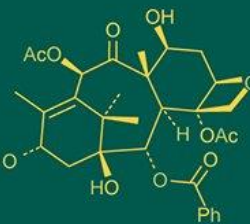
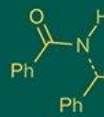
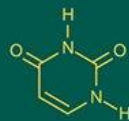


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(8): 196-206
www.biochemjournal.com
Received: 06-06-2026
Accepted: 07-07-2026

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Morphological study of elite lathyrus (*Lathyrus sativus* L) germplasm under Vidarbha Region

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i8Sc.9425>

Abstract

The present investigation entitled “Morphological study of elite lathyrus (*Lathyrus sativus* L) germplasm was undertaken at experimental field of Department of Agricultural Botany, Dr. P.D.K.V., Akola (M.S.) during rabi season of 2009-2010 in RBD with three replications consisted of sixteen treatments with the net plot size of 1.20m x 1.90m. The observations were recorded at 30, 50, 70 and 90 DAS. The present investigation was carried out to the screen the germplasm for morphological parameters. The various morphological traits were found to be differed in all the genotypes in traits viz., plant height, leaf area, total dry matter per plant, CGR, NAR, RWC, total chlorophyll content in leaf. The results revealed that, the genotype EC- 539032 exhibited superior performance in physiological parameters viz., leaf area, CGR, NAR and RWC than check Ratan.

Regarding the biochemical characters, the genotype EC-539032 recorded significantly superior total chlorophyll content than check Ratan.

Keywords: Lathyrus genotype, morphological, physiological parameters, vidarbha

Introduction

Lathyrus (*Lathyrus sativus* L.) is an important protein rich crop (28%) next to soybean (43%) belonging to family leguminaceae, subfamily papilionaceae and chromosome number $2n=14$ (FAO 1997) [10]. It is originated in Indian subcontinent. The crop is sturdy and grown on residual moisture hence considered as a model crop for sustainable agriculture. Lathyrus serves as better alternative to the traditional pulse crop like chickpea and pigeonpea especially in the area under dryland condition (Thakur and Rai 1985 [29], Lal *et al.* 1986) [20].

Not only it is rich source of protein to poor people but also it provides good quality fodder for animals. The cultivation of lathyrus is prominent in India, Bangladesh, Nepal and Ethiopia. In India lathyrus is cultivated in an area of 0.85 million ha in Uttar Pradesh, Bihar, West Bengal, Madhya Pradesh, Chattisgarh and Maharashtra state. In Maharashtra, it is cultivated in Bhandara, Chandrapur, Gadchiroli, Gondia and Nagpur district accounting 24,800 ha area (Anonymous, 2008) [1].

Lathyrus is consumed in various forms like chapattis, wadas, curries and also fed to cattle as a green fodder.

The most common farming system is relay or utera under which its cultivation is mainly prevalent in India. Its ability to restore soil fertility makes it useful in crop rotation system. Being a legume it fixes atmospheric nitrogen through root nodules, part of which is made available to succeeding crop. It is relatively resistant to disease and pest (Arya, 1991) [2].

Flower colour in grass pea varies from blue to pink, red and white. Grass pea types with blue flowers and speckled (coloured) seed coat are common in the Indian subcontinent whereas white flowers with white seed coat are common in the Mediterranean region (Jackson and Yunus, 1984) [19].

In spite of presence of the toxic compound i.e. ODAP (β -N-oxalyl-L- β -diamino propionic acid). Lathyrus seed contain 28% protein, 58% carbohydrates, 0.6% fat, 3% mineral and vitamins β_1, β_2 and niacin.

In Maharashtra and some other states, sale and cultivation of grasspea is banned since 1961. The reasons for ban being ODAP i.e. β -N-oxalyl-L- β -diamino propionic acid, the neurotoxin present in the seed. Which is reported to be responsible for human neurolathyrism a crippling

disorder of lower limbs if consumed in large quantity over prolonged period (Dwivedi and Prasad, 1964) [8].

The consumption of 15 to 150 mg kg⁻¹ body weight per day for prolonged period is enough to develop disease symptom (Cohn and Streifler, 1981) [7]. This work is helpful for further improvement of genetic material for crop breeding in lathyrus genus.

Materials and Methods

The present investigation entitled “Morphological study of elite Lathyrus (*Lathyrus sativus* L.) germplasm was carried out during rabi season of 2009-2010 at experimental field of Department of Agricultural Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola located at 304.415 meter altitude, 20°31'N latitude and 72°02' longitude.

Treatment details

	Genotype	Source
T ₁	IC- 120442	NBPGR Akola
T ₂	IC- 120463	NBPGR Akola
T ₃	IC- 345448	NBPGR Akola
T ₄	IC- 420784	NBPGR Akola
T ₅	IC- 208430	NBPGR Akola
T ₆	EC- 389370	NBPGR Akola
T ₇	EC- 539032	NBPGR Akola
T ₈	EC- 540902	NBPGR Akola
T ₉	EC- 405302	NBPGR Akola
T ₁₀	Pandharabodi	Pulses Research Unit Akola
T ₁₁	IC- 345413	NBPGR Akola

Biometric Observations

Five plants per treatment were randomly selected for recording all the periodical biometric observations at an interval of 20 days during the growth and development of lathyrus crop as affected by the given treatments. The various parameters of observations are indicated below.

Plant height (cm)

Height of each plant was measured in cm at 20 days intervals. Five plants were randomly selected from each plot and replications and tagged for recording observations periodically from base level to the terminal stem at 30, 50, 70, 90, DAS (Days after sowing) and recorded. The mean of treatments and replication wise were worked out.

