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Short Note

Effect of post-emergence herbicides on productivity and profitability of garden pea (*Pisum sativum* L.) in Lahaul valley of Himachal Pradesh

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Abstract

A field experiment was conducted during summer 2013 at Highland Agricultural Research and Extension Centre, CSK Himachal Pradesh Krishi Vishvavidyalaya, Kukumseri to study the effect of post-emergence herbicides *viz*. imazethapyr 50 and 80 g/ha, pendimethalin + imazethapyr 900 and 1200 g/ha, imazethapyr + imazamox 50 and 75 g/ha and clodinafop 60 g/ha in relation to pre-emergence pendimethalin 1200 g/ha and hand weeding twice on weeds and yield and economics of garden pea. *Digitaria sanguinalis* L. was the predominant grass weed while *Chenopodium album* L., *Chenopodium botrys* L., *Gallinsoga parviflora* L. *and Malva parviflora* L. were the major broad-leaf weeds. Pendimethalin at 1200 g/ha significantly reduced weed density and dry weight. This was followed by hand weeding twice (30 and 60 DAS). Pendimethalin resulted in maximum weed control efficiency (65.81%) and herbicide efficiency index (74.13%) and was followed by clodinafop 60 g/ha. Pod weight was not significantly affected. The highest pods/plant, green pods yield (2833 kg/ha), crop productivity (41.06 kg/ha/day), net returns (₹ 76294/ha), crop profitability (₹ 1105.71/ha/day) and B:C ratio (3.06) were recorded under pendimethalin 1200 g/ha. Clodinafop 60 g/ha and hand weeding twice had equal pods/plant and green pod yield. Among post-emergence herbicides, clodinafop 60 g/ha, imazethepyr 50 g/ha and imazethapyr + imazamox 50 g/ha were the economical treatments.

Key words: Garden pea, weeds, imazethapyr, imazamox, clodinafop, pendimethalin, profitability, productivity

Lahaul representing cold desert area is an important vegetable growing region of the state. In Himachal Pradesh, the cold desert area constitutes about 42 percent of its total geographical area (Anonymous 2012). Garden pea (*Pisum sativum* L.) is an important off-season cash crop vegetable in the Lahaul valley. It is a major source of income for the Lahaul farmers as it fetches higher price due to its good aroma, sweetness and freshness. There is a great demand of garden pea in different parts of the country. Heavy weed infestation is one of the major reasons for poor productivity and profitability of garden pea in the region. The prevailing soil and climatic conditions warrant frequent irrigation for better growth and development of garden pea. Climatic conditions and frequent irrigation aggravate weed growth (Singh *et al*. 1991; Sharma 1993). Acute crop-weed competition occurs due to earlier weed germination and faster weed growth than garden pea particularly in initial growth stages. Lahaul farmers generally adopt manual weed control which is not only very expensive but also not feasible due to acute shortage of labour at the time of peak sowing and harvesting of the crop. Delayed harvesting of garden pea results in decreasing quality and green pod yield due to birds' attack.

Pre-and post-emergence herbicides are needed for effective weed control as there is acute weed infestation in the region. Post-emergence herbicides would be proved to be the best alternative in the case, when farmers could not apply pre-emergence herbicide in their crop due to its non-

availability. For effective weed control in garden pea, there is no recommended post-emergence herbicide for the cold desert region of the state. Hence, the present investigation was undertaken to study the effect of post-emergence herbicides on weeds and yield and economics of garden pea.

A field experiment was conducted during summer 2013 at Kukumseri (32° 44' 55" N latitude, 76° 41' 23" E longitude, and 2672 m above the mean sea level). The climate is extremely cold and heavy snowfall occurs during winter. The temperature remains several degrees below zero level. Single cropping season is prevailing in the region which starts from April to September or early October when the mean minimum and maximum temperature range between 12°C to 24°C. There is negligible rainfall followed by high light intensity and low humidity. Average annual rainfall of the region is 250 mm. The soil of the experimental site was sandy loam in texture and acidic in reaction (6.1) with 10.5 g OC/kg soil, 0.9 mg Zn/kg soil, 18 kg S/ha, 280 kg available N/ha, 34 kg available P/ha and 300 kg available K/ha. Soils are shallow in depth and loose in texture resulting in poor water holding capacity. The experiment consisting of ten treatments *viz*. imazethapyr 50 & 80 g/ha, pendimethalin + imazethapyr (ready mix, valor) 900 and 1200 g/ha, imazethapyr + imazamox (ready mix, odyssey) 50 & 75 g/ha, clodinafop 60 g/ha, pendimethalin 1200 g/ha, hand weeding (30 & 60 DAS) and weedy check (Table 1) was laid out in randomized block design with three replications.

