Weed management in groundnut (*Arachis hypogaea* L.) at Nawalpur condition in Sarlahi, Nepal

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Abstract
Groundnut is one of the important summer oilseed crops of Nepal. The area under this crop has decreased considerably in the recent decade due to its high cost of cultivation for weeding and increased labor charge. Crop compete with the repeated flush of diverse weed throughout the growing season which causes substantial yield loss up to 50 -70 %. So, to find out an effective treatment for weed management, an experiment was conducted during 2017 and 2018 with nine treatments laid out in randomized complete block design (RCBD) in three replications. Treatments were constituted by four herbicides, two pre-emergence (pendimethalin and metribuzin) and two post emergences (quizalofop and propaquizafop). Pre emergence herbicide was followed by *(fb)* by hand weeding (HW) in one treatment and by the post emergence herbicides in another treatment. Cover mulch treatment with groundnut pods shell @ 3.0 t/ha was used. Farmer's practice treatment consists of one hand weeding and one intercultural operation while no weeded plot was kept as control treatment. Data on weed dynamics, yield attributes and seed yield were varied among the treatments. Pre emergence herbicide supplemented by one hand weeding proved highly effective in controlling weeds. Pendimethalin @ 1.0 kg a.i/ha *fb* one HW showed superior performance in yield attributes, a high percentage (83.0%) of weed control efficiency (WCE), highest grain yield (2005 kg/ha), high benefits (NRs 222450) and BC ratio 2.84 among the treatments. The treatment metribuzin @ 0.5 kg a.i/ha *fb* one HW was also found as second best treatment with 74.4 % of WCE, yield (1882 kg/ha), benefits of Rs 205060 and BC ratio 2.65.

Keywords: Groundnut, metribuzin, pendimethalin, propaqizalfop, quizaloflop-ethyl, WCE

Introduction

Groundnut (*Arachis hypogaea* L.) or peanuts is one of the major edible oilseed crops cultivated extensively in the world. It is called the king of the oilseeds and is often known as wonder nut and poor men's cashew nut. (Aruna and Sagar, 2018). Groundnut is one of the important summer oilseed crops in Nepal. It is cultivated in 3342 ha with production and productivity of 4,999 mt., and 1,496 kg, respectively (MOALD, 2020). It is one of the important food legume crops of Nepal. It contains 48-50 % oil and 26-28 % protein and rich in fibres, minerals and vitamins. The area under this crop in the nineties was around 10000 ha and decreased in the recent decade due to the high cost of cultivation for weeding and high labor charge (ORP, 2016). Groundnut like in other summer crops is heavily infested with weeds. It is the major constraints that limit the productivity of groundnut. This crop is confronted with the repeated flush of diverse broad-leaved, grassy and sedges throughout the growing season which cause substantial yield loss up to 50 -70 % (Ranjit and Koirala, 1990) and 15-75% (Jat *et al*., 2011). One hand weeding was not sufficient to increase the pod yield of groundnut. It was found that weeding after 40-60 days of weed competition will reduce yield. And weeding after 80 days of crop weed competition has no value and comparable to not weeded check. Combinations of cultural, mechanical and chemical methods of weed management give higher weed control efficiency and economic benefits than that of any individual method. (Jat *et al.,* 2011). During the peak season, it is very difficult to weed groundnut. In such a period, the use of herbicides becomes effective to control weeds. Several studies have reported the effective control of weeds in groundnut with the use of herbicides. Yadav *et al*., (1983) reported Fluochlorain 1.0–1.5 kg/ha, oxyflourfen 0.1-0.2 kg/ha and Pendimethalin 1.0- 1.5 kg/ha gave significantly more yield than the weedy check treatment. Pre emergence herbicide pendimethalin (Patel *et al*., 2013) and post-emergence herbicides quizalofop-ethyl (Samant and Mishra, 2014) was found effective to control weeds in groundnut. Pendimethalin controls weed from emerging, particularly during the early

crucial development phase of the crop (Kaur *et al*., 2014). Quizalofop-ethyl effectively manages narrow leaf weeds in broad-leaved crops. The experiments were set up to evaluate the promising herbicides for effective weed management, to increase yield and to produce higher benefits.