Leaf area /plant (dm²)

Leaf area was measured in cm. five plants were randomly selected in each plot. The plant leaves were grouped under the three groups i.e. large, medium and small and measured the leaf area. The leaf area (dm²) was calculated treatments and replication wise and mean of three groups (large, medium and small) was recorded. The leaf area was measured on automatic leaf area meter at 30, 50, 70 and 90 DAS. Leaf area /plant (dm²) were recorded by summation of the three groups

Total dry matter (g) / plant

Observations on total dry matter per plant (g) recorded at the interval of 20 days i.e. 30, 50, 70, 90 DAS and at harvest. From each replication and treatment five plants were uprooted. Root portion was cutoff and plant samples were washed with tap water in order to remove soil and dust particle if adhered to it. The surface was allowed to soak in dry air. The plant sample was then placed in the big size brown paper bags. The brown paper bags were placed in the

rack to allow the samples to dry with open air. After drying the samples on open air the plant sample was finally dried in hot air oven at 70°C up to the constant weight achieved. The total dry matter was weighed on electronic balance recorded as gram per plant.

Relative Growth rate (RGR)

Relative growth rate is the increase in plant material per unit of time. It was calculated as per formula given by Fisher (1921) [11] and expressed in g/g/day.

$$RGR = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1} (g\ g^{-1}\ day^{-1})$$

Where, W₁ and W₂ are dry weight of crop at t₁ and t₂ time intervals.

Log_e=Napier logarithm (logarithm to the base of 2.303)

Net Assimilation Rate (NAR)

According to Verman and Allison (1963) [30] NAR is a useful measure of the photosynthetic efficiency of plant. Gregory (1926) [14] defined it as increase in dry weight of plant per unit leaf area. Williams (1946) [32] provided equation for estimating mean NAR as...

$$NAR = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{\ln LA_2 - \ln LA_1}{LA_2 - LA_1} (g\ dm^{-2}\ week^{-1})$$

Where,

W₁ and W₂ were total dry weight of whole plant at time intervals t₁ and t₂. LA₁ and LA₂ are leaf area per plant (dm²) measured from consecutive samples collected at time t₁ and t₂ in days, respectively.

Crop Growth Rate (CGR)

It was calculated by the equation worked out by Blackman (1919) [5] and Watson (1958) [31]

$$CGR = \frac{W_2 - W_1}{t_2 - t_1} (g\ day^{-1})$$

Where,

- W₁ = Dry weight of plant at time t₁
- W₂ = Dry weight of plant at time t₂
- t₂ and t₁ = time interval

Relative Water Content (RWC)

Dry weight of leaves was recorded after keeping it in hot air oven at 70°C (Barrs and Weatherly, 1962) [4].

Relative water content was calculated by using following formula.

$$RWC(\%) = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Turgid weight} - \text{Dry weight}} \times 100$$

Biochemical Observations

Estimation of total Chlorophyll content in leaves (mg/g)

Total chlorophyll content in leaf was estimated with DMSO (Dimethyl sulphoxide) method by adopting the procedure given by Hiscox and Israelstan (1979) [18].

The total chlorophyll content of leaves was calculated as per Arnons (1949) [3] equations and was expressed in (mg/g).

$$\text{Total chlorophyll} = \frac{\text{OD at 652 nm} \times 100}{34.5} \times \frac{V}{1000 \times W}$$

Where,

- OD = Optical density,
- V = Final volume of DMSO (10 ml)
- W = Weight of fresh leaves (0.1 gm)

Statistical analysis

The statistical analysis of the data was done by statistical method as suggested by Panse and Sukhatme (1985) [24] and Gomez and Gomez (1983) [12]. F' test of significance was used to know whether observed treatment effects were significant or not. The standard error (SE) and critical difference (CD) at 5% level of probability were calculated. The value of CD was used to interpret the results

Results

In view of above studies, sixteen genotypes of lathyrus including, Ratan as a check were analyzed to ascertain their physiological, biochemical and yield contributing characters. The results and discussion of above investigation are given below.

Physiological observation

Plant height (cm)

Studies on plant height were undertaken at four stages i.e. 30 to 90 days after sowing at specific interval of 20 days. The data are presented in Table 1. At all the stages, plant height gradually increased from 30 DAS to 90 DAS. The genotype EC-540902 recorded significantly highest plant height at all the growth stages. At 30 DAS, plant height was found to be significant. Six genotypes recorded significantly higher plant height than the check Ratan (12.77 cm). The genotype EC-540902 (15.86 cm) recorded significantly highest plant height than check Ratan, followed by IC-120463 (14.67 cm) and EC-539032 (13.89 cm). However, the genotypes IC-120497 (12.81 cm) and EC-389370 (12.74 cm) were found to be at par with check Ratan.

The six genotypes recorded significantly lowest plant height than the check Ratan. Genotype IC-120442 (10.51 cm) recorded the lowest plant height, however the genotype EC-389370 (12.74 cm) was found to be at par with check Ratan. At 50 DAS, plant height was found to be significant. Nine genotypes recorded significantly higher plant height than check Ratan (20.65 cm). The genotype EC-540902 (26.09 cm) recorded significantly highest plant height than check Ratan followed by IC-120463 (24.74 cm) and EC-539032 (23.07 cm).

Six genotypes recorded significantly lower plant height than check Ratan. The significantly lowest plant height was found in genotype IC-120442 (17.77 cm).

At 70 DAS, plant height was found to be significant. Four genotypes recorded significantly higher plant height than check Ratan (35.53 cm). The genotype EC-540902 (42.31 cm) recorded significantly highest plant height followed by IC-120463 (41.73 cm), EC-539032 (38.44 cm) and IC-420494 (36.24 cm). However, the genotype EC-389370 (35.75 cm), IC-420784 (35.60 cm), IC-120497 (35.53 cm), IC-208430 (35.37 cm) and IC-543448 (33.38 cm) were found to be at par to check Ratan.

Six genotypes were recorded significantly lower plant height than check Ratan. The significantly lowest plant height was found in genotype IC-120442 (29.81 cm).

