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Influence of different herbicides on growth, yield and economics of lentil

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ABSTRACT

A field experiment was conducted during *Rabi* season of 2011-12 and 2012-13 at Raipur, Chhattisgarh to find most effective herbicides for weed management in lentil. Best result was found in hand weeding twice at 20 and 40 DAS closely followed by pre-mix application of pendimethalin + imazethapyr 1.0 kg/ha as pre-emergence wherein lowest weed dry weight was recorded at 60 DAS with maximum weed control efficiency, tallest plant, maximum branches/plant, highest plant dry matter accumulation, highest pods/ plant, seeds/plant, test weight, maximum grain and stover yield, maximum net return and B:C ratio over all the treatments.

Key words: Chlorimuron-ethyl, Imazethapyr, Lentil, Pendimethalin, Quizalofop-ethyl, Seed yield, Weed management

Lentil *(Lens culinaris* Medikus) is an important winter season pulse crop in India. It is hardier and capable of withstanding extremes of weather and soil condition. However, due to its short stature, slow initial growth and long duration, its productivity is adversely affected by the presence of weeds. The prominent weed species infesting lentil crop are *Cynodon dactylon, Chenopodium album, Euphorbia hirta, Melilotus alba, Anagallis arvensis* and *Xanthium strumarium*. The concept that high input in high yield also means is high risk, if weeds are not controlled. A weed free crop environment is therefore important both for increasing yield and income for the security of crop. There are number of reasons of low production and productivity of lentil out of which weeds, being serious negative factors in crop production are responsible for reduction in the yield of lentil to a tune of 84% (Mohamed *et al.* 1997). Loss in seed yield may go to the extent of 45-65% under unweeded condition. During winter season, broad-leaved weeds may become dominant in the early stages of crop growth because of their fast growth and deep root system.

To control weeds, generally hand weeding is in practice that is now costly as well as difficult because of non-availability of labour in peak period. With the advancement of agro techniques, chemical weed control has become an effective and cheap alternative to control weeds. It is effective and economical measures to control weeds as compared to manual weeding. Earlier a few studies have been done using herbicdes like quizalofop-ethyl and imazethapyr as post-emergence (Singh *et al*. 2014) and pendimethalin as pre-mergence and isoproturon as post emergence (Yadav *et al.* 2013, Dhuppar *et al.* 2013) with good control of weeds in lentil but there are scanty reports on pre-mix application of herbicides available in the market. Therefore, this study has been done to evaluate this aspect.

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MATERIALS AND METHODS

A field experiment was conducted at Indira Gandhi Krishi Vishwavidyalaya, Raipur ($21^0$4 N latitude, $81^0$39 E longitude and 298 m above mean sea level), Chhattisgarh during *Rabi* season of 2011-12 and 2012-13 to find out the most effective herbicide, their appropriate dose and time of application for lentil. The soils of the experimental plot was sandy loam in texture (Inceptisol) with pH 7.69 (neutral), low in organic carbon (0.48%), low in available N (181 kg/ha) and P (7.74 kg/ha) and high exchangeable K (311 kg/ha) with normal electrical conductivity.

The experiment was laid out in randomized complete block design (RCBD) comprising of 8 treatments, *viz*. quizalofop-ethyl at 50 g/ha at 30 DAS, imazethapyr at 37.5 g/ha at 30 DAS, chlorimuron- ethyl at 4 g/ha at pre-plant incorporation, pendimethalin 1.0 kg/ha at pre-emergence, pre-mix pendimethalin + imazethapyr 0.75 kg/ha as pre-emergence, pre-mix pendimethalin + imazethapyr 1.0 kg/ha at pre-emergence, hand weeding twice at 20 and 40 DAS and weedy check. Crop was sown at a seed rate of 40 kg/ha with a row spacing of 25 cm and plant spacing 5 cm in line during last week of November in 2011 and 2012,

respectively. Recommended dose of N (20 kg/ha), P (17 kg/ha) and K (16 kg) through urea, diammonium phosphate and murate of potash were drilled in the soil before sowing. The crop was raised under irrigated condition with recommended package of practices for the zone.

All the herbicides were sprayed as per their time of application by knapsack sprayer using a flat fan nozzle at 500 l/ha volume by diluting with water. The economics of treatments was computed on the basis of prevailing market prices of inputs and outputs under each treatment. Pooling was made on the basis of two years data as similar trend was noticed during all the years.

RESULTS AND DISCUSSION

Floristic composition

The predominant weeds observed in the experimental field were *Cynodon dactylon* among grasses, *Chenopodium album*, *Cirsium arvense*, *Melilotus alba*, *Euphorbia hirta*, *Anagallis arvensis*, *Xanthium strumarium*, *Convolvulus arvensis* among broad-leaf and *Cyperus rotundus* among sedges during two years. Similarly, weed flora have also been reported by Chandrakar (2011). Thus, broad-leaved weeds were dominant compared to grassy and sedges during both year.

