

Effect of Post-Emergence Application of Imazethapyr on Growth, Yield, Quality and Economics in Garden Pea (*Pisum sativum* L.)

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ABSTRACT

A field experiment was conducted during the *rabi* season of 2023-2024 at the Instructional cum Experimental Farm, Nagaland University, School of Agricultural Sciences, Medziphema campus to evaluate the effect of post-emergence application of imazethapyr on growth, yield, quality and economics in garden pea. The experiment consisted of 12 treatments laid out in RBD with three replications and the variety used for cultivation was KSP-110. Results of the experiment revealed that application of post-emergence spray of imazethapyr @ 125 g a.i. ha⁻¹ at 30 DAS (T₁₁) obtained maximum germination percentage (81.03%),

plant height (55.33 cm), number of leaf/plant (52.67), number of branches/plant (18.33), length of pod (8.10 cm), number of seed per pods (8.27). Application of post-emergence spray of imazethapyr @ 75 g a. i. ha⁻¹ at 40 DAS (T₆) obtained maximum diameter of the pod (1.25 cm), number of pods per plant (7.00), fresh weight of pod (5.97 g), pod yield (139.33 q/ha). Dry matter of seed (32.90%), protein content in seed (28.85%) were obtained maximum when treated with post-emergence spray of imazethapyr @ 75 g a.i./ha at 20 DAS (T₄). Treatment T₆ (post-emergence spray of imazethapyr @ 75 g a. i. ha⁻¹ at 40 DAS) recorded maximum net return of Rs. 452420 with B:C ratio 4.31. The above findings suggest that the application of imazethapyr can be effectively used for obtaining higher yield, reduce weed, reduce labor cost, and higher net returns for cultivation of garden pea.

Keywords Economics, Garden pea, Imazethapyr, Quality, Yield.

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INTRODUCTION

The garden pea (*Pisum sativum* L.) is cultivated leguminous plant that holds a significant place in both agricultural history and the field of genetics. Native to the Mediterranean region and parts of the Middle East, it has been grown for thousands of years as a source of food due to its high protein content and

nutritional value. The garden pea gained scientific prominence in the 19th century through the pioneering work of Gregor Mendel, whose experiments with pea plant traits laid the foundation for modern genetics. Today, *Pisum sativum* remains an important model organism in plant biology and a valuable crop in sustainable agriculture due to its nitrogen-fixing ability. It belongs to Leguminosae family having chromosome number $2n=2x=14$. Pea plants have a bushy or climbing growth habit, with slender stems that attach to support using tendrils, and they grow to a height of 30-150 cm. Garden pea thrives more in cooler climates thus making it cool season annual crop, it is widely cultivated in temperate regions in the world. The pea is a highly significant crop in temperate agriculture globally (Checa *et al.* 2020). As a cool season crop, pea is not highly sensitive to cool, but cultivation is limited to cooler altitudes in tropical regions and winter in subtropical regions because frost can severely damage flowers and young pods. The ideal temperature for germination is 22°C while 15-25°C is optimal for growth and yield. Peas are highly nutritious providing high-quality proteins (7.2 g 100 g⁻¹), dietary fibers, starch, carbohydrates, and essential micronutrients such as vitamins and minerals. They also contain antioxidants and lutein (Kanaujia *et al.* 2020). They are also rich in non-nutritional bioactive compounds like phytochemicals, antioxidants, flavonoids, tannins and other phenolic substances. Pea proteins also present opportunities in nutraceuticals due to their bioactive peptides (Kumari and Deka 2021). Weed competes with vegetable crops for resources like water, nutrients, light, and space causing significant losses in vegetable production and severe harm to the environment. By competing with vegetable crops, weeds typically have negative effects and can even be lethal to livestock when consumed, as some weeds contain toxic chemicals. Weed invasion is one of the most harmful consequences, negatively impacting vegetable production, disturbing ecological community unbalance, reducing biodiversity, and diminishing the aesthetic appeal of the environment (Ekwealor *et al.* 2019). Weeds act as a reservoir for disease inoculum and serve as alternate hosts for pests, while also competing with the main crops for space, light, nutrients and moisture (Kanaujia *et al.* 2024). Therefore, weed management is crucial, as weeds can cause pea yield losses of up