At 90 DAS, plant height was found to be significant. Four genotypes recorded significantly higher plant height than check Ratan (45.63 cm). The genotype EC-540902 (52.66 cm) recorded the highest plant height than check Ratan followed by IC-120463 (52.55 cm), EC-539032 (48.21 cm) and IC-420494 (47.23 cm). However, the genotype IC-420785 (45.83 cm), EC-389370 (45.97 cm), IC-120497 (46.02), EC-405302 (46.24 cm), IC-420784 (45.22 cm), IC-345448 (45.52 cm) and IC-208430 (45.55 cm) were found to be at par to check Ratan.

The significantly lowest plant height was found in genotype IC-120442 (41.87 cm).

Plant height is one of the important morphological characters of lathyrus. The results clearly suggested the increasing trend for plant height. Which is statistically significant at all the growth stages of crop. It might be due to indeterminate behavior of species (Goyal 2003) [13].

The genotype EC-540902 was found tallest with respect to other genotypes. Its tallness is due to erect type and longer internodes, as a resultant of the favorable cell elongation at endogenous level taken place.

The present findings are supported with the results obtained by Falco *et al.* (1991) [9] where they concluded that the selected lines were generally taller (73 cm) than local ones (67cm).

The genotypic differences for plant height in lathyrus (54 cm to 74 cm) were also noted by Zode *et al.* (1999) [34] and Pandey *et al.* (2001) [23] and Goyal (2003) [13].

Tallness is due to the activity of ribulose phosphate carboxylase and sucrose phosphate synthetase of flag leaves, which leads to photosynthetic activities of the plant and helped in enhancement of cell elongation and increased plant height (Goyal 2003) [13].

Leaf area per plant (dm²)

The total leaf area per plant was recorded at 4 stages i.e. at 30, 50, 70 and 90 DAS. The data are presented in Table 2. Genotype EC-539032 recorded numerically higher leaf area per plant at all the growth stages.

At 30 DAS, leaf area was found to be significant. The none of the genotypes recorded significantly higher leaf area than check Ratan (0.72). However the genotype EC-539032 (0.74) and IC-120497 (0.70) were found to be at par with check Ratan (0.72).

Thirteen genotypes recorded significantly lower leaf area than check Ratan. Significantly Lowest was found in genotype IC-420784 (0.38).

At 50 DAS, leaf area was found to be significant. The none of the genotypes recorded significantly higher leaf area than check Ratan (1.72). However twelve genotypes were found to be at par with check Ratan. Three genotypes recorded significantly lower leaf area than check Ratan.

The significantly lowest leaf area was found in genotype IC-420784 (1.09), and by IC-420785 (1.09).

At 70 DAS, leaf area was found to be significant. The genotype EC-539032 (4.24) recorded significantly highest leaf area than check Ratan (4.08). None of the genotypes was found to be at par with check Ratan. Rests of the fourteen genotypes were recorded significantly lower leaf area than check Ratan.

The significantly lowest leaf area was found in genotype IC-420784 (2.35).

At 90 DAS, leaf area was found to be significant. The none of the genotypes recorded significantly higher leaf area than check Ratan (9.02), however the genotype EC-539032 (9.13) was found to be at par with check Ratan (9.02).

Fourteen genotypes recorded significantly lower leaf area than check Ratan. The significantly lowest leaf area was found in genotype IC-420784 (4.05).

Leaf area had increased gradually from vegetative to flowering stage and rapid at pod development stage (i.e. 70-90 DAS). Genotype EC-539032 showed maximum leaf area at all the growth stages. The maximum number of leaves plant⁻¹ contributed towards maximum leaf area while it was least in IC-420784, which could be probably due to increased assimilatory surface at all subsequent growth stages.

Similar findings of leaf area ranges from 3 dm² to 9 dm² in lathyrus were also reported by Zode *et al.* (1999) [34] and Goyal (2003) [13]. It was also reported by Naidu *et al.* (2001) [22] that, high yielding genotypes exhibited maximum leaf area. It is a function of cell expansion which again depends upon turgidity of cell. More leaf area is due to more elongation and enlargement of cell coupled with higher photosynthetic rate.

Total dry matter of plant (g/plant)

The data regarding dry matter accumulation of lathyrus plant was recorded at 30 to 90 days after sowing with an interval of 20 days. Data are presented in Table 3.

All the genotypes responded significantly at all the growth stages of crop.

At 30 DAS, total dry matter per plant was found to be significant. Eight genotypes recorded significantly higher total dry matter per plant than check Ratan (0.54 g). The genotype EC-389370 (0.85 g) recorded significantly highest dry matter per plant than check Ratan followed by IC-208430 (0.75 g) and IC-120463 (0.73 g), however seven genotypes were found to be at par with check Ratan. These genotypes are EC-539032 (0.54 g), EC-345448 (0.55 g), IC-420785 (0.55 g), IC-120536 (0.55 g), IC-543413 (0.55 g), IC-120442 (0.56 g) and IC-420784 (0.57 g).

None of the genotypes recorded significantly lower total dry matter per plant than check Ratan (0.54 g).

At 50 DAS, total dry matter of plant was found to be significant. Eight genotypes recorded significantly higher total dry matter per than check Ratan (1.06 g). The genotype EC-389370 (1.47 g) recorded significantly highest dry matter of plant than check Ratan, followed by IC-208430 (1.31 g) and EC-540902 (1.29 g). However seven genotypes were found to be at par with check Ratan (1.06 g).

None of the genotypes recorded significantly lower total dry matter per plant than check Ratan (1.06). However the genotype EC-539032 (1.02 g) numerically recorded lowest total dry matter per plant.

At 70 DAS, total dry matter of plant was found to be significant. Nine genotypes recorded significantly higher total dry matter per plant than check Ratan (4.11g). The genotype EC-389370 (6.65) recorded significantly highest total dry matter per plant than check Ratan followed by IC-208430 (6.11) and EC-540902 (5.79). However rests of the six genotypes were found to be at par with check Ratan.