Materials and Methods

The field experiment was conducted during the summer season of 2017 and 2018 at the experimental field of the oilseed research program, Nawalpur, Sarlahi. The site is geographically located at latitude 27° 03'86" N, longitude 85° 35'52" E and altitude 144 m. The soil of the field was sandy loam with a soil pH of 5.3. The experiment consists of 9 treatments with four herbicides, one cover mulch and weedy check. The treatment were; T1) Pendimethalin @1.0 kg a.i/ha followed by (*fb*) one Hand weeding (HW), T2) Metribuzin @ 0.5 kg a.i/ha *fb* one HW, T3) Propaquizafop @ 100 g a.i/ha at 20-25 DAS, T4) Quizaloflop-ethyl @ 100 g a. i /ha at 20-25 DAS, T5) Pendimethalin *fb* T3, T6) Pendimethalin *fb* T4, T7) Cover mulch (groundnuts pod shell) @ 3.0 t/ha, T8) Farmers practice (1-Hand weeding + 1-intercultural operation), and T9) Control (not weeded). The experiment was carried out in randomized complete block design (RCBD) with four replications. Plot size was 2.5 m x 4 m (10 m^2) and spacing of 10 cm (plant-plant) x 30 cm (row–row). Pre-release variety, ICGV-07240 (now released as *Sambridhi* was sown manually in line. Sowing of groundnut was carried out on 23 July 2017 and 7 July 2018. Herbicides were applied using Knapsack sprayer using a flat fan nozzle. Groundnut shell was used for cover mulch was applied on the same day after the crop was sown at the rate of 1.75 t/ha. Fertilizers dose of 20:40:20 $N:P_2O_5:K_2O$ kg/ha were applied. Others agronomic practices were carried out during the crop season. Plant height was measured from 10 random plants at maturity. Crop stand was recorded from one running meter at 60 days after sowing (DAS) after the herbicidal effect of all herbicides treatments was observed. Weed data was recorded from the 0.5 m^2 quadrant at 60 DAS. Weed dry weight was measured after oven-dried at 70°C for 72 hours. Weed control efficiency (WCE) was calculated using the formula.

$$\text{WCE \%} = \frac{\text{Weed count in the not weeded plot – weed count in treated plot}}{\text{weed count in not weeded plot}} \text{ x } 100$$

The crop was harvested from the net plot of 6 m^2 and computed into a hectare. For the calculation of economics, total costs (variable and fixed costs) were calculated based on the prevailing prices of all the inputs. Gross return was derived by multiplying the yield by the existing market price (Rs 150). Benefits obtained after deduction of the total cost incurred from gross returns. And benefit-cost ratio obtained by dividing the benefits by the total cost of the individual treatments. Data were analyzed using Excel 2013 and software STAR (Statistical Tool for Agricultural Research).

Results and Discussions

Effect on crop stand

The highest crop count (5.4 and 10.1) was recorded in the treatment Pendimethalin *fb* one HW (T1) in 2017 and the farmers' practice (T8) in 2018 while the lowest (3.6 and 6.1) was found in the treatment cover mulch (T6) and not weeded control in 2017 and 2018, respectively. The treatments mean was insignificantly different. Although there is the effect of treatment on crop stand however the difference is not significant. Covering of soil surface due to groundnut shell do not favor germination of all seeds in cover mulch treatment and by the suppression of germinated crops by the emerged weeds in the unweeded control treatment reduced the crop stand in these treatments. The high crop stands in weed control treatment might be due to the existence of minimum competition between weeds and crops for available resources such as light, space, nutrients and moisture. Effective control of weed in weed control treatment due to herbicides render good growth and crop stand was reported by Singh and Giri, (2001).

