RESEARCH ARTICLE

SABRAO Journal of Breeding and Genetics
56 (4) 1513-15230, 2024
http://doi.org/10.54910/sabrao2024.56.4.17
http://sabraojournal.org/
pISSN 1029-7073; eISSN 2224-8978

PHYSIOLOGICAL AND BIOCHEMICAL PARAMETERS OF THE EXOTIC SPECIES OF GRASS PEA (*LATHYRUS SATIVUS* L.)

S. KODIROVA[1*], B. AMANOV[2], KH. MUMINOV[2], F. ABDIYEV[3], A. BURONOV[2], N. TURSUNOVA[2], and I. KURBANBAYEV[1]

[1]Institute of Genetics and Plants Exp. Biology, Academy of Sciences, Yukori-Yuz, Uzbekistan
[2]Department of Natural Sciences, Chirchik State Pedagogical University, Tashkent, Uzbekistan
[3]Samarkand State University of Vet. Medicine, Livestock and Biotechnologies, Tashkent, Uzbekistan
[*]Corresponding author's email: qsaodat71@gmail.com
Email addresses of co-authors: amanov.81@bk.ru, mxa8215@mail.ru, buronova_1985@mail.ru, abdiyev.fozil@mail.ru, nilufar.azimova.85@inbox.ru, ilhomak@mail.ru

SUMMARY

The article outlines the physiological and biochemical parameters of 10 exotic accessions of two local cultivars of grass pea (*Lathyrus sativus* L.). By analyzing the plant leaf spectrophotometrically at the bud formation phase, exotic sample Bio-520 x 1330 showed chlorophyll a of 21.47 mg/ml, Bio (520 x Bio) x 273 with chlorophyll b of 12.79 mg/ml, and Ratan x IG 135481 had carotenoids at 5.57 mg/ml. Based on total pigments, Ratan x 1307 gave the highest value (30.24 mg/ml), while in the flowering phase, Ratan x IG 135481 showed chlorophyll a of 21.37 mg/ml, Ratan x 2125 with chlorophyll b of 16.51 mg/ml, and Prateek x IG 140034 with carotenoid of 6.02 mg/ml. For Ratan x 2125, the total pigments were 37.14 mg/ml, with the highest values for all traits. In the ripening phase, Bio 520 x 1330 with chlorophyll a (11.92 mg/ml), Ratan x 2125 with chlorophyll b (16.63 mg/ml), 1330 x 2125 with carotenoid (4.04 mg/ml), and Ratan x 2125 with total pigments (25.62 mg/ml). Higher protein content resulted in seeds of Prateek x IG 140035 (26.3%), Bio (520 x Bio) x 273 (26.1%), and Ratan x 1307 (26.0). Besides, 1330 x 2125 has biochemical elements (Li, B, Na, Cu, and As), Ratan x 2125 (Mg, K, Ca, Ti, Sr, and Ba), Ratan x IG 135481 (Rb, Mo, and Cd), and Prateek x IG 140034 with chemical elements (Al, Fe, and Ag). The control Lalmikor provided B, Mn, Rb, and Ag higher than other exotic samples.

Keywords: Grass pea (*Lathyrus sativus* L.), growth phases, leaf stomata, photosynthetic pigments, chlorophyll a and b, carotenoids, total water content, water retention, transpiration intensity, total protein

Communicating Editor: Dr. Samrin Gul

Manuscript received: February 14, 2024; Accepted: April 20, 2024.

Citation: Kodirova S, Amanov B, Muminov KH, Abdiyev F, Buronov A, Tursunova N, Kurbanbayev I (2024). Physiological and biochemical parameters of the exotic species of grass pea (*Lathyrus sativus* L.). *SABRAO J. Breed. Genet.* 56(4): 1513-1523. http://doi.org/10.54910/sabrao2024.56.4.17.

Key findings: Grass pea (*L. sativus* L.) exotic and local genotypes revealed varied values of physiological traits, viz., chlorophyll a and b, total chlorophyll, carotenoid pigments, and concentration of total pigments analyzed spectrophotometrically. The grass pea genotypes showed nonsignificant differences in nitrogen and total protein content.

INTRODUCTION

In the 21st century, it is necessary to overcome hunger and malnutrition by increasing safe, healthy, and good-quality food production. Even though crop plants belonging to the leguminous family have been an integral part of the population's diet for centuries, the sufficient evaluation of the nutritional potential of these plants has not progressed, with their consumption being low (Baboev *et al.,* 2017, 2021; Buronov *et al.,* 2023). Therefore, the breeding and further selection of resistant genotypes to biotic and abiotic stress factors are prerequisites. Hence, planting and breeding the germplasm of the leguminous grain crops of the world collection (International Maize and Wheat Improvement Center [CYMMIT] and International Center for Agricultural Research in the Dry Areas [ICARDA]) and studying their genetic, physiological, and biochemical characteristics are necessary. Legumes demands are high because they are vital for healthy nutrition and food security (Sytnikov, 2012; Qulmamatova *et al.,* 2022).

Grass pea (*Lathyrus sativus* L) is a cool-season legume crop grown mainly for food in the Indian subcontinent and Ethiopia and as a food and fodder crop in other parts worldwide. Grass peas are resistant to salinity, drought, insects, and biotic stresses and have various valuable agronomic properties, such as good growth in semi-arid and marginal soils. Similarly, as a leguminous crop and an efficient nitrogen fixer, it enriches the soil with nitrogen. These characteristics authenticate the plant as a beneficial crop for maintaining and popularizing sustainable productivity in changing climates. On nutritional values, these crops are highly rich in protein, second only to soybeans, providing balanced amino acids as a dietary plant with cereals for poor people in countries consuming these leguminous plants (Muminov *et al.,* 2023; Omonov *et al.,* 2023).