None of the genotypes recorded significantly lower total dry matter per plant than check Ratan (4.11 g).

At 90 DAS, total dry matter per plant was found to be significant. Ten genotypes recorded significantly higher total dry matter per plant than check Ratan (8.31 g). The genotype EC-389370 (13.64 g) recorded significantly highest dry matter of plant than check Ratan followed by IC-208430 (12.69 g) and EC-540902 (12.22 g). However three genotypes viz, IC-420784 (8.32 g), IC-120442 (8.40 g) and IC-120463 (8.29 g) were found to be at par with check Ratan (8.31 g).

The significantly lowest total dry matter per plant was found in genotypes EC-539032 (8.14 g) and Pandharabodi (8.14 g). However the genotype IC-120463 (8.29) was found to be at par with check Ratan (8.31).

At all the growth stages the genotype EC-389370 has recorded highest total dry matter per plant over rest of genotypes. The genotype IC-208430 ranked second in total dry matter accumulation.

At initial stage i.e. at 30 DAS the rate of dry matter accumulation per plant was less but thereafter it was increased upto 90 DAS. It is well known that, dry matter accumulation is higher towards maturity and lower in early growth phase of crop plants.

The genotype EC-389370 accumulated maximum total dry matter plant⁻¹ (g) in comparison with other genotypes, which might be due to its higher capacity to accumulate photoassimilate as a result of increased activity of RuBP-carboxylase and moderate leaf area per plant. It might be due to its physiological superiority and capability of genotypes for efficient accumulation of reserve material as well as the faster translocation of assimilates from source to sink.

The genotypic differences with respect to total dry weight was also reported by Pawar and Bhatiya (1986) [25] in mung, Hemchandra *et al.* (1997) [16] in chickpea, similar results was reported by Zode *et al.* (1999) [34] was found that, total dry matter accumulation ranges from 8.3 to 13.80 g in lathyrus as well as similar type of results were also quoted by Goyal (2003) [13] in lathyrus.

Growth analysis

Growth analysis is one of the measures for assessing seed yield of a plant. Recently an importance to physiological aspects is given in breeding for potentially higher yield, particularly to the significance of photosynthesis. The physiological basis of yield difference can be examined through an evaluation of differences in growth parameters and their impact on yield. The genotypic variation in the productivity of crop may be related the parameters such as RGR, NAR, CGR and partitioning of total photosynthesis into economic and non-economic sink. This was reported by Prasad *et al.* (1978) [26].

Crop Growth Rate (CGR) (g/m²/day)

Crop growth rate is an important index of agricultural productivity on rate of dry matter production. The data on crop growth rate recorded at different growth intervals are presented in tables 4.

At 30-50 DAS, the CGR was found to be non-significant. However significant differences were observed at rest of the stages of observation (i.e. 50-70 and 70-90 DAS). Crop growth rate was minimum at 30-50 DAS and increased subsequently upto 70-90 DAS and was found maximum in 70-90 DAS.

At 50-70 DAS, the CGR was found to be significant. The genotype EC-539032 (0.2666 g/m²/day) recorded

significantly highest CGR than check Ratan followed by IC-345413 (0.2333 g/m²/day) and Pandharabodi (0.2305 g/m²/day). These genotypes were significantly superior to check Ratan (0.2004 g/m²/day). However genotypes viz., IC-420785 (0.2205 g/m²/day), IC-120497 (0.1905 g/m²/day), EC-405302 (0.1833 g/m²/day) and EC-540902 (0.1803 g/m²/day) were found to be at par with check Ratan.

Eight genotypes recorded significantly lower CGR than check Ratan. The significantly lowest CGR was found in genotypes IC-208430 (0.1366 g/m²/day).

At 70-90 DAS, the CGR was found to be significant. The genotype EC-539032 (0.3330 g/m²/day) recorded significantly highest CGR than check Ratan (0.2566 g/m²/day) followed by IC-420785 (0.3203 g/m²/day) and Pandharabodi (0.3202 g/m²/day). These genotypes were significantly superior to check Ratan (0.2566 g/m²/day). However the genotypes viz., IC-345413 (0.2603 g/m²/day), IC-120497 (0.2433 g/m²/day) and EC-540902 (0.2406 g/m²/day) were found to be at par with check Ratan.

Nine genotypes recorded significantly lower CGR than check Ratan. The significantly lowest CGR was found in genotype IC-208430 (0.2033 g/m²/day).

Crop growth rate was minimum at 30-50 DAS and increased subsequently upto 70-90 DAS and was found maximum in 70-90 DAS. Similar results were also reported by Zode *et al.* (1999) [34] in lathyrus and Harshvardhan (2004) [17] in lathyrus.

Relative Growth Rate (g/g/day)

Increase in drymatter of a plant is a process of continuous compound interest where in the increment in any interval adds to the "Capital for subsequent growth." This rate of increment in growth is called as relative growth rate.

The data on relative growth rate was recorded at different growth intervals are presented in Table 5.

At 30-50 DAS, the RGR was found to be non-significant. The genotype EC-539032 (0.0433 g/g/day) showed numerically maximum RGR followed by genotype Ratan (0.0369 g/g/day) over rest of the genotypes. Similarly numerically lowest RGR was recorded in genotype IC-208430 (0.0266 g/g/day).

At 50-70 DAS, the RGR was found to be non-significant. The genotype EC-539032 (0.0807 g/g/day) showed numerically maximum RGR followed by genotype IC-420785 (0.0802 g/g/day) over rest of the genotypes. Similarly numerically lowest RGR was recorded in genotype EC-389370 (0.0602 g/g/day).

At 70-90 DAS, the RGR was found to be non-significant. The genotype EC-539032 (0.0369 g/g/day) showed numerically maximum RGR, followed by genotype IC-345413 (0.0368 g/g/day) over rest of the genotypes. Similarly numerically lowest RGR was recorded in genotype EC-540902 (0.0330 g/g/day).

