadh 2015). Its productivity is quite low as compared to many groundnut-producing countries like the USA, China and Myanmar. Low productivity of groundnut is due to many reasons of which rainfed cultivation under hot and humid weather, lack of awareness about modern production technologies, lower input use, loss of commodity at various stages of crop production by biotic and abiotic stresses are important.

Groundnut is confronted by repeated flushes of diversified weed flora throughout its growing season (Yadav *et al.*, 2014). Competitional stresses of weeds cause substantial yield losses (15–75%) depending on the season, cultivars, weed composition and duration of crop weed competition, and the packages of practices adopted (Jat *et al.*, 2011). The crop-weed competition remains maximum during the early stages, especially in bunch-type varieties because of its slow-seedling emergence and initial growth,

small foliage cover, prostrate growth habit and consequently poor competitive ability.

Continuous monitoring and refinement in management strategies is essential for alleviating adverse effects of weeds on agricultural productivity and environmental health (Rao and Nagamani, 2013). Farmers rely predominantly on mechanical/ manual methods of weed control in case of groundnut. But these practices alone do not ensure weed free conditions and are expensive, cumbersome and time-consuming too; further reducing the profit margin. Most often protracted rains do not allow or delay the conventional farm operations during the critical weeding season. The pre-emergence herbicides like pendimethalin was found effective in controlling the weeds during early stages but late flushes and escaped/regenerated weeds in later stages also hamper the crop yield to certain extent possible (Devi Dayal, 2004). Currently, weed scientists of India have the challenge of evolving effective weed-management technologies that are economical and have least impact on environment and non-target organisms. This necessitates for an alternative cost-effective integrated weed-management strategy involving the pre- and post-emergence application of herbicides and intercultural operations considering the present situation of labour scarcity, quality of weed control, productivity and profitability concerns.

<sup>1</sup>Corresponding author Email: sheoran76@rediffmail.com

<sup>1,4</sup>Senior Scientist, <sup>3</sup>Scientist, ICAR-Central Soil Salinity Research Institute, Karnal, Haryana 132 001, <sup>2</sup>Senior Agronomist; <sup>5</sup>Breeder, Punjab Agricultural University, Ludhiana, Punjab 141 004

## MATERIALS AND METHODS

The field experiment was conducted during rainy seasons of 2009 and 2010 on well drained typic ustipsamment at Punjab Agricultural University, Ludhiana (30°56' N, 75°52' E, 247 m above mean sea-level) located in the Indo-Gangetic alluvial plains in the state of Punjab, north-western India. The soil (plough layer, 0–20 cm) was loamy sand in texture (73% sand; 15% silt; 12% clay) with electrical conductivity (EC) 0.21 dS/m and pH 7.9; containing 2.3 g/kg organic carbon, 104 kg/ha  $\text{KMnO}_4\text{-N}$ , 14.8 kg/ha Olsen's P and 184 kg/ha  $\text{NH}_4\text{OAc-K}$  in the surface soil. The climate is semi-arid and monsoonal with average annual rainfall of about 760 mm representing greater distribution (80%) in June to September months. The study comprised 7 treatments (Table 1) involving combinations of hand-weeding(s) with pre-emergence application of pendimethalin (Stomp 30 EC) 0.75 kg/ha, and post-emergence application of imazethapyr (Pursuit 10 WSC) 0.05 kg/ha allocated in randomized block design with 3 replications.

Spanish bunch type groundnut 'SG 99' was sown on 17 June and 6 June during 2009 and 2010, respectively, on flat beds at 30 cm × 15 cm spacing in gross plot size of 18.9 m<sup>2</sup> area, accommodating 14 rows each of 4.5 m length. The crop was fertilized with 15 kg N and 20 kg  $\text{P}_2\text{O}_5$ /ha applied basal in the form of urea (46%) and single superphosphate (16%  $\text{P}_2\text{O}_5$ ) respectively. A total rainfall of 818 mm in 26 rainy days in 2009 and 648 mm in 38 rainy days was recorded during the crop-growing season. Only one irrigation was applied each year a week before the crop harvest for full recovery of pods from the soil. Plant-protection measures were followed according to local agronomic practices unless otherwise indicated. The crop was hand harvested on 23 October 2009 and 11 October 2010 at the stage of physiological maturity when uniform yellowing of leaves as well as shedding of older leaves was noticed.

Weed density and dry weight were recorded with the help of quadrat (0.25 m<sup>2</sup>) placed randomly at 2 places at crop harvest. Species-wise weed seedlings within each quadrat were counted and the efficacy of different weed-control treatments was evaluated. The data on weed population was subjected to square-root transformation before statistical analysis. Weeds were cut to the ground level, washed with tap-water, sun-dried, and then oven dried at 70°C for 48 h, and then weighed. Weed-control efficiency was determined (WCE) as per Sheoran *et al.* (2012).

