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RESEARCH NOTE

Effect of imazethapyr on weeds and productivity of garden pea (*Pisum sativum* var. *hortense* L.)

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ABSTRACT

A field experiment was conducted during *Rabi* season of 2023-24 at the Vegetable Research Farm Maharajpur, Department of Horticulture, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh, to evaluate the effect of imazethapyr on weeds and productivity of garden pea (*Pisum sativum* var. *hortense* L.). The predominant weed species were *Medicago polymorpha, Avena fatua, Cynodon dactylon, Parthenium hysterophorus, Cyperus rotundus, Alternanthera sessilis, Spergula arvensis* and *Cichorium intybus*. Among the tested herbicidal treatments, the post-emergence application (PoE) of imazethapyr 75 g/ha at 20 days after seeding (DAS), was observed to be the most effective in reducing both weed density and biomass with highest weed control efficiency (79.33% and 88.42% at 25 and 50 DAS, respectively), lower weed index of (-13.19%) and higher green pod yield without causing any phytotoxic effects on the crop.

Keywords: Garden pea, Imazethapyr, Phyto-toxicity, Productivity, Weed management

Garden pea (*Pisum sativum* var. *hortense* L.), also called the kitchen pea or green pea, is an essential vegetable crop of India which belongs to the family of Leguminosae. It is grown as a winter vegetable in the plains of northern India and used during summers as well in hill regions (Rana *et al.* 2015). A major source of protein worldwide, this plant is mainly grown for its sweet green pods used in fresh vegetables and it serves as a rich source of protein. Each 100 grams of edible green peas contain 17-22 g of carbohydrates, 6.2-6.5 g of protein, 79 g of moisture, 4.0-5.1 g of fiber, 0.5-1.8 g of fat and offer 81-93 kcal of energy (Kumari and Deka 2021). In India, garden peas are the third most popular *Rabi* (winter) leguminous crop, following chickpeas and lentils. In Madhya Pradesh, peas are cultivated in over 56.1 thousand hectares, with an annual production of 474.2 metric tonnes and productivity of 8.5 tons/ha (Anonymous 2020). The garden pea thrives in well-drained, loose and friable soil with a pH of 6.0-7.5 and rich organic matter content. However, vegetable peas are highly susceptible to weed infestation, leading to potential yield losses of 45-81% (Kumar *et al.* 2015). Hand weeding is effective but uneconomical (Singh and Angiras 2004). Relying solely on pre-emergence herbicides is insufficient for controlling diverse weed species (Mawalia *et al.* 2016), as their effectiveness is compromised by soil surface dryness during winter. Therefore, integrating other methods with herbicides is necessary for effective weed management (Kaur *et al.* 2023). Keeping this in view, the present experiment was conducted to assess the impact of pre- and post-emergence herbicides and mechanical weeding on weeds and productivity of garden pea.

The field experiment was carried out in the *Rabi* season of 2023-24 at the Vegetable Research Farm Maharajpur, affiliated with the Department of Horticulture, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur (23°10’N, 79°56’E, altitude 412 m), Madhya Pradesh. The soil in the experimental area was sandy clay loam, composed of 49.3% sand, 30.5% silt and 26.8% clay with a pH of 7.51, organic carbon content of 0.76% and available nutrients of 295.5 kg/ha nitrogen, 20.77 kg/ha phosphorus and 130.4 kg/ha potassium. During the 2023-24 growing season, the region received a total rainfall of 152.8 cm over 65 rainy days. Fertilizers used for the crops were 20 kg N, 50 kg P and 40 kg K/ha. Full doses of phosphorus and potassium and half the nitrogen were applied as a basal dose with the remaining nitrogen top-dressed 20 days after sowing (DAS). The twelve treatments tested were: weedy check; hand weeding twice at 20 and 40 DAS; pre-emergence application (PE) of pendimethalin 1 kg/ha; post-emergence application (PoE) of imazethapyr 75 g/ha at 20 DAS; imazethapyr 75 g/ha at 30 DAS; imazethapyr 75 g/ha at 40 DAS; imazethapyr 100 g/ha