The RGR is the measures of dry matter production on per day basis. RGR increased upto 50-70 DAS and thereafter it declined. Similar results were also reported by Goyal (2003) [13] in lathyrus

Net Assimilation Rate (g/dm²/day)

Net assimilation rate is closely associated with photosynthetic efficiency of plant but it is not a absolute measure of photosynthesis. The apparent photosynthesis depends upon the excess of dry matter gain over loss of

respiration. The NAR is the increase in plant dry weight per unit leaf area of assimilatory tissue per unit time.

The data on net assimilation rate are presented in Table 6. NAR differed significantly at different growth intervals of crop.

At 30-50 DAS, the NAR was found to be significant. None of the genotypes recorded significantly higher NAR than check Ratan (0.0361 g/dm²/day). However eleven genotypes were found to be at par with check Ratan (0.0361 g/dm²/day). The significantly lower NAR was found in genotypes viz., EC-389370 (0.0264 g/dm²/day), IC-208430 (0.0265 g/dm²/day), IC-120463 (0.0266 g/dm²/day) and EC-405302 (0.0267 g/dm²/day) than the check Ratan.

At 50-70 DAS, the NAR was found to be significant. The genotype EC-539032 (0.1303 g/dm²/day) recorded significantly highest NAR than check Ratan (0.1033 g/dm²/day) followed by IC-345413 (0.1301 g/dm²/day) and Pandharabodi (0.1166 g/dm²/day). These genotypes were significantly superior to check Ratan (0.1033 g/dm²/day).

Eleven genotypes recorded significantly lower NAR than check Ratan. The significantly lowest NAR was found in genotype IC-120463 (0.0566 g/dm²/day). However the genotype IC-420784 (0.0934 g/dm²/day) was found to be at par with check Ratan (0.1033 g/dm²/day).

At 70-90 DAS, the NAR was found to be significant. Only two genotypes EC-539032 (0.0913 g/dm²/day) and IC-345413 (0.0787 g/dm²/day) have recorded significantly higher NAR than check Ratan (0.0613 g/dm²/day). However five genotypes viz., Pandharabodi (0.0703 g/dm²/day), IC-420784 (0.0564 g/dm²/day), EC-540902 (0.0576 g/dm²/day), IC-345448 (0.0578 g/dm²/day) and IC-120536 (0.0512 g/dm²/day) were found to be at par with check Ratan (0.0613 g/dm²/day).

Eight genotypes recorded significantly lower NAR than check Ratan. The significantly lowest NAR was found in genotypes IC-120497 (0.0405 g/dm²/day).

Mean NAR was found lowest in 30-50 DAS, highest in 50-70 DAS and again it decreased at 70-90 DAS in present investigation. Above findings are confirmatory to the results obtained by Zode (1998) [35] and Goyal (2003) [13].

The genotypic differences with respect to NAR were also reported by Shrivastava *et al.* (1982) [27] in soybean and Zode *et al.* (1999) [34] in lathyrus and Mundada (2000) [21] in lathyrus.

Relative water content (%)

The data on relative water content are presented in Table 7.

At 30 DAS, statistical differences in relation to relative water content in different lathyrus genotypes were non-significant. However significant differences were noted at rest of the stages of observation.

At 50 DAS, statistical differences in relation to relative water content in different lathyrus genotypes were significant. The genotypes viz., EC-539032 (86.04%) and IC-120536 (83.81%) have recorded significantly higher relative water content than check Ratan (78.91%). However six genotypes viz., IC-120463 (80.37%), EC-405302 (80.04%), IC-420494 (75.63%), Pandharabodi (76.73%), IC-420785 (77.13%) and IC-120497 (77.95%) were found to be at par with the check Ratan (78.91%).

The significantly lowest relative water content was found in genotypes IC-345448 (71.59%).

At 70 DAS, statistical differences in relation to relative water content in different lathyrus genotypes were significant.

Grand mean relative water content in leaves was found to be 79.27% which was increased as compared to 50 DAS due to rainfall (14 mm) received in 24-31 December 2009. None of the genotypes was significantly superior to check Ratan (82.91%). However eleven genotypes were found to be at par with check Ratan.

The significantly lowest relative water content was found in genotype IC-345448 (73.67%) other genotypes recorded significantly lower RWC are IC-120442 (74.49%), IC-120497 (75.40%) and IC-120463 (76.33%) than check Ratan. At 90 DAS, statistical differences in relation to the relative water content in different lathyrus genotypes were significant. Eleven genotypes have recorded significantly higher relative water content in leaves than check Ratan. The genotypes EC-539032 (49.22%) recorded significantly highest relative water content followed by IC-208430 (47.57%) and IC-120536 (47.49%).

The significantly lowest relative water content was found in genotypes IC-345448 (37.73%). Other genotypes also recorded significantly lower RWC are IC-120442 (38.25%), IC-120497 (40.32%) and EC-405302 (40.38%).

At initial stage i.e. 30 DAS difference in relative water content was not found. Similar results are also reported by Harshvardhan (2004) [17]. At subsequent stages genotypic difference in relation to relative water content were observed. The present investigations are in supported with the results of Gupta *et al.* (2004) [15] and Reddy *et al.* (2003) [28].

Total chlorophyll content in leaf (mg/g)

The data are presented in Table 8. Total chlorophyll content in leaves of different lathyrus genotypes was estimated at four different consecutive growth stages i.e. at 30, 50, 70, and 90 DAS.

It is revealed from the Table 4.5 that, total chlorophyll content in leaves has increased upto 50 DAS and thereafter decreased at 70 DAS and 90 DAS respectively.

At 30 DAS, significant differences in respect of the total chlorophyll content in different lathyrus genotypes were observed. The genotypes viz., EC-539032 (1.34 mg/g) and IC-120463 (1.33 mg/g) recorded significantly higher chlorophyll content in leaves than check Ratan (1.23 mg/g). However the genotypes viz., IC-120442 (1.24 mg/g), IC-345413 (1.24 mg/g) and EC-540902 (1.22 mg/g) were found to be at par with check Ratan (1.23 mg/g).