Measurements for biometric observations were taken from 10 random plants from the second last row on either side of each subplot. The data on pod and haulm yields were recorded from the central rows by discarding 2 external rows of each subplot (as borders). The yield samples

were dried to a constant weight and threshed manually to determine the pod yield which was then expressed in t/ha. Haulm yield was expressed on dry-weight basis. Hand shelling of 500 g pods was done for determining shelling percentage. The data thus obtained were analysed using OPSTAT statistical programme ([www.hau.ernet.in/opstat.html](http://www.hau.ernet.in/opstat.html)). Mean comparison was performed based on critical difference at the 0.05 probability level. The monetary benefits (net returns, benefit: cost ratio) were also worked out for different weed-control treatments by using the prevailing market price of the produce and the inputs used.

## RESULTS AND DISCUSSION

### Weed flora

The predominant weed flora in groundnut field were hairy crab grass (*Digitaria sanguinalis*) and Bermuda grass (*Cynodon dactylon*) in grassy weeds, while pigweed (*Trianthema protulacastrum*) and Bengal dayflower (*Commelina benghalensis*) infested the most among broad-leaf weeds. In sedges, nutsedge (*Cyperus rotundus*) was the most dominant weed. On an average, almost two-thirds of the weed infestation was dominated by sedges followed by broad-leaf (26.3%) and grassy (9.3%) weeds (Fig. 1).

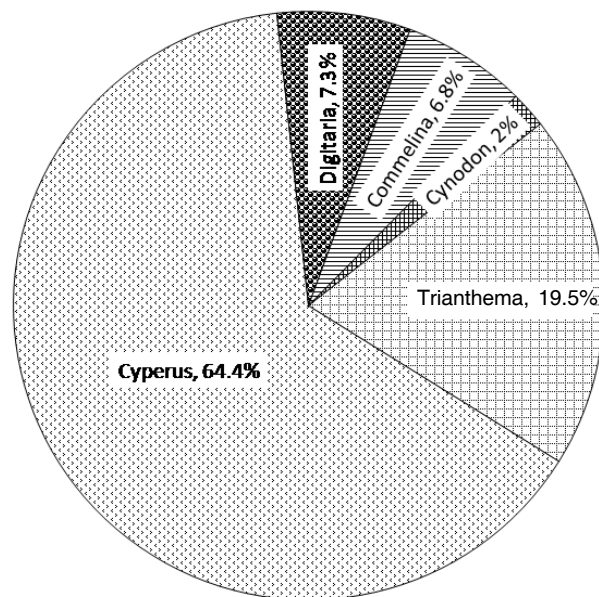


Fig. 1. Dominant weed flora in groundnut crop at experimental site

### Effect on weeds

All the weed-control treatments resulted in significantly lower density and dry weight of weeds as compared to weedy check (Table 1). The highest weed-control efficiency with lowest weeds dry weight was observed with 2

hand-weedings done at 3 and 6 weeks after sowing (WAS). Pre-emergence application of pendimethalin 0.75 kg/ha followed by post-emergence application of imazethapyr 0.05 kg/ha 20 DAS + 1 hand-weeding 45 DAS was found to be the next superior treatment for all weed parameters. Integration of 1 hand-weeding with pre- and post-emergence application of herbicides ( $T_7$ ) resulted in significant reduction in weeds dry matter. Pre-emergence application of pendimethalin checked the annual grassy and certain broad-leaf weeds by inhibiting their root and shoot growth while post-emergence application of imazethapyr inhibited acetolactate synthase (ALS) or acetohydroxyacid synthase (AHAS) enzymatic activities causing destruction of mostly broad-leaf weeds at 3–4 leaf stage. Escaped or re-emerged weeds were taken care by hand weeding done at 45 DAS, thereby providing weed free environment for longer period of crop growth tilting the crop-weed competition in favour of crop. These results corroborate with the findings of Dubey and Gangwar (2012). The application of pre- ( $T_3$ ) and post-emergence ( $T_4$ ) application of herbicides controlled the weed growth during the initial stages but could not have much impact on the late flush of weeds (Table 1).