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at 20 DAS; imazethapyr 100 g/ha at 30 DAS; imazethapyr 100 g/ha at 40 DAS; imazethapyr 125 g/ha at 20 DAS; imazethapyr 125 g/ha at 30 DAS; imazethapyr 125 g/ha at 40 DAS. A randomized block design with three replications was used. Imazethapyr was applied using 500 L/ha of water with a backpack sprayer equipped with a flat-fan nozzle. The garden pea crop cultivar *'Kashi Nandini'* was sown on 24th September 2023 with a spacing of 30×10 cm and a seed rate of 120 kg/ha. Each plot size was 3×2 m. Seeds were planted at a depth of 3 to 4 cm after being treated with carbendazim at 2 g per kg of seeds. The garden pea growth and yield characteristics were assessed by selecting and labeling five random plants from each plot. The first harvest was done on 29th January 2024 and the second harvest was on 5th February 2024.

A 1m² quadrat was randomly placed at three different locations in each plot and the weeds density within the quadrat was counted at 25 and 50 DAS. The weed biomass (fresh and dry weight) of 1 m² from different plots across all treatments was recorded. Associated weeds were counted and separated manually according to their species. The data on total weed density and dry matter (biomass) were normalized using square root transformation ($\sqrt{X} + 0.5$) to adjust their distribution (Gomez and Gomez, 1984). The collected weeds samples were initially sun-dried, then placed in paper bags and oven-dried at 60 °C for 48 hours until a constant weight was achieved.

Weed control efficiency also calculated based on dry weed biomass. Observations on the phytotoxicity effect of herbicides were made visually with the help of the recommended phytotoxicity scale.

Effect on weeds

The predominant weed species at the experimental site were *Medicago polymorpha*, *Avena fatua*, *Cynodon dactylon*, *Parthenium hysterophorus*, *Cyperus rotundus*, *Alternanthera sessilis*, *Spergula arvensis* and *Cichorium intybus*.

The maximum weed density, highest total fresh and dry weed biomass was recorded in weedy check at 25 and 50 DAS (**Table 1, 2** and **3**). The minimum weeds density, lowest total fresh and dry weed biomass and highest weed control efficiency was recorded in hand weeding twice at 20 and 40 DAS and was at par with imazethapyr 75 g/ha PoE at 20 DAS. The pendimethalin 1 kg/ha PE also significantly reduced the density of all the weeds supporting findings of Rakesh *et al*. (2016); Meleta *et al*. (2024) in garden pea. Hand weeding eliminated all types of weeds during active crop growth and development,

Table 1. Effect of weed control treatments tested on weed density in garden pea at 25 DAS