Ten genotypes recorded significantly lower total chlorophyll content in leaves than check Ratan. The significantly lowest

total chlorophyll content was found in genotypes IC-120536 (1.12 mg/g).

At 50 DAS, significant differences in respect of total chlorophyll content in different lathyrus genotypes were observed. Five genotypes viz., IC-120463 (1.74 mg/g), EC-539032 (1.74 mg/g), IC-345413 (1.67 mg/g), IC-120442 (1.65 mg/g), and EC-540902 (1.64 mg/g) were recorded significantly higher total chlorophyll content than check Ratan (1.60 mg/g). Grand mean total chlorophyll content of 1.54 mg/g fresh leaves was observed at 50DAS which was highest value as compared to 30,70 and 90 DAS. Similar findings were observed by Harshvardhan (2004) [17]. The genotype IC-120463 (1.74 mg/g) and EC-539032(1.74 mg/g) recorded highest chlorophyll content.

Ten genotypes recorded significantly lower total chlorophyll content than check Ratan. The significantly lowest total chlorophyll content was found in genotype IC-120536 (1.33 mg/g).

At 70 DAS, significant differences in respect of the total chlorophyll content in different lathyrus genotypes were observed. None of the genotypes was found significantly superior to check Ratan (1.29 mg/g). However seven genotypes viz., the genotype IC-420494 (1.31 mg/g), IC-208430 (1.27 mg/g), IC-120463 (1.25 mg/g), IC-420784 (1.25 mg/g), EC-540902 (1.25 mg/g), EC-389370 (1.24 mg/g) and IC-120536 (1.22 mg/g) were found to be at par with the check Ratan.

Eight genotypes recorded significantly lower total chlorophyll content than check Ratan. The significantly lowest total chlorophyll content was found in genotype IC-345448 (0.86 mg/g).

At 90 DAS, significant differences in respect of the total chlorophyll content in different lathyrus genotypes were observed. Only one genotype IC-420494(0.86mg/g) recorded significantly higher total chlorophyll content than check Ratan(0.82mg/g). However none of the genotypes was found to be at par with the check Ratan

Fourteen genotypes recorded significantly lower total chlorophyll content than check Ratan at this important stage. The significantly lowest total chlorophyll content was found in genotypes EC-405302 (0.47 mg/g)

Similar findings were observed by Zode (1998)[35] they reported that chlorophyll content in leaf ranges from 1.13 to 1.18 mg/g at flowering stage in lathyrus and Harshvardhan (2004)[17] observed that chlorophyll content in leaves ranges from 0.96 to 1.26 mg/g at 30 DAS while 0.96 to 1.17 mg/g at 70 DAS in lathyrus.

Table 1: Plant height (cm) of different genotypes of lathyrus at 30, 50, 70 and 90 DAS

Treatments	Growth Stage			
	30 DAS	50 DAS	70 DAS	90 DAS
IC-120442	10.51	17.77	29.81	41.87
IC-120463	14.67	24.74	41.73	52.55
IC-345448	10.79	18.91	33.38	45.52
IC-420784	12.05	21.03	35.60	45.22
IC-208430	11.67	19.79	35.37	45.55
EC-389370	12.74	21.61	35.75	45.97
EC-539032	13.89	23.07	38.44	48.21
EC-540902	15.86	26.09	42.31	52.66
EC-405302	12.08	20.23	33.94	46.24
Pandharabodi	11.67	19.44	34.47	45.62
IC-345413	10.77	18.14	32.57	44.49
IC-120497	12.81	22.27	35.53	46.02
IC-120536	13.81	22.26	33.73	45.62
IC-420494	13.77	22.65	36.24	47.23

IC-420785	12.96	21.43	33.92	45.83
Ratan (check)	12.77	20.65	35.53	45.63
Grand Mean	12.68	21.26	35.52	46.51
'F' test	Sig.	Sig.	Sig.	Sig.
SE(m) +	0.06	0.05	0.12	0.30
CD at 5%	0.18	0.15	0.36	0.90

Table 2: Leaf area per plant (dm²) in different genotypes of lathyrus at 30,50,70 and 90 DAS

Treatments	Growth Stage			
	30 DAS	50 DAS	70 DAS	90 DAS
IC-120442	0.57	1.60	2.87	5.04
IC-120463	0.65	1.67	3.68	5.25
IC-345448	0.63	1.58	2.65	4.73
IC-420784	0.38	1.09	2.35	4.05
IC-208430	0.54	1.63	3.18	7.25
EC-389370	0.65	1.63	3.66	5.35
EC-539032	0.74	1.78	4.24	9.13
EC-540902	0.59	1.59	2.87	5.17
EC-405302	0.52	1.56	3.17	7.25
Pandharabodi	0.58	1.57	2.86	5.44
IC-345413	0.64	1.10	2.67	5.13
IC-120497	0.70	1.70	4.03	8.53
IC-120536	0.65	1.62	3.66	5.33
IC-420494	0.58	1.58	2.86	5.13
IC-420785	0.62	1.09	2.58	4.64
Ratan (check)	0.72	1.72	4.08	9.02
Grand Mean	0.61	1.53	3.21	6.03
'F' test	Sig.	Sig.	Sig.	Sig.
SE(m) +	0.01	0.06	0.01	0.04
CD at 5%	0.03	0.18	0.03	0.12

Table 3: Total dry matter accumulation per plant in different genotypes of lathyrus (g)