Garden pea cv Azad P-1 was sown on 22nd May, 2013 at 45 cm inter-row spacing with a seed rate of 100 kg/ha. Seed was treated with bavistin at 2.5 g/kg seed. Recommended dose of nutrients @ 25 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha was applied at the time of sowing through urea, single super phosphate and muriate of potash, respectively. Pendimethalin was applied next day of sowing whereas imazethapyr, odyssey, valor and clodinafop were applied at 30 days after sowing. Snow-melt water, the only source of irrigation was used to irrigate garden pea through sprinklers, rain gun or *Kuhl*. The crop was harvested on 30th July 2013. Other practices were in accordance with the recommended package for the region.

Weed density (stems/m^2 was noted due to dense and compact stems with rooting from nodes touched with soil), weed dry matter accumulation, yield attributes, green pod yield, productivity, cost of cultivation, gross returns, net returns, B:C ratio and profitability were recorded and/or computed after the harvest of the crop. Weed control efficiency (WCE) and herbicide efficiency index (HEI) were worked out using the following formulae:

$$HEI = \frac{\text{Yield in treated plot - Yield in control plot}}{\text{Yield in treated plot}} \times 100$$

$$WCE\ (\%) = \frac{\text{Weed dry weight in control plot - Weed dry weight in treated plot}}{\text{Weed dry weight in control plot}} \times 100$$

Statistical differences between treatments were tested with Fisher's least significant difference (P=0.05) test (Fisher and Yates 1949) using analysis of variance for randomized block design as described by Panse and Sukhatme (1967).

The experimental field was heavily infested with different weed flora. *Digitaria sanguinalis* L. was the predominant grass weed while *Chenopodium album* L., *Chenopodium botrys* L., *Gallinsoga parviflora L. and Malva parviflora* L. were the major broad-leaf weeds. Other weeds were *Polygonum alatum* L., *Setaria glauca* L., *Amaranthus spinosus* L., *Medicago denticulata* L. *and Poa annua* L. (Rana *et al*. 2004; Kumar *et al.* 2015a; Kumar *et al.* 2015b). *Digitaria sangunalis* L. was the most predominant weed.

Different weed control treatments significantly influenced weed density (Table 1). Pre-emergence application of pendimethalin 1200 g/ha significantly reduced the number of weeds. This was followed by hand weeding at 30 and 60 days after sowing and post-emergence application of clodinafop 60 g/ha. The weed dry weight showed the similar trend like weed density (Table 1). The lowest weed dry weight was recorded in pendimethalin 1200 g/ha followed by hand weeding at 30 and 60 days after sowing. Rest of the treatments produced similar dry matter. Pre-emergence application of pendimethalin 1200 g/ha had maximum weed control efficiency of 65.81% and herbicide efficiency index of 74.13%. Post-emergence application of clodinafop 60 g/ha was found to be the next best treatment in respect of weed control efficiency (40.17%) and herbicide efficiency index (58.88%). The highest weed density and weed dry matter accumulation was noted in weedy check. Pre-emergence application of pendimethalin suppresses weeds effectively resulting in low weed density and dry weight. Post-emergence herbicides were not as effective due to well establishment of weeds by 30 days after sowing resulted in acute crop weed competition.

The highest number of pods per plant was recorded with pre-emergence application of pendimethalin 1200 g/ha while the lowest was in weedy check (Table 2). The second highest number of pods/plant was recorded in hand

Table 1. Effect of herbicides on weed density and weed dry weight

Treatment	Dose (g/ha)	Time of application (DAS)	Grass weeds * (No./m^2)	Broad-leaf * weeds (No./m^2)	Weed dry weight (kg/ m^2)	Weed control efficiency (%)	Herbicide efficiency index (%)
Imazethapyr	50	30	55(3289)	4 (21)	1.10	5.98	45.01
Imazethapyr	80	30	54(2928)	2 (3)	1.09	6.84	39.22
Pendimethalin + imazethapyr**	900	30	48(2328)	2(3)	0.80	31.62	25.43
Pendimethalin + imazethapyr**	1200	30	53(2913)	1(1)	0.97	17.09	41.36
Imazethapyr + imazamox**	50	30	48(2335)	1(1)	0.73	37.61	39.72
Imazethapyr + imazamox**	75	30	49(2561)	2(5)	0.70	40.17	15.36
Clodinafop	60	30	34(1221)	6(49)	0.70	40.17	56.88
Pendimethalin	1200	2	21(672)	2(5)	0.40	65.81	74.13
Hand weeding	-	30 & 60	24(951)	1(1)	0.47	59.83	-
Weedy check (control)	-	-	57(3300)	4(20)	1.17	-	-
S Em±	-	-	4.28	1.24	0.17	-	-
C D (P=0.05)	-	-	12.71	3.67	0.52	-	-

*√x transformation ** ready mix

weeding followed by post-emergence clodinafop 60 g/ha and pendimethalin + imazethapyr 1200 g/ha. Green weight/ pod remained unaffected due to weed control treatments .

