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Tosan Kumar Sahu
 Ph.D. Scholar, Department of
 Agronomy, College of
 Agriculture, IGKV, Raipur,
 Chhattisgarh, India

Deepak Kumar Chandrakar
 Professor and Head,
 Department of Agronomy,
 College of Agriculture, IGKV,
 Raipur, Chhattisgarh, India

Mangla Parikh
 Senior Scientist, Department
 of Genetics and Plant
 Breeding, College of
 Agriculture, IGKV, Raipur,
 Chhattisgarh, India

Sanidhya Singh
 Ph.D. Scholar, Department of
 Agronomy, College of
 Agriculture, IGKV, Raipur,
 Chhattisgarh, India

Corresponding Author:
Tosan Kumar Sahu
 Ph.D. Scholar, Department
 of Agronomy, College of
 Agriculture, IGKV, Raipur,
 Chhattisgarh, India

Productivity and profitability of low-ODAP *Lathyrus* varieties as influenced by different sowing dates in Chhattisgarh plains

Tosan Kumar Sahu¹, Deepak Kumar Chandrakar², Mangla Parikh³, Sanidhya Singh⁴

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ABSTRACT

A field experiment was conducted during the Rabi season of 2025–26 at the Agriculture Instructional-cum-Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.), to evaluate the productivity and profitability of low-ODAP *Lathyrus* varieties as influenced by different sowing dates in Chhattisgarh plains. The experiment was laid out in a Factorial Randomized Complete Block Design (FRBD) with three replications. The treatments comprised five low-ODAP *Lathyrus* varieties, viz., V_1 (RLS-3004-2), V_2 (RLS-2022-4), V_3 (Mahatheora), V_4 (Prateek) and V_5 (Ratan), and three sowing dates, viz., S_1 (25th November), S_2 (05th December) and S_3 (15th December). Among the varieties, V_1 (RLS-3004-2) recorded the highest seed yield (1299 kg ha^{-1}), productivity rating index (84.4%), production efficiency (12.7), gross return (Rs. 67458 ha^{-1}), net return (Rs. 39,276 ha^{-1}) and B:C ratio (2.39). However, it was found comparable with variety V_2 (RLS-2022-4), which recorded seed yield (1266 kg ha^{-1}), productivity rating index (84.4 %), production efficiency ($12.0 \text{ kg ha}^{-1} \text{ day}^{-1}$), gross return (Rs. 65730 ha^{-1}), net return (Rs. 37548 ha^{-1}) and B:C ratio (2.33). whereas variety V_5 (Ratan) recorded the lowest seed yield (823 kg ha^{-1}), productivity rating index (54.9 %), production efficiency ($7.5 \text{ kg ha}^{-1} \text{ day}^{-1}$) gross return (Rs. 42738 ha^{-1}), net return (Rs. 14556 ha^{-1}) and B:C ratio (1.52). Among sowing dates, S_1 (25th November) recorded the highest seed yield (1229 kg ha^{-1}), productivity rating index (81.9 %), production efficiency (12.7), gross return (Rs. 63786 ha^{-1}), net return (Rs. 35604 ha^{-1}) and B:C ratio (2.26) whereas delayed sowing resulted in a decline in productivity and profitability. As the sowing is delayed, net realization from the cost goes on decreasing. In the sowing date S_3 (15th December) date of sowing was recorded lowest seed yield (855 kg ha^{-1}), productivity rating index (57.0 %), production efficiency (8.2), gross return (Rs. 44450 ha^{-1}), net return (Rs. 16268 ha^{-1}) and B:C ratio (1.58).

Keywords: Low-ODAP *Lathyrus*, Productivity, Seed yield, Sowing date, Net return, Profitability, Vertisols, Chhattisgarh plains

Introduction

Lathyrus (*Lathyrus sativus* L.), commonly known as grass pea, is an important rabi pulse crop grown under rainfed and residual-moisture conditions in several parts of India. The crop possesses several desirable characteristics such as drought tolerance, low input requirement, adaptability to marginal soils and ability to produce grain under moisture-stress conditions. Because of its hardy nature, *Lathyrus* has considerable potential for inclusion in rice-based and other cereal-dominated cropping systems, particularly in regions where moisture availability during the post-rainy season is limited.

