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Productivity and plant stand of perennial lucerne (*Medicago sativa*) under different weed-control measures during establishment year

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ABSTRACT

A field experiment was conducted during 1998–99 to 2000–01 at the Indian Grassland and Fodder Research Institute, Jhansi, using different weed-control measures in perennial lucerne (*Medicago sativa* L.). Pre-emergence application of pendimethalin at 0.5 kg/ha with hand-weeding at 6-week-crop stage was found superior to other measures for lower weed dry matter (2.5 tonnes/ha) and weed intensity (72 weeds/m^2), and higher weed-control efficiency (77.2%) without phytotoxic effect on lucerne crop. Moreover, it also produced higher green fodder (60.7 tonnes/ha), dry matter (13.2 tonnes/ha), crude protein (2,192 kg/ha) yields and plant stand (70 plant/m^2) during first growing season. Imazapyr and metribuzin with and without hand-weeding were found phytotoxic to the lucerne and resulted in lower yields due to poor initial and final plant stand despite, very good in controlling weeds. Combination of herbicides and hand-weeding resulted in more yields than chemical, mechanical and manual measure alone.

Key words: Lucerne productivity, Weed, Forage yield, Crude protein

Lucerne is an important forage crop and it occupies a sizeable area in north-western India. The high yield and forage quality potential, versatility in utilization, soil improvement and symbiotic N_2 fixation of lucerne are among the most important factors in favour of its wider use in agricultural production systems (Amos, 1993). Initial growth of this crop is very poor and severely suppressed by different seasonal weeds, which result in poor plant stand and ultimately low fodder yield. Hence an experiment was conducted to reduce yield loss by reduced crop–weed competition and optimum plant stand through different weed-control measures.

MATERIALS AND METHODS

A field experiment was conducted on perennial lucerne cv. 'LH 84' at the Central Research Farm, Indian Grassland and Fodder Research Institute, Jhansi, from 1998–99 to 2000–01. The soil of experimental fields was sandy clay loam having pH 7.5, 7.7 and 7.5; available N 180.0, 175.0 and 191.0 kg/ha; available P 19.3, 18.7 and 17.1 kg/ha; and available K 380, 372 and 368 kg/ha during first, second and third year respectively. The experiment was laid out in randomized block design with 4 replications. Fourteen treatments [weedy check (T_1), weed-free (T_2), weeder-cum-mulcher (T_3) and hand-weeding (T_4) at 4-week crop stage; pre-emergence application of imazapyr @ 0.25 (T_5), metribuzin @ 0.5 (T_6), alachlor @ 2.5 (T_8), pendimethalin @ 1.0 (T_9) and fluchloralin @ 1.0 kg ai/ha as pre-plant incorporation (T_7); and 5 treatments with half dose of pendimethalin (T_{10}), imazapyr (T_{11}), metribuzin (T_{12}), fluchloralin (T_{13}) and alchlor (T_{14}) herbicide with hand-weeding at 6-week crop stage)] were assessed for plant stand and yield. All weed-control treatments were imposed only during the first year. The lucerne crop was sown in rows 30 cm apart using 15 kg seed/ha. The experiment was sown in different fields during each year. The crop was sown on 12 December, 9 November, and 16 November and 5, 8 and 8 cuttings were obtained during first, second and third year respectively. Crop received 1,118.2; 712.1 and 1,182.2 mm precipitation with 52, 37 and 51 rainy days during crop period of 1998–99, 1999–2000 and 2000–2001 respectively. The crop was fertilized basally with 20 kg N, 34.96 kg P and 49.8 kg K/ha. Sources of N, P and K fertilizers were urea, single superphosphate and muriate of potash respectively. All the other crop-management practices were followed as per recommendation.

Initial and final plant stand was recorded at 6-week crop stage and at the end of growing season (end of October), respectively, of each year. Weed-control efficiency and weed intensity were recorded during each cut and finally data were averaged for whole year. Weed dry weight

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was recorded by summing the values obtained from all cuttings of a particular growing season. Mortality per cent was calculated using initial and final data of plant stand. The data of 3 growing seasons were pooled, analysed and presented in this paper.

RESULTS AND DISCUSSION

Effect of weeds

Perennial lucerne crop was infested with different weed species during its whole growing season. During initial phase, in winter season weeds like *Caronopus didymus*, *Rumex demiculata*, *Anagallis arvensis*, *Cichorium intybus*, *Melilotus* spp., *Spergula arvensis* and *Medicago denticulata* were found predominantly. *Convolvulus arvensis*, *Commelina benghalensis*, *Parthenium hysterophorus*, *Cynodan dactylon*, *Cyperus* spp, *Echinocloa* spp. and *Digitaria sanguinalis* were found during summer and rainy seasons. *Parthenium hysterophorus*, *Cynodan dactylon*, *Cyperus* spp., *Echinocloa* spp. and *Digitaria sanguinatis* were found during summer and rainy seasons. *Parthenium hysterophorus*, *Cynodon dactylon* and *Cyperus* spp. were found in lucerne field during entire growing period.