#### Effect on yield attributes and yield

Season-long weed competition reduced the mean seed yield of groundnut by 60.9% in comparison to farmers' conventional practice of 2 hand-weedings at 3 and 6 weeks after sowing; (WAS) (Table 2). Significant improvement in pod yield of groundnut was observed with all the weed-management practices when compared with unweeded control ( $T_1$ ). Two hand-weedings done at 3 and

6 WAS ( $T_2$ ) resulted in the highest pod yield. Alone application of herbicides either through pre-emergence application of pendimethalin 0.75 kg/ha ( $T_3$ ) or post-emergence application of imazethapyr 0.05 kg/ha ( $T_4$ ) ensured 43.5–53.3% weed-control efficacy (Table 1), elucidating 77.4–87.4% yield superiority (Table 2) over the control (0.83 t/ha), but still not competent enough to achieve the targeted yield potential as in case of  $T_2$  treatment. This is because many weeds, especially sedges and broad-leaf weeds though initially controlled to some extent by sole application of herbicides (pre- or post-) but might have re-emerged later to compete with crop plants causing significant yield reductions. It is interesting to note that synergism for weed-management (72.3% WCE) and yield improvement (15.6–22.3%) was noticed with integrated approach ( $T_5$ ) in comparison to individual herbicide application either as pre- ( $T_3$ ) or post-emergence ( $T_4$ ) whatever the case may be. Supplementation of 1 hand-weeding at 45 days after sowing (DAS) ( $T_7$ ) further enhanced the WCE to the tune of 83.7% (Table 1), achieving 2.11 t/ha groundnut yield (Table 2) which was quite similar to that achieved with 2 hand-weedings done 3 and 6 WAS. This could be attributed to decreased crop-weed competition at the critical stages for longer growth period which facilitated better peg initiation and development resulting in better expressions of yield-attributing characters, viz. pods/plant, 100-kernel weight, shelling outturn (Table 2), culminating in higher pod yield. Kalhapure *et al.* (2013) and Yadav *et al.* (2014) also reported similar beneficial effect of integrated approach for better weed control and higher groundnut yield. Pod yield of groundnut linearly decreased as the weeds dry matter increased and the weeds

**Table 1.** Weed dynamics and dry weight in relation to weed management practices in groundnut (pooled mean)

Treatment	Weeds density (Nos./m <sup>2</sup> ) at harvest				Weeds dry weight (g/m <sup>2</sup> )	Weed control efficiency (%)
	Grassy	Sedges	BLWs	Total		
Unweeded control	12.7 (3.7)	88.0 (9.4)	36.0 (6.1)	136.7 (11.7)	456.2	-
Two hand-weedings, 3 and 6 weeks after sowing	1.7 (1.6)	24.7 (5.1)	1.3 (1.5)	27.7 (5.4)	79.3	82.6
Pendimethalin 0.75 kg/ha, PE	3.3 (2.1)	53.3 (7.4)	5.3 (2.5)	62.0 (7.9)	257.6	43.5
Imazethapyr 0.05 kg/ha, PoE 20 days after sowing	3.3 (2.1)	50.7 (7.2)	4.7 (2.3)	58.7 (7.7)	212.9	53.3
Pendimethalin 0.75 kg/ha, PE + imazethapyr 0.05 kg/ha, PoE	0.7 (1.3)	38.7 (6.3)	1.3 (1.5)	40.7 (6.5)	126.6	72.3
Pendimethalin 0.75 kg/ha, PE + 1 hand-weeding 45 days after sowing	1.3 (1.5)	32.0 (5.7)	1.73 (1.6)	35.0 (6.0)	111.3	75.6
Pendimethalin 0.75 kg/ha, PE + imazethapyr 0.05 kg/ha, PoE + 1 hand-weeding 45 days after sowing	1.7 (1.6)	27.7 (5.4)	1.7 (1.6)	31.0 (5.7)	74.0	83.7
SEm±	0.6 (0.5)	0.5 (0.1)	1.1 (0.2)	5.6 (0.4)	17.1	-
CD (P=0.05)	1.7 (1.4)	1.6 (0.4)	3.3 (0.6)	16.2 (1.2)	49.4	-

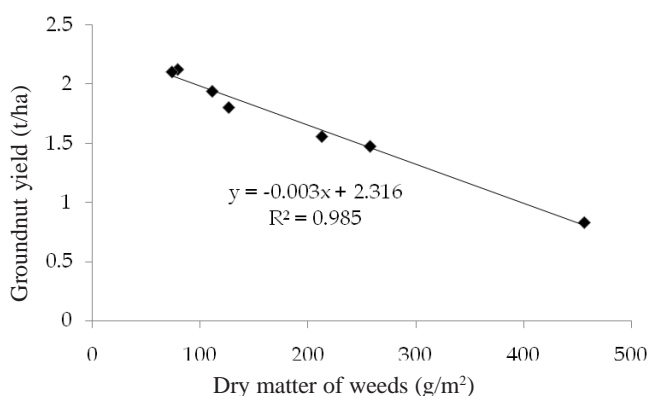
BLWs, Broad leaf weeds; WCE, weed-control efficiency; PE, pre-emergence application 1 DAS; PoE, post-emergence application 20 DAS; figures in parentheses indicate the transformed values