In Chhattisgarh, *Lathyrus* is an important pulse crop grown predominantly after kharif rice under residual soil moisture. The Vertisols of the Chhattisgarh plains provide considerable scope for *Lathyrus* cultivation; however, its productivity remains comparatively low due to several production constraints. Among the major factors influencing crop productivity, varietal performance and sowing time play a crucial role. Appropriate sowing time ensures favourable temperature and moisture conditions during crop establishment, vegetative growth, flowering and pod development, thereby improving yield formation and resource-use efficiency.

A climate-smart pulse crop for a sustainable crop production system is lathyrus (*Lathyrus sativus* L.). Indian grass pea growers consider their crop to be a reliable source of income. With an average yield of 750 kg ha^{-1} , grass pea was cultivated on about 0.255 million hectares during the 2025-26 Rabi season, producing nearly 0.19-0.20 million tonnes (Anonymous, 2025) [1]. In contrast, West Bengal produced the most grass peas (0.12 mt), followed by Bihar (0.43 mt) and Chhattisgarh (0.96 mt). During Rabi productivity at the national level was 903 kg ha^{-1} , with West Bengal having the highest productivity (1273 kg ha^{-1}), followed by Bihar (1083 kg ha^{-1}) and Chhattisgarh (630 kg ha^{-1}).

The cultivation of conventional *Lathyrus* varieties has also been associated with concerns regarding the presence of β -N-oxalyl-L- α , β -diaminopropionic acid (ODAP), an antinutritional compound. The development of

low-ODAP varieties has provided an opportunity to expand *Lathyrus* cultivation while improving its food and nutritional acceptability. However, the productivity and economic potential of these newly developed varieties may vary considerably with the prevailing agro-climatic conditions and sowing time.

Besides yield, economic profitability is an important consideration for farmers while selecting a suitable variety and sowing schedule. A variety producing higher grain yield does not necessarily provide maximum economic returns unless the production cost and market value are also considered. Therefore, assessment of cost of cultivation, gross returns, net returns and benefit-cost ratio is essential for identifying economically viable production practices.

Timely sowing can further improve economic performance by providing favourable growing conditions and reducing the adverse effects of terminal temperature and moisture stress. Delayed sowing may shorten the crop growth period and adversely affect yield attributes, ultimately reducing profitability. Hence, identification of the best-performing low-ODAP *Lathyrus* variety and optimum sowing date is important for improving productivity and profitability under rice-based cropping systems of Chhattisgarh.

Material and Methods

A field investigation was carried out during the Rabi season of 2025–26 at the Agriculture Instructional-cum-Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The experiment was conducted in a Factorial Randomized Block Design (FRBD) with three replications, involving five *Lathyrus* varieties and

three sowing dates, resulting in a total of fifteen treatment combinations. The treatments included T₁: RLS-3004-2 sown on 25th November; T₂: RLS-3004-2 sown on 05th December; T₃: RLS-3004-2 sown on 15th December; T₄: RLS-2022-4 sown on 25th November; T₅: RLS-2022-4 sown on 05th December; T₆: RLS-2022-4 sown on 15th December; T₇: Mahateora sown on 25th November; T₈: Mahateora sown on 05th December; T₉: Mahateora sown on 15th December; T₁₀: Prateek sown on 25th November; T₁₁: Prateek sown on 05th December; T₁₂: Prateek sown on 15th December; T₁₃: Ratan sown on 25th November; T₁₄: Ratan sown on 05th December; and T₁₅: Ratan sown on 15th December. Sowing operations were performed between 25th November and 15th December 2025, while harvesting was completed by 18th March 2026. The experimental field was characterized by Vertisols typical of the Chhattisgarh plains. The following methodology is taken for observation are:

1. Seed yield (kg ha⁻¹)

After each net plot was harvested, threshed, and winnowed, the clean seeds were weighed using a weighing balance to determine the seed yield. The net plot yield also includes the seed yield from the sample plants. Each net plot's yield has been converted into kg ha⁻¹ or seed yield ha⁻¹.