Dry matter of weeds, weed intensity and weed-control efficiency were affected by different weed-control measures (Table 1). Imazapyr without hand-weeding at par with half dose of this herbicide + hand-weeding resulted in significantly less dry matter than other treatments. Pendimethalin with hand-weeding at par with metribuzin + hand-weeding resulted significantly lower weed dry matter than remaining treatments. The highest weed dry matter was recorded from weedy check followed by weeder-cum-mulcher treatment. Schmierer and Lym (1993) also reported better control of annual grasses and broad-leaf weeds with the application of metribuzin.

Significantly lower weed intensity was observed with the application of imazapyr and metribuzin than the other treatments. Significantly lower weed intensity was found with the application of pendimethalin + hand-weeding (72 weed/m^2) than remaining treatments, however, it was at par with metribuzin without hand-weeding (47 weeds/m^2). Application of herbicides were found superior to mechanical and manual weeding with respect to weed intensity.

Imazapyr with and without hand-weeding gave the relatively higher weed-control efficiency than remaining treatment. Half dose of pendimethalin + hand-weeding closely followed the imazapyr alone and metribuzin + hand-weeding and found optimum for weed-control efficiency because it did not exert any phytotoxic effect on lucerne crop. The lowest weed-control efficiency was recorded from mechanical and manual weeding.

Effect on lucerne

Plant stand : Initial and final plant stand and mortality significantly affected by differened weed-control measures (Table 2). Weed-free treatment was at par with T_{10} showed significantly higher initial plant stand compared to remaining treatments. Curran *et al.* (1993) also recorded maximum growth and plant stand of lucerne from weekly hand-weeding treatment. Manual weeding at 4-week crop stage was found equally effective as mechanical weeding and herbicide treatments with and without hand-weeding. Initial plant stand in hand-weeding treatment was at par with mechanical treatment, fluchloralin and alachlor with

Table 1. Effect of weed-control measures on weed dry weight, weed intensity and weed-control efficiency (pooled data of 3 seasons)

Treatment	Dry weight* (tonnes/ha)	Weed intensity* (weeds/m^2)	Weed-control efficiency (%)
Weedy check	3.36 (10.8	17.18 (295)	0.0
Weed-free	0.71 (0.0)	0.71 (0)	100.0
Weeder-cum-mulcher at 4-week crop stage	2.88 (7.8)	14.36 (206)	28.1
Hand-weeding at 4-week crop stage	2.59 (6.2)	13.31 (177)	42.9
Imazapyr 0.25 kg/ha PE	1.52 (1.8)	5.14 (26)	83.3
Metribuzin 0.5 kg/ha PE	2.02 (3.6)	6.89 (47)	66.7
Fluchloralin 1.0 kg/ha PPI	2.43 (5.4)	10.26 (105)	50.3
Alachlor 2.5 kg/ha PE	2.49 (5.7)	10.69 (114)	47.8
Pendimethalin 1.0 kg/ha PE	2.21 (4.4)	9.91 (98)	59.6
Pendimethalin 0.5 kg/ha PE + HW	1.73 (2.5)	8.54 (72)	77.2
Imazapyr 0.125 kg/ha PE + HW	1.48 (1.7)	5.86 (34)	84.9
Metribuzin 0.25 kg/ha PE + HW	1.64 (2.2)	8.29 (68)	79.9
Fluchloralin 0.5 kg/ha PPI + HW	1.97 (3.4)	10.60 (112)	68.8
Alachlor 1.25 kg/ha PE + HW	2.05 (3.7)	11.17 (124)	66.4
CD (P=0.05)	0.32	0.86	

PE, Pre-emergence; PPI, preplant incorporation; HW, hand-weeding at 6-week crop stage
*Transformed values [$Y = \sqrt{X + 0.5}$; figures in parentheses indicate original values

Table 2. Effect of weed-control measures on plant stand and yields of lucerne (pooled data of 3 seasons)

Treatment	Initial (shoots/m)	Final (shoots/m)	Mortality (%)	Green fodder (tonnes/ha)	Dry matter (tonnes/ha)	Crude protein (kg/ha)
Weedy check	49	13	74	36.3	6.9	1,208
Weed-free	86	79	8	63.6	14.3	2,294
Weeder-cum-mulcher at 4-week crop stage	54	24	57	45.4	10.1	1,598
Hand-weeding at 4-week crop stage	62	33	47	47.0	10.3	1,661
Imazapyr 0.25 kg/ha PE	14	8	43	26.9	5.4	808
Metribuzin 0.5 kg/ha PE	43	27	38	39.4	8.0	1,233
Fluchloralin 1.0 kg/ha PPI	63	42	34	49.4	9.8	1,635
Alachlor 2.5 kg/ha PE	62	42	33	49.6	9.8	1,592
Pendimethalin 1.0 kg/ha PE	65	45	30	49.6	10.0	1,611
Pendimethalin 0.5 kg/ha PE + HW	80	70	12	60.7	13.2	2,192
Imazapyr 0.125 kg/ha PE + HW	22	12	45	36.4	6.2	910
Metribuzin 0.25 kg/ha PE + HW	45	27	39	45.4	9.1	1,300
Fluchloralin 0.5 kg/ha PPI + HW	67	57	14	53.7	11.2	1,884
Alachlor 1.25 kg/ha PE + HW	66	56	15	55.7	10.7	1,781
CD (P=0.05)	8.9	11.3	8.9	6.0	1.5	339