Treatment	*Medicago polymorpha*	*Avena fatua*	*Cynodon dactylon*	*Parthenium hysterophorus*	*Cyperus rotundus*	*Alternanthera sessilis*	*Spergula arvensis*	*Cichorium intybus*
Weedy check (Control)	(56.43)	(27.33)	(21.29)	(17.63)	(14.64)	(8.72)	(5.69)	(4.67)
	7.55	5.29	4.70	4.28	3.91	3.06	2.50	2.29
Hand weeding twice at 20 DAS	(2.62)	(0.00)	(0.75)	(0.00)	(0.36)	(0.00)	(0.00)	(0.00)
	1.75	0.71	1.11	0.71	0.92	0.71	0.71	0.71
Pendimethalin 1 kg/ha PE	(11.74)	(4.16)	(6.79)	(7.55)	(5.77)	(4.33)	(2.55)	(2.74)
	3.46	2.13	2.68	2.82	2.49	2.18	1.74	1.79
Imazethapyr 75 g/ha PoE at 20 DAS	(5.34)	(3.75)	(1.43)	(1.33)	(2.69)	(0.58)	(1.38)	(0.39)
	2.39	2.04	1.38	1.34	1.77	1.03	1.36	0.94
Imazethapyr 75 g/ha PoE at 30 DAS	(48.52)	(23.43)	(17.92)	(15.34)	(13.41)	(7.69)	(4.94)	(4.33)
	7.02	4.90	4.30	3.98	3.74	2.87	2.34	2.21
Imazethapyr 75 g/ha PoE at 40 DAS	(50.76)	(24.56)	(20.36)	(15.67)	(13.67)	(8.17)	(5.13)	(4.47)
	7.17	5.02	4.60	4.03	3.78	2.69	2.38	2.24
Imazethapyr 100 g/ha PoE at 20 DAS	(17.63)	(6.47)	(6.89)	(6.43)	(5.84)	(5.43)	(2.67)	(2.67)
	4.22	2.61	2.69	2.61	2.50	2.42	1.77	1.77
Imazethapyr 100 g/ha PoE at 30 DAS	(52.48)	(25.67)	(18.66)	(16.73)	(12.69)	(6.94)	(5.43)	(3.98)
	7.29	5.13	4.39	4.16	3.64	2.73	2.44	2.12
Imazethapyr 100 g/ha PoE at 40 DAS	(54.38)	(26.34)	(18.73)	(15.46)	(13.94)	(7.71)	(5.51)	(4.31)
	7.42	5.19	4.40	4.00	3.81	2.88	2.46	2.20
Imazethapyr 125 g/ha PoE at 20 DAS	(22.79)	(9.84)	(7.87)	(8.08)	(6.97)	(5.78)	(2.82)	(2.98)
	4.79	3.19	2.87	2.91	2.72	2.50	1.81	1.86
Imazethapyr 125 g/ha PoE at 30 DAS	(49.84)	(24.73)	(18.36)	(14.97)	(13.51)	(8.16)	(4.48)	(4.03)
	7.11	5.03	4.36	3.94	3.75	2.96	2.23	2.13
Imazethapyr 125 g/ha PoE at 40 DAS	(54.37)	(25.73)	(19.74)	(16.84)	(13.73)	(8.38)	(5.48)	(4.23)
	7.42	5.13	4.52	4.18	3.78	3.00	2.45	2.18
LSD (p=0.05)	0.89	0.67	0.61	0.44	0.42	0.43	0.27	0.27

*LSD= Least Significant Difference, DAS= days after sowing, PE= pre-emergence application, PoE= post-emergence application
Note: Figure in the outside of parenthesis denotes square root $\sqrt{x+0.5}$ transformed value.

Table 2. Effect of weed control treatments on weed density in garden pea at 50 DAS

Treatment	*Medicago polymorpha*	*Avena fatua*	*Cynodon dactylon*	*Parthenium hysterophoru*	*Cyperus rotundus*	*Alternanther sessilis*	*Spergula arvensis*	*Cichorium intybus*
Weedy check (control)	(64.82) 8.20	(48.72) 7.06	(36.31) 6.20	(21.83) 4.85	(26.43) 5.27	(14.62) 3.98	(9.02) 3.14	(7.76) 2.92
Hand weeding twice at 20 and 40 DAS	(4.75) 2.26	(3.94) 2.08	(2.45) 1.70	(0.64) 1.06	(2.73) 1.78	(0.51) 1.00	(0.00) 0.71	(0.00) 0.71
Pendimethalin 1 kg/ha PE	(19.64) 4.44	(12.41) 3.57	(13.97) 3.79	(8.89) 3.05	(9.63) 3.17	(5.07) 2.34	(3.46) 1.98	(3.67) 2.04
Imazethapyr 75 g/ha PoE at 20 DAS	(13.83) 3.74	(8.64) 2.99	(7.18) 2.75	(3.17) 1.90	(6.65) 2.66	(3.04) 1.86	(3.16) 1.90	(0.89) 1.17
Imazethapyr 75 g/ha PoE at 30 DAS	(36.72) 6.09	(18.62) 3.57	(14.14) 3.81	(11.96) 3.52	(10.63) 3.32	(6.37) 2.61	(3.92) 2.09	(2.88) 1.83
Imazethapyr 75 g/ha PoE at 40 DAS	(53.39) 6.64	(20.47) 4.57	(15.52) 3.99	(12.71) 3.63	(12.32) 3.57	(6.81) 2.70	(6.10) 2.58	(3.77) 2.07
Imazethapyr 100 g/ha PoE at 20 DAS	(22.47) 4.75	(13.75) 3.75	(15.16) 3.94	(9.46) 3.14	(9.89) 3.21	(7.78) 2.88	(3.66) 2.03	(2.73) 1.79
Imazethapyr 100 g/ha PoE at 30 DAS	(37.81) 6.18	(21.28) 4.66	(15.96) 4.05	(13.43) 3.73	(11.86) 3.51	(6.44) 2.63	(3.79) 2.06	(2.87) 1.83
Imazethapyr 100 g/ha PoE at 40 DAS	(45.37) 6.79	(22.58) 4.80	(16.84) 4.16	(12.92) 3.66	(11.93) 3.52	(6.96) 2.73	(4.82) 2.30	(2.98) 1.86
Imazethapyr 125 g/ha PoE at 20 DAS	(26.18) 5.13	(14.31) 3.82	(17.37) 4.22	(11.72) 3.49	(9.79) 3.19	(7.99) 2.92	(4.03) 2.12	(3.36) 1.96
Imazethapyr 125 g/ha PoE at 30 DAS	(35.43) 5.98	(21.81) 4.72	(16.74) 4.14	(10.93) 3.37	(11.76) 3.49	(6.78) 2.69	(4.19) 2.16	(3.55) 2.01
Imazethapyr 125 g/ha PoE at 40 DAS	(44.39) 6.72	(22.94) 4.84	(16.84) 4.16	(12.85) 3.65	(11.88) 3.51	(6.97) 2.73	(7.05) 2.77	(3.69) 2.05
LSD (p=0.05)	0.93	0.76	0.75	0.55	0.52	0.55	0.42	0.34