2. Productivity rating index (%)

The productivity rating index (PRI) is used to evaluate the productivity of different treatments by comparing their yield performance relative to standard yield of lathyrus.

$$PRI (\%) = \frac{\text{Average yield of lathyrus (q ha}^{-1}\text{) obtained from experimental plots}}{15.50 \text{ q ha}^{-1}} \times 100$$

Where,

The term standard yield (10 q ha⁻¹) was used for the maximum yield as reported in Annual Report of AICRP on MULLARP, IGKV, Raipur.

3. Production efficiency (kg ha⁻¹ day⁻¹)

To evaluate the yield attained per unit of time throughout the crop growth cycle, production efficiency was computed. It shows the crop's rate of economic yield production. The formula provided by Tomar and Tiwari (1990) is used to determine production efficiency:

$$\text{Production efficiency (kg ha}^{-1} \text{ day}^{-1}\text{)} = \frac{\text{Seed Yield (kg ha}^{-1}\text{)}}{\text{Duration of the crop (days)}}$$

4. Cost of cultivation

The total cost of cultivation was calculated by summing up all the expenses incurred in rising the crop, including cost of seed, fertilizers, plant protection chemicals, labour charges and other operation cost. It was calculated by using the following formula by considering the current market price as follows:

Cost of cultivation (Rs. ha⁻¹) = Variable cost (Rs. ha⁻¹) + Fixed cost (Rs. ha⁻¹).

5. Gross return

The yield obtained was converted into its monetary value using the prevailing market price at the time of experiments, resulting gross return (Rs. ha⁻¹)

Gross return (Rs. ha⁻¹) = Seed yield (Rs. ha⁻¹) + Stover yield (Rs. ha⁻¹).

6. Net return

By subtracting the cost of cultivation from the gross return, net return was calculated.

Net return (Rs. ha⁻¹) = Gross return (Rs. ha⁻¹) - Cost of cultivation (Rs. ha⁻¹)

7. Benefit cost ratio

The benefit-cost ratio was calculated to evaluate the economic feasibility of the treatments. The benefit-cost ratio was calculated by using the following formula:

$$\text{Benefit - cost ratio} = \frac{\text{Net return}}{\text{Cost of cultivation}}$$

Results and Discussion

Effect on seed yield

The *Lathyrus* varieties, V₁ (RLS-3004-2) recorded the significantly highest seed yield (1299 kg ha⁻¹), which was statistically comparable with V₂ (RLS-2022-4) (1266 kg ha⁻¹). The higher yield of V₁ was mainly attributed to its superior yield attributes, particularly pods plant⁻¹, seeds pod⁻¹ and seeds plant⁻¹. Similar findings were reported by Ghosh *et al.* (2018) [2] and Rafaat *et al.* (2021) [3]. With respect to sowing dates, S₁ (25th November) resulted in the highest seed yield (1229 kg ha⁻¹). Seed yield declined progressively with delayed sowing, following the order S₁ > S₂ > S₃. Similar observations were reported by Larbi *et al.* (2010) [4] and Sayar *et al.* (2015) [5].

Effect on productivity rating indices

Productivity Rating Index (PRI) varied significantly among varieties and sowing dates. V₁ (RLS-3004-2) recorded the highest PRI (86.6%), which was at par with V₂ (RLS-2022-4) (84.4%). The higher PRI of V₁ was associated with its superior growth and yield-attributing characteristics, resulting in greater seed yield. Among sowing dates, S₁ (25th November) recorded the highest PRI (81.9%), statistically comparable with S₂ (05th December) (74.1%). Similar findings were reported by Rao *et al.* (2007) [6], Parihar *et al.* (2019) [7] and Shubha *et al.* (2025) [8].