Treatments	Growth Stage			
	30 DAS	50 DAS	70 DAS	90 DAS
IC-120442	0.56	1.28	4.27	8.40
IC-120463	0.73	1.27	4.13	8.29
IC-345448	0.55	1.13	4.25	10.42
IC-420784	0.57	1.20	4.14	8.32
IC-208430	0.75	1.31	6.11	12.69
EC-389370	0.85	1.47	6.65	13.64
EC-539032	0.54	1.02	4.04	8.14
EC-540902	0.73	1.29	5.79	12.22
EC-405302	0.61	1.09	4.69	9.30
Pandharabodi	0.65	1.15	5.12	8.14
IC-345413	0.55	1.15	5.77	11.27
IC-120497	0.66	1.25	4.98	9.81
IC-120536	0.55	1.17	4.50	8.69
IC-420494	0.65	1.16	4.17	8.44
IC-420785	0.55	1.09	4.87	9.63
Ratan (check)	0.54	1.06	4.11	8.31
Grand Mean	0.63	1.19	4.85	9.73
'F' test	Sig.	Sig.	Sig.	Sig.
SE(m) +	0.01	0.03	0.07	0.04
CD at 5%	0.03	0.09	0.21	0.12

Table 4: Crop growth rate (g/m²/day) of different genotypes of lathyrus at 30-50, 50-70, and 70-90 DAS

Treatments	Growth Stage		
	30-50 DAS	50-70 DAS	70-90 DAS
IC-120442	0.0300	0.1608	0.2103
IC-120463	0.0266	0.1407	0.2033
IC-345448	0.0271	0.1601	0.2105
IC-420784	0.0301	0.1633	0.2107
IC-208430	0.0268	0.1366	0.2033
EC-389370	0.0333	0.1533	0.2104

EC-539032	0.0366	0.2666	0.3330
EC-540902	0.0334	0.1803	0.2406
EC-405302	0.0233	0.1833	0.2366
Pandharabodi	0.0308	0.2305	0.3202
IC-345413	0.0336	0.2333	0.2603
IC-120497	0.0307	0.1905	0.2433
IC-120536	0.0338	0.1666	0.2134
IC-420494	0.0331	0.1633	0.2206
IC-420785	0.0306	0.2205	0.3203
Ratan (check)	0.0305	0.2004	0.2566
Grand Mean	0.0306	0.1843	0.2432
'F' test	NS	Sig.	Sig.
SE(m) +	0.0044	0.0077	0.0065
CD at 5%	---	0.0233	0.0196

Table 5: Relative growth rate (g/g/day) of different genotypes of lathyrus at 30-50, 50-70 and 70-90, DAS.

Treatments	Growth Stage		
	30-50 DAS	50-70 DAS	70-90 DAS
IC-120442	0.0333	0.0703	0.0332
IC-120463	0.0338	0.0633	0.0331
IC-345448	0.0330	0.0667	0.0366
IC-420784	0.0332	0.0731	0.0333
IC-208430	0.0266	0.0607	0.0364
EC-389370	0.0268	0.0602	0.0334
EC-539032	0.0433	0.0807	0.0365
EC-540902	0.0367	0.0707	0.0330
EC-405302	0.0334	0.0713	0.0367
Pandharabodi	0.0335	0.0766	0.0365
IC-345413	0.0331	0.0706	0.0368
IC-120497	0.0267	0.0733	0.0335
IC-120536	0.0365	0.0735	0.0334
IC-420494	0.0336	0.0666	0.0363
IC-420785	0.0362	0.0802	0.0361
Ratan (check)	0.0369	0.0750	0.0365
Grand Mean	0.0335	0.0708	0.0351
'F' test	NS	NS	NS
SE(m) +	0.0095	0.0049	0.0032
CD at 5%	-----	-----	-----

Table 6: Net assimilation rate (g dm² day⁻¹) of different genotypes of lathyrus at 30-50, 50-70, 70-90 DAS.

Treatments	Growth Stage		
	30-50 DAS	50-70 DAS	70-90 DAS
IC-120442	0.0333	0.0733	0.0503
IC-120463	0.0266	0.0566	0.0470
IC-345448	0.0366	0.0732	0.0578
IC-420784	0.0367	0.0934	0.0564
IC-208430	0.0265	0.0633	0.0507
EC-389370	0.0264	0.0567	0.0504
EC-539032	0.0433	0.1303	0.0913
EC-540902	0.0268	0.0834	0.0576
EC-405302	0.0267	0.0801	0.0505
Pandharabodi	0.0331	0.1166	0.0703
IC-345413	0.0402	0.1301	0.0787
IC-120497	0.0334	0.0664	0.0405
IC-120536	0.0332	0.0665	0.0512
IC-420494	0.0335	0.0735	0.0506
IC-420785	0.0339	0.0668	0.0409
Ratan (check)	0.0361	0.1033	0.0613
Grand Mean	0.03289	0.08335	0.0565
'F' test	Sig.	Sig.	Sig.
SE(m) +	0.0031	0.0042	0.0033
CD at 5%	0.0093	0.0127	0.0099

Table 7: Relative water content (%) in leaf of different genotypes of Lathyrus at 30,50,70,90 DAS