**Table 2.** Effect of weed-management practices on yield components and monetary returns of groundnut (pooled mean)

Treatment	Pods/ plant	100-kernel weight (g)	Pod yield (t/ha)	Haulm yield (t/ha)	Shelling outturn (%)	Harvest index (%)	Net returns ( $\times 10^3$ /ha)	Benefit: cost ratio
Unweeded control	10.4	51.0	0.83	2.17	61.6	27.8	8.7	1.49
Two hand-weedings, 3 and 6 weeks after sowing	14.9	54.7	2.13	4.46	68.9	32.3	44.3	2.93
Pendimethalin 0.75 kg/ha, PE	12.7	52.3	1.48	3.58	66.6	29.2	28.0	2.48
Imazethapyr 0.05 kg/ha, PoE 20 days after sowing	13.5	53.0	1.56	3.82	67.3	29.0	31.1	2.66
Pendimethalin 0.75 kg/ha, PE + imazethapyr 0.05 kg/ha, PoE	14.7	54.3	1.81	4.25	67.6	29.8	37.6	2.90
Pendimethalin 0.75 kg/ha, PE + 1 hand-weeding 45 days after sowing	14.0	54.0	1.94	4.40	68.4	30.6	40.1	2.87
Pendimethalin 0.75 kg/ha, PE + imazethapyr 0.05 kg/ha, PoE + 1 hand-weeding 45 days after sowing	15.0	54.7	2.11	4.49	68.7	31.9	44.3	2.99
SEm $\pm$	0.7	0.2	0.05	0.2	0.7	0.9	-	-
CD (P=0.05)	2.2	NS	0.16	0.50	2.1	2.8	-	-

PE, Pre-emergence application 1 DAS; PoE, post-emergence application 20 DAS

infestation accounted for nearly 98.5% variation in seed yield (Fig. 2).

**Fig. 2.** Relationship between weeds dry matter and pod yield of groundnut

### Economics

Implication of any of the weed-management practice resulted in better monetary returns when compared with weedy check (control). Unweeded control resulted in lowest net returns and benefit: cost ratio (Table 2). Pendimethalin 0.75 kg/ha as PE + Imazethapyr 0.05 kg/ha as PoE + 1 hand-weeding at 45 DAS ( $T_7$ ) resulted in the highest net returns and benefit: cost ratio which was as good as 2 hand-weedings done 3 and 6 WAS. Integration approach involving hand-weeding at 45 DAS significantly improved the groundnut yield but the profit margin gets reduced due to higher wages of human labour incurred.

The present study documented that integrated weed management through sequential application of pendimethalin 0.75 kg/ha as pre-emergence and

imazethapyr 0.05 kg/ha as post-emergence 20 days after sowing followed by 1 hand-weeding 45 days was found to be the practically feasible and economically best strategy in reducing the weed infestation and achieving better yields under semi-arid irrigated conditions in groundnut growing areas of India and similar environments.

### REFERENCES

- DGR, Junagadh. 2015. *Annual Report 2014–15*, ICAR-Directorate of Groundnut Research, Junagadh, Gujarat, India.
- Devi Dayal. 2004. Weed management in groundnut. (In:) *Groundnut Research in India*, pp. 248–59. Basu, M.S. and Singh, N.B.
- Dubey, M. and Gangwar, S. 2012. Effect of chemical control of Imazethapyr (Pursuit) in groundnut var 'TAG 24'. *Plant Achieves* **12**(2): 675–77.
- Jat, R.S., Meena, H.N., Singh, A.L., Surya, J.N. and Misra, J.B. 2011. Weed management in groundnut (*Arachis hypogaea* L.) in India – A Review. *Agricultural Reviews* **32**(3): 155–71.
- Kalhpure, A.H., Shete, B.T. and Bodake, P.S. 2013. Integration of chemical and cultural methods for weed management in groundnut. *Indian Journal of Weed Science* **45**(2): 116–19.
- Rao, A.N. and Nagamani, A. 2013. Eco-efficient weed management approaches for rice in tropical Asia, pp. 78–87. (In:) *Proceedings of the 4<sup>th</sup> Tropical Weed Science Conference. 'Weed-Management and Utilization in the Tropics'* held during 23–25 January, 2013 at the Empress Hotel, Chiang Mai, Thailand.
- Sheoran, P., Sardana, V., Singh, S., Sharma, P. and Atwal, A.K. 2012. Evaluation of pre-emergence herbicides for weed management in sesame (*Sesamum indicum* L.) under semi-arid subtropical conditions. *Journal of Oilseeds Research* **28**(2): 53–57.
- Yadav, J.P., Banga, R.S., Yadav, A., Sheoran, P. and Bajjiya, R. 2014. Efficacy of herbicides integrated with manual weeding in groundnut. *Environment and Ecology* **32**(2): 554–57.