to 70%. Weeds are likely the most widespread type of crop pests, leading to significant reductions in crop yields. They account for a substantial portion of total pest-related losses, contributing around 30%. Effective weed management across all agro-ecosystems is essential for maintaining crop productivity and ensuring food security for the growing population. The effectiveness of weed management is directly linked to the overall success of agriculture (David *et al.* 2012). Herbicides are often regarded as one of the most effective methods for weed control (Kaur *et al.* 2019). Hand weeding has never been a highly effective weed control method, as it is often done too late and not frequently enough. Weeding with hand or manually are costly and times consuming compared to weeding with herbicides. In some regions, herbicides are increasingly being used as a substitute for tillage to enhance environmental conditions. Compared to tillage, herbicide use helps reduce erosion, fuel consumption, greenhouse gas emissions, and nutrient runoff, while also conserving water. The use of herbicide is becoming more widespread globally. Many developing nations, such as India, China, and Bangladesh are experiencing labor shortages for manual weeding as large number of people migrate from rural to urban areas. In these countries, herbicides are more affordable and accessible than manual labor for weeding. Historically, a similar trend occurred in industrializing countries like the United States, Germany, Japan and South Korea, where the adoption of herbicide increases as the workforce shifted away from agriculture (Gianessi 2013). Imazethapyr is a selective herbicide used to control a wide spectrum of broad leaves and grasses in several leguminous crop (Hart *et al.* 2017). Therefore, this study aims to evaluate the impact of imazethapyr on growth, yield, quality and economics of garden pea with the goal of providing science-based recommendations for farmers and policymakers.

MATERIALS AND METHODS

The experiments were carried out in the experimental farm of the School of Agricultural Sciences, Nagaland University, Medziphema campus, Nagaland during the year 2023-2024 to determine the effect of post emergence application of imazethapyr on growth, yield, quality and economics in garden pea. The

experimental farm is situated in a humid and sub-tropical climate region, characterized by an average annual rainfall ranging from 2000 to 2500 mm. The mean temperature typically falls within the range of 21-32°C during the summer and even in winter, it seldom drops below 8°C due to the presence of high atmospheric humidity. The experimental field was laid out in Randomized Block Design (RBD) consisting of twelve (12) treatments that were replicated thrice. The treatments were T₁ - Weedy check (control), T₂ - Two hand weeding at 20 and 40 DAS, T₃ - Pre-emergence application of pendimethalin @ 1 kg a.i. ha⁻¹, T₄ - Post-emergence spray of imazethapyr @ 75 g a.i./ha at 20 DAS, T₅ - Post-emergence spray of imazethapyr @ 75 g a.i. ha⁻¹ at 30 DAS, T₆ - Post-emergence spray of imazethapyr @ 75 g a.i. ha⁻¹ at 40 DAS, T₇ - Post-emergence spray of imazethapyr @ 100 g a.i. ha⁻¹ at 20 DAS, T₈ - Post-emergence spray of imazethapyr @ 100 g a.i. ha⁻¹ at 30 DAS, T₉ - Post-emergence spray of imazethapyr @ 100 g a.i./ha at 40 DAS, T₁₀ - Post-emergence spray of imazethapyr @ 125 g a.i. ha⁻¹ at 20 DAS, T₁₁ - Post-emergence spray of imazethapyr @ 125 g a.i. ha⁻¹ at 30 DAS, T₁₂ - Post-emergence spray of imazethapyr @ 125 g a.i. ha⁻¹ at 40 DAS. The application of FYM was done @ 20t/ha at 20 days before sowing. The chemical fertilizers were incorporated in the soil just before sowing as per the recommended dose i.e., 30:60:60 NPK, respectively. The entire quantity of N, P and K was applied as basal at the time of sowing. Data on growth, yield and quality were recorded and statisti-