Effect on weed dynamics

Weed density/m^2 vary among the different weed control treatments. Fewer weeds were observed in the herbicides sprayed plot than in the control. Weed ranged found from 15.3 to 107.3 weeds/m^2 in 2017 and

13.0–70 weeds/m^2 in 2018. The lowest number of weeds (21.3 and 13) weeds/m^2 was recorded in Pendimethalin *fb* one HW in 2017 and 2018 respectively. Similarly, metribuzin *fb* one HW also recorded less number of weeds and the mean difference is par with Pendimethalin *fb* one HW. The highest numbers of weeds 107.3 and 70.3 were found in the control (not weeded plot). Propaquizafop and Quizaloflop applied plots also recorded higher number of weed revealing these two post emergence herbicides did not affect weeds in such conditions. Farmers practice plots recorded comparatively less weed than the control. Treatments mean difference is statistically significant. Reduction in weed numbers by applying pendimethalin and one hand weeding was reported by Praveen *et al.,* (2019). Application of pendimethalin at 1.5 kg/ha as pre-emergence effectively controlled both broad-leaved and grassy weeds compared to the unweeded check was also observed by Aruna and Sagar (2018). Similarly, the use of pre emergence herbicide Fluchloralin and pendimethalin @ 1.5 kg/ha was found effective in controlling weeds in groundnut was reported by Jat *et al.,* (2011).

Table 1. Weed density, weed dry weight and weed control efficiency of groundnut as influenced by weed management practices in Sarlahi, Nepal

Treatment	Weed density/0.5/m^2		Weed dry weight (g/0.5/m^2)		WCE (%)		
	2017	2018	2017	2018	2017	2018	Mean
1.Pendimethalin *fb* one HW	3.8 (15.3)	3.6 (13)	3.8 (3.0)	4.4 (3.5)	84.26	81.68	83.0
2.Metribuzin *fb* one HW	4.6 (21.6)	4.5 (21.0)	4.6 (4.3)	4.5 (6.1)	79.67	69.09	74.4
3.Propaquizafop	6.7 (44.6)	5.8 (33.6)	6.7 (8.9)	5.8 (12.7)	57.29	51.29	54.3
4.Quizaloflop ethyl	7.5 (57.0)	5.0 (26.3)	7.5 (11.4)	5.0 (8.7)	44.14	62.89	53.5
5.Pendimethalin *fb* T3	6.5 (42.0)	5.0 (24.6)	6.5 (8.4)	5.0 (8.0)	60.11	64.61	62.4
6.Pendimethalin *fb* T4	7.0 (48.6)	4.4 (21.3)	7.0 (9.7)	3.6 (2.8)	53.36	68.62	61.0
7.Cover mulch	7.2 (52.6)	5.1 (25.0)	7.2 (10.5)	5.1 (18.1)	48.26	64.60	56.4
8.Farmers practice	6.3 (38.6)	4.8 (22.6)	6.3 (7.7)	4.8 (6.4)	62.50	67.48	65.0
9.Control	10.3(107.3)	8.4 (70.3)	10.3(21.4)	8.4 (22.0)	-	-	-
Grand mean	6.7	5.2	6.7	5.2	61.20	66.28	
LSD (P<0.05)	2.5	3.4	2.5	3.4	27	43.8	
CV, %	13.7	22.5	13.1	22.5	15.32	23.95	

Note: *Figures in parentheses indicate original values, data subject to square root transformation (SQRT(x+1); Fb =followed by*

Weed dry weight

Less weed dry weight was recorded in the herbicides applied plots compared to control. Pendimethalin *fb* one HW recorded the lowest weed dry weight of 3.8 and 3.6 g in 2017 and 2018. Metribuzin *fb* one HW also recorded considerably less dry weight. Whereas, the highest weed dry weight of 10.3 and 8.4 g was found in unweeded control in the respective years. Similar to weed density the post emergence herbicides Propaquizafop and Quizaloflop applied plots also measured high weed dry weight.There was significant difference among the different treatments whereas the mean difference between Pendimethalin fb one HW and Metribuzin *fb* one HW were at par. Reduced weed dry weight was also observed by Ranjit and Sharma (1986) in herbicides applied compared to control. Parwar *et al.,* (1988) also reported integrated use of manual weeding with chemical reduced weed dry weight significantly than hand weeding alone.