Effect on weeds

All the weed control treatments significantly curtailed weed dry weight compared to weedy check (Table 1). However, hand weeding twice at 20 and 40 DAS recorded lowest weed biomass compared to other treatments. Amongst the herbicides, lowest weed biomass 31.2 and 38.9 g/m^2 was recorded at 40 and 60 DAS in pendimethalin + imazethapyr 1.0 kg/ha at pre- emergence, respectively. It was closely followed by pendimethalin + imazethapyr 0.75 kg/ha as pre-emergence over rest of the treatments and weedy check. Combination of pendimethalin + imazethapyr and imazethapyr alone effectively controlled germinating broad-leaved as well as grassy weeds. This might be due to inhibition of weed seedling emergence, resulting in least weed biomass and higher crop growth. Similar findings were reported in field pea (Ram *et al.* 2011) and in Rajmash (french bean) (Ram *et al.* 2012). On the other hand, hand weeding twice at 20 and 40 DAS recorded the lowest weed biomass (19.87 g/m^2 at 40 DAS and 24.00 g/m^2 at 60 DAS) over all the herbicide treatments including weedy check by controlling weed population to the extent of 74.59 % (Table 1).

On efficiency factor, pre-emergence application of pendimethalin + imazethapyr at 1.0 kg/ha had maximum weed control efficiency (58.86%) recorded at 60 DAS and was closely followed by pre-emergence application of pendimethalin + imazethapyr at 0.75 kg/ha whereas, it was the least under chlorimuron-ethyl at 4 g/ha applied at pre plant incorporation. This might be due to the lower weed biomass and higher efficiency of weed control under combination of pendimethalin + imazethapyr against both broad-leaved and grassy weeds (Table 1). Imazethapyr at 25 as well as 40 g/ha at either 25 or 35 DAS showed promise in improving the grain yield of lentil (Singh *et al.* 2014). Similarly, minimum weed index (21.06 %) was recorded with pre-emergence application of pendimethalin + imazethapyr at 1.0 kg/ha over rest of the herbicide treatments and weedy check (Table 1) as this treatment effectively controlled both broad-leaved and grassy weeds. Similar findings were reported by Godara and Deshmukh (2002).

Table 1. Influence of different herbicides on weed biomass, weed control efficiency at 60 DAS and per cent reduction in yield due to presence of weeds of lentil (mean of 2 years)

Treatment	Total weed biomass (g/m^2)		Weed control efficiency at	Weed dry matter (kg/ha)		Weed index
	40 DAS	60 DAS	60 DAS (%)	40 DAS	60 DAS	(%)
Quizalofop-ethyl at 50 g/ha at 30 DAS	44.0	55.0	41.8	440	547	37.5
Imazethapyr at 37.5 g/ha at 30 DAS	36.3	44.7	52.7	363	447	31.2
Chlorimuron-ethyl at 4 g/ha as pre plant incorporation	60.5	66.1	30.0	605	661	44.6
Pendimethalin 1.0 kg/ha as pre-emergence	40.1	49.0	49.2	401	490	34.3
Pendimethalin + imazethapyr 0.75 kg/ha as pre-emergence	32.8	40.3	57.4	328	403	24.9
Pendimethalin + imazethapyr 1.0 kg/ha as pre-emergence	31.2	38.8	58.9	312	388	21.1
Hand weeding at 20 and 40 DAS	19.9	24.0	74.6	199	240	-
Weedy check	78.3	94.4	-	783	944	61.6
LSD (P=0.05)	8.4	9.3		84	93	

Table 2. Influence of different herbicides on growth and yield attributes of lentil (mean of 2 years)

Treatment	Plant height at harvest (cm)	Branches/ plant (no.)	Plant dry matter accumulation (g/m^2)	Pods/ plant (no.)	Seeds/ pod (no.)	1000 - seeds weight (g)
Quizalofop-ethyl at 50 g/ha at 30 DAS	34.8	4.07	21.8	25.8	1.60	22.4
Imazethapyr at 37.5 g/ha at 30 DAS	38.0	4.40	23.4	30.0	1.79	23.3
Chlorimuron-ethyl at 4 g/ha as pre plant incorporation	34.2	3.63	21.7	25.0	1.52	21.3
Pendimethalin 1.0 kg/ha as pre-emergence	36.5	4.20	23.4	27.7	1.71	23.6
Pendimethalin + imazethapyr 0.75 kg/ha as pre-emergence	39.8	4.80	23.7	32.3	1.85	23.7
Pendimethalin + imazethapyr 1.0 kg/ha as pre-emergence	41.6	5.23	24.6	34.2	1.89	24.7
Hand weeding at 20 and 40 DAS	49.2	5.90	26.3	41.0	1.98	24.7
Weedy check	33.3	3.13	18.4	20.3	1.39	18.9
LSD (P=0.05)	7.3	0.66	3.3	5.2	0.27	3.4

Table 3. Influence of different herbicides on seed yield, stover yield, harvest index and economics of lentil (mean of 2 years)