Green pod yield was significantly increased due to pre -emergence pendimethalin 1200 g/ha (2833 kg/ha). Hand weeding and post-emergence application of clodinafop 60 g/ha were the next superior treatments in influencing green pod yield (Table 2). Statistically equal pod yield was noted in manual weed control (two hand weeding at 30 and 60 DAS) and post-emergence application of clodinafop 60 g/ ha. Pendimethalin resulted in 286.49%, 40% and 37.84% higher green pod yield than weedy check, post-emergence application of clodinafop 60 g/ha and hand weeding, respectively. Post-emergence application of imazethapyr 50 g/ha showed superiority in respect of green pod yield over weedy check and imazethapyr + imazamox 75 g/ha. It gave 81.86 and 53.93% higher green pod yield than weedy check and imazethapyr + imazamox 75 g/ha, respectively. The highest crop productivity of 41.06 kg/ha/day was recorded with pre-emergence application of pendimethalin 1200 g/ha. Two hand weeding at 30 and 60 DAS and post-emergence application of clodinafop 60 g/ha were the next superior treatments (Table 2). Higher yield in these treatments might be due to less weed competition thereby more photosynthesis and better translocation of photosynthates (Dhanpal *et al*. 1989; Kundra *et al*. 1993; Rao *et al.* 1997; Rana, 2004; *Rana et al.*2013*;* Mawalia *et al.* 2015).

Since adoption of any technology depend on its economics, it is pertinent to have economic analysis of the treatments. The highest gross returns (₹ 1,13,320/ha), net returns (₹ 76,294/ha), B:C ratio (3.06) and profitability (₹ 1105.11/ha/day) was recorded with pre-emergence pendimethalin 1200 g/ha. This might be due to the highest green pod yield and low cost of its treatment. The highest cost of cultivation (₹ 63155/ha) was recorded in hand weeding. Post-emergence application of clodinafop 60 g/ha and imazethepyr 50 g/ha were the other economical treatments in garden pea. Hand weeding was not economical due to the higher cost of labour.

The present study inferred that clodinafop 60 g/ha as post-emergence is as good as pendimethalin 1200 g/ha as pre-emergence for the control of weeds and increasing productivity and profitability of garden pea in cold desert region of Lahaul valley.

Table 2. Effect of herbicides on yield attributes, yield and economics of garden pea

Treatment	Dose (g/ ha)	Time of application (DAS)	Pods/ plant	Pod weight (g/pod)	Green pod yield (kg/ha)	Crop productivity (kg/ha/day)	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C ratio	Crop profitability (₹/ha/day)
Imazethapyr	50	30	1.63	3.83	1333	19.32	36115	53320	17205	1.48	249.35
Imazethapyr	80	30	1.45	2.96	1206	17.49	36535	48240	11705	1.32	169.64
Pendimethalin +imazethapyr**	900	30	1.36	3.36	983	14.25	37384	39320	1936	1.05	28.06
Pendimethalin +imazethapyr**	1200	30	1.77	3.16	1250	18.12	38040	50000	11960	1.31	173.37
Imazethapyr + imazamox**	50	30	1.63	3.23	1216	17.63	36344	48640	12296	1.34	178.20
Imazethapyr + imazamox**	75	30	1.36	3.03	866	12.56	36808	34640	-2168	0.94	-31.42
Clodinafop	60	30	1.90	4.10	1700	24.64	36465	68000	31535	1.86	457.03
Pendimethalin	1200	2	2.55	4.76	2833	41.06	37026	113320	76294	3.06	1105.71
Hand weeding	-	30 & 60	2.00	3.83	1761	25.52	63115	70440	7285	1.12	105.58
Weedy check (control)	-	-	0.81	3.33	733	10.63	34655	29320	-5335	0.85	-77.32
S Em±		-	0.69	0.37	143	-	-	-	-	-	-
LSD (P=0.05)		-	0.26	NS	424	-	-	-	-	-	-

** ready mix

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