Weed control efficiency

The highest weed control efficiency (WCE) was recorded in the pendimethalin *fb* one HW compared with other treatments. Metribuzin *fb* one HW and farmers practice treatments also showed a higher value of WCE. WCE % of 81.26 % (2017) and 81.68 % (2018) was found in pendimethalin *fb* one HW. The treatment mean differences of WCE % in treatment pendimethalin *fb* one HW, Metribuzin *fb* one HW and farmers practice were at par. The lowest WCE was observed in Quizaloflop ethyl (44.4 %) in 2017 and Propaquizafop (51.2 %) in 2018 (table 1).

Yield attributes and yield

Pods/plant: The highest numbers of pods per plant were recorded in the treatment Farmers practice and in metribuzin *fb* one HW in 2017 and 2018 respectively (Table 2). The numbers of pods per plant ranged from 12 – 27 (2017) and 15-47 (2018). The mean treatment difference among the treatments Pendimethalin *fb* one HW (T), Metribuzin *fb* one HW (T2) and Farmers practice (T8) were at par. Increased pods number due to integration of pendimethalin with hand weeding was also reported by Patra and Naik, (2001) and Aruna and Sagar, (2018).

Shelling

The shelling percentage of the different treatments ranged from 73.6-78.6 % (2017) and 73-76.6 % (2018). The highest value of shelling % was observed in the treatment farmers practice (T8) in 2017 and in Pendimethalin *fb* one HW (T1) in 2018.The treatments mean difference was significant only in 2017.

Table 2. Crop stand and yield attributes in groundnut as influenced by weed management practices, Sarlahi Nepal

Treatment	Crop stand /m		Pods/plant		Percentage of Shelling		100 grain weight (g)	
	2017	2018	2017	2018	2017	2018	2017	2018
1.Pendimethalin *fb* one HW	5.4	9.6	23	32	78.3	76.6	51.6	51.0
2.Metribuzin *fb* one HW	4.6	6.4	22	47	77.3	73.3	43.0	50.0
3.Propaquizafop	4.0	6.9	14	24	76.0	73.4	47.3	50.0
4.Quizaloflop ethyl	4.0	6.5	14	18	74.6	73.3	49.0	49.0
5.Pendimethalin *fb* T3	5.3	6.9	16	20	75.0	76.5	49.0	50.0
6.Pendimethalin *fb* T4	4.6	7.8	17	24	75.0	73.0	43.0	50.0
7.Cover mulch	3.6	6.6	21	16	76.0	73.3	50.0	50.0
8.Farmers practice	4.6	10.1	27	24	78.6	73.3	44.0	50.0
9.Control	4.6	6.1	12	15	73.6	73.0	42.6	46.6
Grand mean	5.5	7.4	18.5	24.7	76.0	74.04	46.6	49.6
LSD (P<0.05)	ns	ns	7.7	14.7	2.6	ns	0.04	ns
CV %	17.1	25.1	24.2	34.3	2.08	7.5	7.9	3.8

Note: *fb =followed by, ns; nonsignificant*

Hundred seed weight

The 100 grain weight ranged from 42.6 -51.6 g and 46.6 -51.0 g in 2017 and 2018.The highest grain weight was measured in Pendimethalin *fb* one HW whereas the lowest value was found in control. The mean difference was significant in 2017 only.