Treatment	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)	*Gross returns ($x10^3$ `/ha)	*Net returns ($x10^3$ `/ha)	B:C ratio
Quizalofop-ethyl at 50 g/ha at 30 DAS	0.79	1.39	36.8	32.99	20.51	1.64
Imazethapyr at 37.5 g/ha at 30 DAS	0.87	1.64	34.6	36.41	24.32	2.01
Chlorimuron-ethyl at 4 g/ha as pre plant incorporation	0.70	1.27	35.5	29.27	17.64	1.52
Pendimethalin 1.0 kg/ha as pre-emergence	0.83	1.62	33.8	34.83	21.63	1.64
Pendimethalin + imazethapyr 0.75 kg/ha as pre-emergence	0.95	1.78	34.8	39.74	26.98	2.11
Pendimethalin + imazethapyr 1.0 kg/ha as pre-emergence	1.00	1.84	35.1	41.73	28.47	2.15
Hand weeding at 20 & 40 DAS	1.26	2.17	36.8	52.71	36.94	2.34
Weedy check	0.48	0.84	36.6	20.22	9.25	0.84
LSD (P=0.05)	0.15	0.28	NS	6.02	6.02	0.47

*The price of quizalofop-ethyl ₹ 1200/-lit, imazethapyr ₹ 1600/-lit, pendimethalin ₹ 580/- lit**,** chlorimuron-ethyl ₹ 350/-, pendimethalin 30 EC+ imazethapyr 2 EC)- ₹ 630/-lit, the cost of two hand weeding (20 and 40 DAS) were ₹ 4800/- for 30 man days, sale price Lentil grain ₹ 50/kg and stover ₹1/kg.

Effect on crop

All the pre- and post-emergence herbicide treatments had significantly higher values of crop growth and yield contributing characters over the weedy check. Among the herbicide treatments, tallest plants (41.63 cm), highest branches/plant (5.23), plant dry matter accumulation (24.57 g/m^2), pods/ plant (34.17), seeds/pod (1.89) and test weight (24.68 g) were recorded with application of pendimethalin + imazethapyr at 1.0 kg/ha as pre-emergence and was closely followed by pendimethalin + imazethapyr at 0.75 kg/ha as pre-emergence. Because of poor weed control efficiency and higher weed competition index among weeds, chlorimuron-ethyl at 4 g/ha as pre-plant incorporation was least effective for raising crop growth and yield contributing characters of lentil (Table 2). On the contrary, hand weeding twice at 20 and 40 DAS recorded significantly tallest plants (49.23 cm), highest branches/plant (5.90), plant dry matter accumulation (26.30 g/m^2), pods/plant (40.97), seeds/pod (1.98) and test weight (24.68 g) over weedy check and most of the treatments.

Seed and stover yield of lentil varied significantly due to weed control treatments. Significantly maximum seed and stover yield 1.26 and 2.17 t/ha was obtained with hand weeding twice at 20 and 40 DAS, respectively over rest of the treatments. Among the herbicides, application of pendimethalin + imazethapyr 1.0 kg/ha as pre-emergence recorded maximum seed (1.0 t/ha) and stover yield (1.84 t/ha), which was obvious due to its higher values of yield attributes, weed control efficiency (58.86%) and lower weed index (21.06%) compared to the rest of the herbicide treatments. However, this treatment was at par with pendimethalin + imazethapyr 0.75 kg/ ha as pre-emergence. Effectiveness of these treatments could be attributed to better control of weeds during critical period of crop–weed competition and thus, provided a weed free environment for a better growth and development of rajmash. These findings were in close proximity with that of Billore *et al.* (1999) and Ram *et al.* (2011) with imazethapyr on field pea. Lower seed yield under chlorimuron ethyl could be attributed to its poor weed control efficiency and higher weed index against grassy weeds**.**

Economics

The highest net returns (₹ 36,937/ha) and benefit: cost ratio (2.34) were fetched with hand weeding twice at 20 and 40 DAS owing to effective control of broad-leaved as well as grassy weeds (Table 3) over rest of treatments. Among the herbicide treatments, highest net return (₹ 28471/ha) and benefit: cost ratio (2.15) was recorded with pendimethalin + imazethapyr 1.0 kg/ha as pre-mergence (PE) and was followed by pendimethalin + imazethapyr 0.75 kg/ha as PE and imazethapyr at 75 g/ha at 30 DAS. Excellent control of dominant broad-leaved as well as grassy weeds without any adverse effect on crop growth resulting in higher seed yield might have caused superior economic indices in these treatments. Least net return (₹ 9249/ha) and B:C ratio (0.84) was recorded with weedy check due to both poor weed control and low crop yield.

Thus, it may inferred from the above that hand weeding twice at 20 and 40 DAS could be recommended for effective control of mixed weed flora in lentil for getting higher productivity and profitability. However, in case of unavailability of agricultural labour at appropriate time for manual weeding in lentil, pre-emergence application of pre-mix pendimethalin + imazethapyr 1.0 kg/ha (Vellor) could be a good alternative to control the weeds effectively and economically.

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