*LSD= Least Significant Difference, DAS= days after sowing, PE= pre-emergence application, PoE= post-emergence application
Note: Figure in the outside of parenthesis denotes square root $\sqrt{x+0.5}$ transformed value.

Table 3. Effect of weed control treatments on weed biomass, green pod yield and phytotoxicity in garden pea

Treatment	Total fresh weed biomass (g/m^2)		Total dry weed biomass (g/m^2)		Weed control efficiency (%)		Weed index (%)	Green pod yield (t/ha)	Phytotoxicity (leaf injury)
	25 DAS	50 DAS	25 DAS	50 DAS	25 DAS	50 DAS			
Weedy check (control)	(340.64) 18.86	(486.51) 22.57	(85.18) 9.40	(121.65) 11.30	0.00	0.00	45.02	5.78	0
Hand weeding twice at 20 and 40 DAS	(9.62) 3.15	(32.00) 5.62	(2.42) 1.69	(8.02) 2.88	93.41	97.16	0.00	10.05	0
Pendimethalin 1 kg/ha PE	(101.15) 9.96	(168.18) 12.86	(25.30) 5.03	(42.06) 6.46	65.42	70.30	3.28	9.75	0
Imazethapyr 75 g/ha PoE at 20 DAS	(39.40) 6.22	(100.53) 9.91	(9.86) 3.18	(25.14) 4.99	79.33	88.42	-13.19	11.49	0
Imazethapyr 75 g/ha PoE at 30 DAS	(217.28) 14.78	(297.85) 17.30	(54.34) 7.41	(74.48) 8.67	12.56	55.33	12.21	9.10	0
Imazethapyr 75 g/ha PoE at 40 DAS	(254.15) 16.07	(305.02) 17.52	(63.55) 8.04	(77.11) 8.83	9.47	47.76	14.01	9.50	0
Imazethapyr 100 g/ha PoE at 20 DAS	(123.95) 11.04	(196.34) 13.92	(33.16) 5.76	(49.10) 6.99	59.64	61.07	-6.73	10.78	0
Imazethapyr 100 g/ha PoE at 30 DAS	(224.85) 15.05	(300.68) 17.38	(56.22) 7.54	(75.19) 8.71	11.73	53.78	12.99	8.78	0
Imazethapyr 100 g/ha PoE at 40 DAS	(254.71) 16.09	(308.26) 17.61	(63.69) 8.05	(77.59) 8.86	8.91	47.64	13.83	8.47	0
Imazethapyr 125 g/ha PoE at 20 DAS	(132.64) 11.44	(204.20) 14.20	(33.51) 5.79	(49.29) 7.00	59.48	60.66	6.61	8.78	10
Imazethapyr 125 g/ha PoE at 30 DAS	(233.34) 15.35	(304.88) 17.51	(58.37) 7.69	(76.18) 8.77	10.56	52.02	26.47	7.28	10
Imazethapyr 125 g/ha PoE at 40 DAS	(260.00) 16.27	(314.53) 17.80	(65.04) 8.14	(80.52) 9.04	5.47	46.53	38.66	6.44	10
LSD (p=0.05)	2.89	3.06	1.19	1.54				16.82	