Grain yield

The grain yield of the different treatments range from 0.39 -1.34 t/ha (2017) and 0.79 -2.00 t/ha (2018) and the treatments mean are significantly different (table 3). The highest mean grain yield of 2.01 tones was recorded in the pre-emergence application of herbicide Pendimethalin *fb* one HW and the second-highest (1.88 t/ha) yield was obtained in pre-emergence application of herbicide metribuzin *fb* one HW. The grain yield of these two treatments is statistically at par. The lowest yield was recorded in control (1.38 t/ha). The grain yield in 2017 was comparatively lower than in 2018 due to late sowing and heavy rainfall at the crop branching stage in 2017. Meteorological data could't be presented due to the dysfunctional of the Met station of the Oilseed Research Program. The highest yield in the herbicides supplemented by one hand weeding treatment viz., Pendimethalin *fb* one HW and metribuzin *fb* one HW might be due to the weed-free environment which facilitated crop for better peg initiation and development at the critical growth stages of groundnut which tends to increase the number of pods and yield. A similar, finding was also observed by Kumari *et al*., (2020).

Effect on Economics

The total costs of the different experimented treatments ranged from Nepali Rupees (NRs 55000 – 95000. The highest total cost was calculated in the treatment Farmers practice while the lowest was found in control. The total benefits derived in the different treatments ranged from NRs 63800 - 222450 with the highest benefits in Pendimethalin *fb* one HW and the lowest in control (Table 3). The benefit-cost ratio ranged from 1.16 -2.84 and similarly, the highest BC ratio was obtained in Pendimethalin *fb* one HW and the lowest in unweeded control. Similarly, higher benefits and benefit-cost ratio was also reported by Rao *et al*., (2011) by using pre-emergence herbicides in groundnut.

Table 3. Grain yield and economics of groundnut as influenced by weed management practices, Sarlahi, Nepal

Treatment	Grain yield (t/ha)			Total cost (NRs)	Total Benefits (NRS)	B:C ratio
	2017	2018	Mean			
1.Pendimethalin *fb* one HW	1.34	2.67	2.01	78300	222450	2.84
2.Metribuzin *fb* one HW	1.33	2.43	1.88	77240	205060	2.65
3.Propaquizafop	0.78	1.63	1.21	58500	122250	2.09
4.Quizaloflop ethyl	0.64	1.43	1.04	61592	94108	1.53
5.Pendimethalin *fb* T3	0.92	1.80	1.36	61800	142050	2.30
6.Pendimethalin *fb* T4	0.75	2.07	1.41	64892	146008	2.25
7.Cover mulch	0.99	1.27	1.13	61000	108200	1.77
8.Farmers practice	1.09	2.13	1.61	95000	146500	1.54
9.Control	0.39	1.19	0.79	55000	63800	1.16
Grand mean	0.91	1.85	1.38	68147	138936	2.02
LSD (P<0.05)	0.47	0.85		-	-	-
CV %	30	26		-	-	-

Note: *fb =followed by*

Conclusion

Application of pre emergence herbicides follow by or supplemented by one hand weeding proved effective in controlling all types of weeds and increasing yield of ground nut in the experiment. Post emergence herbicides quizalofop and propaqizafop applied alone or after the pre emergence herbicides exhibit poor control of weeds and yield in sandy loam soil conditions in low soil pH. Pendimethalin @1.0 kg a.i/ha *fb* one HW was effective in controlling weeds and resulted in high yield and economics. Alternatively, application of metribuzin @ 0.5 kg a.i/ha *fb* one HW also found effective in weed management, higher yield and economics

Acknowledgement

The authors like to acknowledge Nepal Agricultural Research Council for approving the project. We like to thank National Agronomy Research Centre, Khumaltar and OilSeed Research Programme, Sarlahi for providing the facilities for conducting the trial. We also like to give special thanks to technical staff Subindra Balami and Chaudhary.

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