Effect on production efficiency

Production efficiency differed significantly among varieties and sowing dates. V₁ (RLS-3004-2) recorded the highest production efficiency (12.7 kg ha⁻¹ day⁻¹), which was at par with V₂ (RLS-2022-4) (12.0 kg ha⁻¹ day⁻¹). The higher efficiency of V₁ was mainly due to its higher seed yield and comparatively shorter crop duration. Similar results were reported by Sayar *et al.* (2015) [5], Ghosh *et al.* (2018) [2] and Rafaat *et al.* (2021) [3]. Among sowing dates, S₁ (25th November) recorded the highest production efficiency (11.4 kg ha⁻¹ day⁻¹), which was at par with S₂ (05th December) (10.5 kg ha⁻¹ day⁻¹). Thus, timely sowing improved production efficiency compared with delayed sowing.

Effect on economics

Economic analysis revealed that V₁ (RLS-3004-2) recorded the significantly highest gross return (Rs. 67,458 ha⁻¹), net return (Rs. 39,276 ha⁻¹) and B:C ratio (2.39) were recorded under the variety of V₁ (RLS-3004-2) which was at par with V₂ (RLS-2022-4). The higher profitability of V₁ was mainly associated with its superior seed yield. Similar findings were reported by Das *et al.* (2020) [9] and Bag *et al.* (2023) [10]. Among sowing dates, S₁ (25th November) resulted in the significantly highest gross return (Rs. 63,786 ha⁻¹), net return (Rs. 35,604 ha⁻¹) and B:C ratio (2.26). Thus, timely sowing proved more profitable for *Lathyrus* production. Similar results were reported by Navaz *et al.* (2017) [11] and Ghosh *et al.* (2025).

Table 1. Seed yield, productivity rating index, production efficiency and economics of lathyrus as affected by different varieties and date of sowing

Treatment	Seed yield (kg ha ⁻¹)	Productivity rating index (%)	Production efficiency (kg ha ⁻¹ day ⁻¹)	Cost of cultivation (Rs. ha ⁻¹)	Gross return (Rs. ha ⁻¹)	Net return (Rs. ha ⁻¹)	B: C Ratio (Rs. ha ⁻¹)
Varieties							
V ₁ -RLS-3004-2	1299	86.6	12.7	28182	67458	39276	2.39
V ₂ -RLS-2022-4	1266	84.4	12.0	28182	65730	37548	2.33
V ₃ -Mahateora	1020	68.0	9.4	28182	52968	24787	1.88
V ₄ -Prateek	918	61.2	8.5	28182	47712	19530	1.69
V ₅ -Ratan	823	54.9	7.5	28182	42738	14556	1.52
SEm±	33	2.2	0.32	-	-	-	-
CD (P = 0.05)	95	6.3	0.93	-	-	-	-
Date of sowing							
S ₁ -25 th November 2025	1229	81.9	11.4	28182	63786	35604	2.26
S ₂ -05 th December 2025	1111	74.1	10.5	28182	57728	29546	2.05
S ₃ -15 th December 2025	855	57.0	8.2	28182	44450	16268	1.58
SEm±	25	1.7	0.25	-	-	-	-
CD (P = 0.05)	73	4.9	0.72	-	-	-	-

Conclusion

Based on the study of this experiment it may be concluded that among the five varieties of *Lathyrus*, V₁ (RLS-3004-2) recorded the highest seed yield (1299 kg ha⁻¹), productivity rating index (86.6 %), production efficiency (12.7), net return (Rs. 39,276 ha⁻¹) and B:C ratio (2.39) demonstrating its superior yield potential and profitability. However, it was found comparable with variety V₂ (RLS-2022-4), which recorded seed yield (1266 kg ha⁻¹), productivity rating index (84.4 %), production efficiency (12.0), net return (Rs. 37548 ha⁻¹) and B:C ratio (2.33). As regards the timely sowing of *Lathyrus* (25th Nov. or meteorological week is 47th) significantly enhanced seed yield (1229 kg ha⁻¹), productivity rating index (81.9 %), production efficiency (12.7), net return (Rs. 35604 ha⁻¹) and B:C ratio (2.26) over other late sowing by 10 days interval. Overall, timely sowing on S₁ (25th November) coupled with variety V₁ (RLS-3004-2) proved to be the most productive, economically viable and sustainable treatment for maximizing lathyrus yield, quality and profitability in Vertisols of Chhattisgarh plains.

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