*LSD= Least Significant Difference, DAS= days after sowing, PE= pre-emergence application, PoE= post-emergence application
Note: Figure in the outside of parenthesis denotes square root $\sqrt{x+0.5}$ transformed value.

Table 4. Effect of weed control treatments on economics of garden pea

Treatment	Gross returns (x10^3 Rs./ha)	Net returns (x10^3 Rs./ha)	B:C ratio
Weedy check (control)	95.666	59096.44	1.62
Hand weeding twice at 20 and 40 DAS	180.93	139.36	3.35
Pendimethalin 1 kg/ha PE	174.87	137.22	3.65
Imazethapyr 75 g/ha PoE at 20 DAS	209.73	171.30	4.46
Imazethapyr 75 g/ha PoE at 30 DAS	169.80	131.36	3.42
Imazethapyr 75 g/ha PoE at 40 DAS	161.87	122.98	3.16
Imazethapyr 100 g/ha PoE at 20 DAS	195.40	156.96	4.08
Imazethapyr 100 g/ha PoE at 30 DAS	155.47	116.58	3.00
Imazethapyr 100 g/ha PoE at 40 DAS	149.33	110.44	2.84
Imazethapyr 125 g/ha PoE at 20 DAS	155.40	116.05	2.95
Imazethapyr 125 g/ha PoE at 30 DAS	125.40	86.05	2.19
Imazethapyr 125 g/ha PoE at 40 DAS	108.73	69.39	1.76
LSD (p=0.05)	-	-	-

*LSD= Least Significant Difference, DAS= days after sowing, PE= pre-emergence application, PoE= post-emergence application,

resulting in a substantial reduction of weed density over control and herbicidal treatments as reported earlier in garden pea by Kumar *et al.* (2015).

The uncontrolled weeds caused 44.02% reduction in yield of garden pea. The weed index was lowest (-13.19%) and negative with imazethapyr 75 g/ha PoE at 20 DAS (**Table 3)** as reported by Rana *et al.* (2019) in blackgram.

Effect on crop

The highest garden pea yield was recorded in with imazethapyr 75 g/ha PoE at 20 DAS (**Table 3**) and it was followed by imazethapyr 100 g/ha PoE at 20 DAS. The lowest yield was in the untreated weedy check. The highest yield was recorded with the use of post-emergence herbicides, highlighting their effectiveness in managing weeds in garden pea. This method proves superior to manual weeding, which, although generally effective, poses significant risks to pea plants due to their delicate nature. The hollow stems and fragile branches of pea plants are easily and frequently/often damaged during manual weeding, particularly during the critical flowering and pod formation stages. Therefore, to minimize plant damage and optimize yield, the use of post-emergence herbicides is recommended as a more suitable and efficient approach to manage weeds..

The maximum gross returns (Rs. 209734/ha), net returns (Rs. 171299/ha) and B:C ratio (4.46) was achieved with imazethapyr 75 g/ha PoE at 20 DAS (**Table 4**) and it was followed by imazethapyr 100 g/ha PoE at 20 DAS.

Crop phytotoxicity

Application of imazethapyr at 125 g/ha at 20, 30 and 40 DAS caused some mild yellowing of the newly leaves of garden pea about 3 days after spray. However, as the garden pea plants continued to grow, they gradually recovered with the yellowing almost completely disappearing within 15 days of the application.

In conclusion, imazethapyr 75 g/ha PoE at 20 days after sowing was proved as the most effective weed management strategy, resulting in effective weed management, higher yield and economics of garden pea.

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