cally analyzed as per procedure given by Panse and Sukhatme (1989). Economics of different treatments were also calculated as per prevailing market price of inputs and outputs. Gross income was calculated by yield multiplied by wholesale rate of garden pea @ Rs 40 kg⁻¹. Net income was estimated by deducting the total cost of cultivation (fixed cost + treatment cost) from gross income of the particular treatment. Cost benefit ratio was worked out by dividing net return from total cost of cultivation.

RESULTS AND DISCUSSION

Post emergence application of imazethapyr at different rates and dates has appreciable effect in the altering of growth of garden pea. It is revealed from Table 1 that treatment T₁₁ (post-emergence spray of imazethapyr @ 125 g a.i. ha⁻¹ at 30 DAS) showed maximum germination percentage with 81.03% while lowest germination percentage was found on T₁ (control) with 66.42%. T₁₁ (post-emergence spray of imazethapyr @ 125 g a.i. ha⁻¹ at 30 DAS) showed maximum plant height with 55.33 cm while T₁ was observed with minimum plant height of 31.67 cm. Other growth parameters like number of leaves/plant (52.67) and number of branches/plant (18.33) were also recorded highest in T₁₁ (post-emergence spray of imazethapyr @ 125 g a.i. ha⁻¹ at 30 DAS). This superior performance was attributed to the treatment in effectively reducing weed competition while minimizing stress on the crop. When imazethapyr

Table 1. Effect of different treatments of imazethapyr on growth parameters of garden pea.

Treatments	Germination (%)	Plant height (cm)	Number of leaves/plant	Number of branches/plant
T ₁ Weedy check (control)	66.42	31.67	30.33	10.67
T ₂ Two hand weeding at 20 and 40 DAS	70.83	51.57	31.03	12.33
T ₃ Pre-emergence application of pendimethalin @ 1kg a.i./ha	70.70	45.67	31.33	11.67
T ₄ Post-emergence spray of imazethapyr @ 75 g a.i./ha at 20 DAS	77.42	51.33	45.33	12.67
T ₅ Post-emergence spray of imazethapyr @ 75 g a.i./ha at 30 DAS	70.37	54.67	50.33	12.67
T ₆ Post-emergence spray of imazethapyr @ 75 g a.i./ha at 40 DAS	75.67	33.27	46.67	13.33
T ₇ Post-emergence spray of imazethapyr @ 100 g a.i./ha at 20 DAS	68.95	32.67	36.33	13.33
T ₈ Post-emergence spray of imazethapyr @ 100 g a.i./ha at 30 DAS	70.42	43.33	34.33	11.33
T ₉ Post-emergence spray of imazethapyr @ 100 g a.i./ha at 40 DAS	69.98	52.67	44.33	12.67
T ₁₀ Post-emergence spray of imazethapyr @ 125 g a.i./ha at 20 DAS	73.87	53.67	38.67	15.67
T ₁₁ Post-emergence spray of imazethapyr @ 125 g a.i./ha at 30 DAS	81.03	55.33	52.67	18.33
T ₁₂ Post-emergence spray of imazethapyr @ 125 g a.i./ha at 40 DAS	71.07	54.33	51.67	12.33
SEm±	1.27	0.74	1.31	0.92
CD (P=0.05)	3.73	2.16	3.88	2.69

Table 2. Effect of different treatments of imazethapyr on yield and quality attributes of garden pea.