Treatments	Growth Stage			
	30 DAS	50 DAS	70 DAS	90 DAS
IC-120442	77.65 (61.75)	72.34 (58.24)	74.49 (59.67)	38.25 (38.17)
IC-120463	79.01 (62.72)	80.37 (63.72)	76.33 (60.87)	46.19 (42.82)
IC-345448	77.04 (61.34)	71.59 (57.80)	73.67 (59.15)	37.73 (37.88)
IC-420784	81.82 (64.75)	72.48 (58.37)	81.03 (64.16)	44.30 (41.73)
IC-208430	80.69 (63.94)	73.79 (59.21)	77.41 (61.62)	47.57 (43.62)
EC-389370	80.54 (63.79)	74.57 (59.74)	80.18 (63.58)	45.22 (42.25)
EC-539032	87.87 (69.64)	86.04 (68.03)	85.21 (67.37)	49.22 (44.54)
EC-540902	78.93 (62.65)	74.66 (59.80)	82.68 (65.42)	44.62 (41.90)
EC-405302	78.87 (62.65)	80.04 (63.44)	79.19 (62.87)	40.38 (39.47)
Pandharabodi	81.29 (64.38)	76.73 (61.14)	79.81 (63.29)	45.22 (42.25)
IC-345413	80.26 (63.65)	72.43 (58.31)	78.25 (62.24)	45.55 (42.42)
IC-120497	82.28 (65.12)	77.95 (61.96)	75.40 (60.27)	40.32 (39.41)
IC-120536	85.80 (67.86)	83.81 (66.34)	84.95 (67.13)	47.49 (43.57)
IC-420494	79.20 (62.87)	75.63 (60.40)	77.89 (61.96)	43.37 (41.21)
IC-420785	81.44 (64.45)	77.13 (61.41)	78.89 (62.65)	45.22 (42.25)
Ratan (check)	82.01 (64.90)	78.91 (62.65)	82.91 (65.57)	41.32 (39.99)
Grand Mean	79.13 (62.80)	76.78 (61.21)	79.27 (62.94)	43.87 (41.50)
'F' test	NS	Sig.	Sig.	Sig.
SE(m) +	7.64	1.13	2.18	0.12
CD at 5%	----	3.39	6.55	0.36

(Figures in parentheses are arc sine values)

Table 8: Total chlorophyll content (mg/g) of different lathyrus genotypes at 30,50,70,90 DAS

Treatments	Growth Stage			
	30 DAS	50 DAS	70 DAS	90 DAS
IC-120442	1.24	1.65	1.17	0.66
IC-120463	1.33	1.74	1.25	0.75
IC-345448	1.17	1.49	0.86	0.48
IC-420784	1.16	1.43	1.25	0.67
IC-208430	1.14	1.40	1.27	0.67
EC-389370	1.13	1.56	1.24	0.56
EC-539032	1.34	1.74	1.12	0.53
EC-540902	1.22	1.64	1.25	0.64
EC-405302	1.16	1.43	0.98	0.47
Pandharabodi	1.16	1.47	1.08	0.51
IC-345413	1.24	1.67	1.10	0.48
IC-120497	1.14	1.41	1.12	0.56
IC-120536	1.12	1.33	1.22	0.62
IC-420494	1.17	1.51	1.31	0.86
IC-420785	1.16	1.49	1.10	0.66
Ratan (check)	1.23	1.60	1.29	0.82
Grand Mean	1.20	1.54	1.16	0.62
'F' test	Sig.	Sig.	Sig.	Sig.
SE(m) +	0.01	0.01	0.03	0.01
CD at 5%	0.03	0.03	0.09	0.03

Discussion

Experimental material comprised of sixteen genotypes of lathyrus viz. IC-120442, IC-120463, IC-345448, IC-420784, IC-208430, EC-389370, EC-539032, EC-540902, EC-405302, Pandharabodi, IC-345413, IC-120497, IC-120536, IC-420494, IC-420785 and Ratan as a check.

The field observations were recorded on various morphological characters such as plant height (cm), leaf area (dm^2). Physiological parameters included total dry matter of plant (g/plant), Net assimilation rate ($\text{g}/\text{dm}^2/\text{day}$), relative growth rate ($\text{g}/\text{g}/\text{day}$), crop growth rate ($\text{g}/\text{m}^2/\text{day}$).

The laboratory observations included certain physiological parameters i.e. relative water content (%). The observations on biochemical parameters such as chlorophyll content in leaves at 30, 50, 70, and 90 DAS.

The important results of present investigation are summarized as below.

a) Field study

1. The maximum plant height was recorded in genotype EC-540902 at all stages of plant under study.

2. None of the genotypes exhibited significantly higher in total leaf area per plant than check Ratan at 30, 50 and 90 DAS while the genotype EC-539032 recorded significantly superior in total leaf area per plant at 70 DAS.
3. The genotype EC-389370 exhibited significantly superior in total dry matter production.
4. Regarding the physiological parameters, crop growth rate was found non significant at 30-50 DAS. Significant differences were found at 50-70 and 70-90 DAS in genotype EC-539032 was found superior.
5. Relative growth rate was found to be non significant at all the growth stages. The genotype EC-539032 was found numerically superior to check Ratan.
6. None of the genotypes exhibited significantly higher net assimilation rate than check Ratan at 30-50 DAS. But the genotype EC-539032 was found significantly superior at both the stages (i.e. 50-70 and 70-90 DAS).

b) Laboratory study

7. The relative water content (RWC) (%) was found to be non significant at 30 DAS. The genotype EC-539032 was found to be significantly superior at remaining stages (i.e. 50, 70 and 90 DAS. Grand mean relative water content in leaves was increased at 70 DAS as compared to 50 DAS due to rainfall.
8. The total chlorophyll content (mg/g) was found significantly superior in genotype EC-539032 at 30 and 50 DAS while genotype IC-420494 was found significantly more at 70 and 90 DAS.

Conclusion

1. In the light of the results obtained, it can be concluded that, the genotypic variability existed regarding the physio-morphological, biochemical and other attributes at various growth stages of the crop.
2. In present investigation, among all the genotypes studied EC-539032 exhibited superior performance in leaf area, CGR, NAR, relative water content as well as total chlorophyll content the average content than safe value for consumption.
3. The genotype EC-539032 and EC-389370 could be used in breeding programme for developing genotypes of highest dry matter production.

Acknowledgments

The present investigation entitled "Morphological studies of elite lathyrus (*Lathyrus sativus* L) germplasm was undertaken at experimental field of Department of Agricultural Botany, Dr. P.D.K.V., Akola (M.S.) during rabi season of 2009-2010 in RBD with three replications consisted of sixteen treatments with the net plot size of 1.20m x 1.90m. thanks to Head Department of Agricultural Botany, Dr. P.D.K.V., Akola (M.S.) for provided to all facility for given experiment and my all staff members of agriculture research station under Dr. PDKV Akola and my friends to help to taken observation and analysis of data and also laboratory work.

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