PE, Pre-emergence; PPI, preplant incorporation; HW, hand-weeding at 6-week crop stage

and without hand-weeding, and pendimethalin without hand-weeding. Imazapyr and metribuzin reduced the plant stand due to their phytotoxic effect on lucerne. The initial plant stand in imazapyr treatments were found significantly lower than the weedy check treatment; however, application of metribuzin alone or with hand-weeding was at par with weedy check. The chlorosis and stunting of plant observed in these treatments during initial phase but after 2 months these symptoms disappeared, however, plant stand reduced to a great extent. Zamora *et al.* (1991) also recorded similar effects. Manual weeding was found at par with mechanical measure with respect to initial plant stand but no significant differences were recorded among weedy check, hand-weeding and metribuzin.

The final plant stand was significantly higher in weed-free and pendimethalin + hand-weeding treatments as compared to remaining treatments. Significantly lower final plant stand was recorded from imazapyr and it was at par with imazapyr + hand-weeding and weedy check treatments. The initial plant stand of these treatments was low and crop did not recover up to the end of growng season. Treatments with fluchloralin, alachlor and pendimethanlin herbicides with or without hand-weeding were found significantly superior to mechanical or manual weeding.

Mortality of lucerne crop ranged from 8 to 74%. The significantly higher (74%) mortality was recorded from weedy check treatment as compared to remaining treatments. More stable plant stand at the end of growing season due to lowest mortality (8%) was recorded from weed-free conditions and it was at par with pendimethalin + hand-weeding (12%), followed by fluchloralin + hand-weeding (14%) and alachlor + hand-weeding (15%). Mortality in imazapyr and metribuzin treatments was found at par with hand-weeding, however due to high initial damage of crop by these herbicides the poor stand was observed during end of growing season.

Yield

Green fodder, dry matter and crude protein yields were significantly affected by various weed-control measures (Table 2). Significantly higher green fodder yield (63.6 tonnes/ha) was obtained from weed-free than the other treatments, however it was at par with pendimethalin with hand-weeding (60.7 tonnes/ha). No significant differences were recorded between manual and mechanical weeding. Curran *et al.* (1993) also recorded maximum yields of lucerne from weekly hand-weeding. The full dose of herbicides without hand-weeding except imazapyr and metribuzin also gave comparable yield as of manual and mechanical weeding. The yield from imazapyr and metribuzin without hand-weeding treatments was significantly lower due to lower plant stand. Schmierer and Lym (1993) also find the similar results. Among different herbicide + hand-weeding treatments significantly higher yield was obtained from pendimethalin over other treatments except it was at par with alachlor, however, significantly lower from imazapyr and metribuzin treatments. The hand-weeding treatment was at par with fluchloralin, alachlor and pendimethalin without hand-weeding, mechanical weeding and with combination of hand-weedings and half dose of metribuzin.

Weed-free situation produced significantly higher dry matter over remaining treatments, except it was at par

with pendimethalin + hand-weeding and gave 93.3% yield as in weed-free tratment. Pendimethalin + hand-weeding gave significantly higher dry-matter yield (13.2 tonnes/ha) over remaining treatments. Dimitrova (2001) recorded 17–29% increase in dry-matter yield when herbicides were applied during active growth phase in spite of presence of weeds and found optimum for weed control in alfalfa. Pedreros and Soto (2001) also reported similar results. The mechanical and manual measures were at par with each other and resulted in almost equal yield as in full dose of fluchloralin, alachlor and pendimethalin and half dose of hebricide with hand-weeding.

Different weed-control measures significantly influenced the crude protein yield by affecting the green forage yield. The significantly higher crude protein yield was recorded from weed-free treatment as compared to other treatments, however, it was at par with pendimethalin + hand-weeding. No significant differences were observed among mechanical and manual weeding; use of fluchloralin, alachlor and pendimethalin without hand-weeding and fluchloralin and alachlor with hand-weeding. The lowest crude protein yield was recorded from imazapyr without hand-weeding. Surovsik (1991) also recorded variation in crude protein yield but no effect was observed in its content.

Thus pre-emergence application of pendimethalin @ 0.5 kg a.i./ha + hand-weeding at 6-week crop stage was found better for lower weed intensity, optimum weed-control efficiency, higher yields and establishment of perennial lucerne.

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