Treatment	Length of pod (cm)	Diameter of pod (cm)	Number of seed/pod	Number of pods/plant	Fresh weight of pod (g)	Pod yield (q/ha)	Protein content of seed (%)	Dry matter of seed (%)
T ₁ Weedy check (control)	7.13	0.96	6.37	5.67	4.63	87.67	17.67	23.07
T ₂ Two hand weeding at 20 and 40 DAS	7.20	1.03	6.40	5.70	5.03	96.00	21.77	26.03
T ₃ Per-emergence application of pendimethalin @ 1kg a.i./ha	7.90	1.13	8.27	6.43	5.87	125.67	23.80	26.53
T ₄ Post-emergence spray of imazethapyr @ 75 g a.i./ha at 20 DAS	7.57	1.16	6.83	6.00	5.10	102.00	28.85	32.90
T ₅ Post-emergence spray of imazethapyr @ 75 g a.i./ha at 30 DAS	7.73	1.18	7.43	6.57	5.90	129.00	19.64	28.07
T ₆ Post-emergence spray of imazethapyr @ 75g g.i. /ha at 40 DAS	7.77	1.25	7.77	7.00	5.97	139.33	25.35	30.23
T ₇ Post-emergence spray of imazethapyr @ 100 g a.i. /ha at 20 DAS	7.53	1.03	6.77	6.00	5.23	104.67	25.68	24.67
T ₈ Post-emergence spray of imazethapyr @ 100 g a.i. /ha at 30 DAS	7.67	1.11	7.43	6.33	5.63	118.67	17.95	32.00
T ₉ Post-emergence spray of imazethapyr @ 100 g a.i. /ha at 40 DAS	7.20	1.03	6.43	6.33	5.77	119.33	20.16	30.67
T ₁₀ Post-emergence spray of imazethapyr @ 125 g a.i. /ha at 20 DAS	7.57	1.11	6.80	6.00	5.57	108.00	24.20	28.60
T ₁₁ Post-emergence spray of imazethapyr @ 125 g a.i. /ha at 30 DAS	8.10	1.13	8.27	6.33	5.63	117.33	17.69	31.83
T ₁₂ Post-emergence spray of imazethapyr @ 125 g a.i. /ha at 40 DAS	7.33	1.15	6.77	6.33	5.67	119.67	22.79	29.17
SE m±	0.13	0.03	0.35	0.24	0.11	4.75	0.21	0.82
CD (P=0.05)	0.39	0.11	1.05	1.72	0.32	13.90	0.64	2.41

is applied, it selectively eliminates or suppresses competing weeds, allowing the crop to access more resources, which supports better growth and development. By minimizing weed pressure at crucial stage of development that is at 30 DAS, the crop benefits from reduce stress and can express its full growth potential, resulting in increased plant height, more foliage and better branching. While Treatment T₁ (control) recorded minimum plant height, germination percentage and lesser number of leaves and branches per plant. This can be due to increase in weed population, resulting in competition for nutrient, water, sunlight and space which eventually decrease germination percentage, plant height, number of leaves and branches per plant. This finding aligns with the work of Rana *et al.* (2013), who observed increase in plant height and crop growth rate with 150 g a.i. ha⁻¹ of imazethapyr at 40 DAS. Sajid *et al.* (2012) also found similar results in pea.

Post emergence application of imazethapyr at different rates and dates has appreciable effect in

the altering of yield and yield attributes of garden pea. It is revealed from Table 2 that treatment T₆ (post-emergence spray of imazethapyr @ 75 g a.i. ha⁻¹ at 40 DAS) recorded the maximum value for diameter of pod (1.25 cm), number of pods/plant (7.00), fresh weight of pod (5.97 g) and pod yield (139.33 q ha⁻¹). However, treatment T₁₁ (post-emergence spray of imazethapyr @ 125 g a.i. ha⁻¹ at 30 DAS) was found positively affecting on yield attribute like length of pods (8.10 cm) and number of seed/pod (8.27). One of the primary reasons is the timely control of both grassy and broad leaf weeds, which are particularly competitive during the early vegetative and flowering stages of garden pea. Similar findings have been reported by Sajid *et al.* (2012), Rana *et al.* (2015), Rana *et al.* (2019), Walia and Kumar (2022). Post emergence application of imazethapyr at different rates and dates has appreciable effect in the altering of quality attributes of garden pea. It is revealed from Table 2 that treatment T₄ (post-emergence spray of imazethapyr @ 75 g a.i. ha⁻¹ at 20 DAS) recorded the maximum protein content in seed (28.85%) and dry

Table 3. Effect of different treatments of imazethapyr on economics of garden pea.

Treatment No.	Fixed cost	Cost of cultivation		Pod yield (q/ha)	Gross income (Rs 40/kg)	Net income (Rs)	B:C ratio
		Treatment cost	Total cost				
T ₁	104000	0	104000	87.67	350680	246680	2.37
T ₂	104000	20000	124000	96.00	384000	260000	2.09
T ₃	104000	2348	106348	125.67	502680	396332	3.72
T ₄	104000	900	104900	102.00	408000	303100	2.88
T ₅	104000	900	104900	129.00	516000	411100	3.91
T ₆	104000	900	104900	139.33	557320	452420	4.31
T ₇	104000	1200	105200	104.67	418680	313480	2.97
T ₈	104000	1200	105200	118.67	474680	369480	3.51
T ₉	104000	1200	105200	119.33	477320	372120	3.53
T ₁₀	104000	1500	105500	108.00	432000	326500	3.09
T ₁₁	104000	1500	105500	117.33	469320	363820	3.44
T ₁₂	104000	1500	105500	119.67	478680	373180	3.53

matter of seed (32.90 g). Treatment T₄ (post-emergence spray of imazethapyr @ 75 g a.i. ha⁻¹ at 20 DAS) was found to significantly enhance protein content and dry matter accumulation in seed. This improvement can primarily be attributed to effective weed control provided by imazethapyr, which inhibits the enzyme Aceto Hydroxy Acid Synthase (AHAS), a key catalyst in the synthesis of essential amino acids in weeds. By suppressing early weed competition, the crop gains better access to critical resources such as light, water and nutrients, leading to improved growth and biomass production. Furthermore, the reduction in weed pressure allows for greater nitrogen, phosphorous and potassium uptake by the pea plants, enhancing nutrient accumulation in both vegetative and reproductive parts. Since nitrogen plays a direct role in protein synthesis, this increased availability translates into higher protein content in seeds. Additionally, the enhanced canopy development under weed-free conditions supports more efficient photosynthesis and dry matter production. Similar finding was also found by Rana *et al.* (2019).

It is also evident from the Table 3 that the highest net return (Rs. 4,52,450) and B:C (4.31) was observed in the treatment T₆ (post-emergence spray of imazethapyr @ 75 g a.i. ha⁻¹ at 40 DAS). The higher B:C ratio in treatment T₆ may be attributed to the lower cost of cultivation and higher yield. Lowest net return (Rs. 2,46,680) was found in Treatment T₁ (control) due to less yield but the lowest cost benefit ratio (2.09) was found in treatment T₂ (two hand weeding at 20 and 40 DAS) due to high labor cost.

Close finding was reported by Rana *et al.* (2019) in garden pea. And similar report was also recorded by Kaur *et al.* (2020) with highest net return and highest cost of benefit ratio.

CONCLUSION

Based on the present findings, it may be concluded that Treatment T₆ (post-emergence spray of imazethapyr @ 75 g a.i. ha⁻¹ at 40 DAS) emerged as the best treatment for yield and economics. Some quality attributes like protein content and dry matter of seed were found superior in treatment T₄ (post-emergence spray of imazethapyr @ 75 g a.i. ha⁻¹ at 20 DAS). The result suggests that treating with imazethapyr @ 75 g a.i. ha⁻¹ at 20 and 40 DAS significantly influence yield, quality and economic benefit. Thus, we can conclude that imazethapyr can be promoted for weed management by effectively killing weed with low cost and also reduce labor cost and providing economic benefits to farmers and communities.

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