The grass pea is a multi-purpose crop and a drought-tolerant and climate-adaptive legume that can withstand drought, waterlogging, and salinity and grow under minimal external influences. It is also a multi-purpose grain, fodder, vegetable, and hay crop that improves soil fertility by fixing atmospheric nitrogen (Amanov *et al.,* 2020, 2022). As such, ICARDA is exploring opportunities to grow crops in areas where other field crops are unable to survive due to poor soil quality and water scarcity, providing prospects for sustainable crop production and nutritional security for resource-hungry farmers and end users (https://www.icarda.org/research/climate-smart-crops/grass-pea).

Organic compounds formed through photosynthesis are living organisms' main life source. In photosynthesis, the oxygen released into the atmosphere is necessary for the respiration of living organisms (Beknazarov, 2009). Reduced photosynthetic pigments under water deficit conditions also decrease the chlorophyll and disrupt photosynthesis. A significant decrease in chlorophyll synthesis may be due to factors negatively affecting photosynthesis. It also authenticated that dehydration enhances chlorophyll catabolism (Loggini *et al.,* 1999).

Ethanol is a safer solvent than acetone and methanol; however, its use is seldom in chlorophyll analysis, although it has a and b equivalence. Several reasons for its limited use are prevalent, and due to negative consequences, it is not applicable in laboratory conditions (Lichtenthaler and Wellburn, 1983). Ethanol does not affect the polystyrene; thus, polystyrene plastic spectrophotometer cuvettes can be suitable. Hence, significantly safe, practical, and economic advantages prevail in using ethanol as a solvent for chlorophyll extraction and analysis (Wright *et al.,* 1997).

Proteins are the basic and important biological substances that are irreplaceable. Lack of protein weakens the body, causing difficulty in metabolism, decreasing immunity, preventing growth, disrupting internal secretion, and raising other harmful conditions. An excess of protein leads to a change in the sensitivity of the nervous system and malfunction of the liver, kidney, and other internal organs (Kudryashova, 2000; Shatnyuk and Yudina, 2004).

Mineral substances do not have energy values; however, the body cannot function well without them. Minerals perform a constructive function in humans, contribute to the metabolism of human body tissues, and construct bones (Fedichkina, 2000). Based on the above discussion, the latest study scrutinized the physiological and biochemical parameters of 10 exotic grass peas (*L. sativus* L.) obtained from ICARDA and two local cultivars.

MATERIALS AND METHODS

The pertinent research commenced in the experimental field at the Chirchik State Pedagogical University, Tashkent, Uzbekistan. The research object was the germplasm of 10 exotic species belonging to the grass pea (*L. sativus* L.), i.e., Bio (520 x Bio) x 273, Prateek x IG 140034, Ratan x 2125, Jabbouleh, 1330 x 2125, Ratan x 1307, Ratan x IG 135481, Bio (520 x Bio) x 274, Prateek x IG 140035, and Bio 520 x 1330, obtained from ICARDA and two local cultivars of Uzbekistan, viz., Lalmikor and Polvon.

The experiment determined the amounts of chlorophyll a and b and carotenoids in leaves of *L. sativus* L. species collection. The process comprised samples from 3–4 leaves, counting from the plant's growing point under field conditions. Upon filling 50 mg of each leaf specimen in a test tube, each leaf sample bore homogenization in 5 ml of 95% ethyl alcohol solution (Lichtenthaler and Wellburn*,* 1983). The homogenate attained centrifugation at a speed of 5000 for 12 min. The chlorophyll a and b and carotenoid content in the resulting extract's determination used an Agilent Cary 60 UV-Vis spectrophotometer at 664, 649, and 470 nm. Based on this indicator, calculating the amounts of chlorophyll a and b and carotenoids in plant leaves engaged the following equation (Nayek *et al.,* 2014):

$$\text{Chlorophyll a (mg/g)} = 13.36A664 - 5.19 \times A649$$

$$\text{Chlorophyll b (mg/g)} = 27.43A649 - 8.12 \times A664$$

$$\text{Carotenoid (mg/g)} = (1000A470 - 2.13 \times \text{chl a} - 97.63 \text{ chl b})/209$$

$$F\ (Mg/g) = (V \times S)/P$$

Determination of macro and micro elements

Determination of macro and microelements followed the Inductively Coupled Plasma Mass Spectrometry (ICP-MS). The procedure helped determine food products' calcium, phosphorus, magnesium, iron, and iodine elements. For this purpose, 0.0500–0.500 g of the tested substance measured on an analytical balance continued into a Teflon autoclave container, with an appropriate amount of purified concentrated mineral acids (nitric acid and hydrogen peroxide) added. The autoclave in a Berghof-programmed (MWS-3+) microwave oven continued to digest. Determining the appropriate program relied on the type of substance for testing. After the decomposition of the substances placed in the autoclave, samples' transfer in 50 ml volumetric flasks ensued up to the required mark with 0.5% nitric acid. Determination of substances progressed on an ICP-MS or similar inductively coupled argon plasma emission spectrometer.

The following equipment and materials comprised the analysis.

ICP-MS NEXION-2000 or similar mass spectrometer, microwave separators (Germany), or similar Teflon autoclave, and flasks of various sizes.

Reagents used: Multielement standard #3 (29 elements for MS).

Standards - quicksilver, nitric acid, hydrogen peroxide, bidistilled water, and argon (gas purity 99.995%).

Determination of nitrogen and protein content

For the total protein determination, the study used the Kjeldahl method. Determining the nitrogen amount helped calculate the total protein. The essence of the technique was to hydrolyze the organic substances in the sample with the help of concentrated sulfuric acid (the amine groups in the protein) to form ammonium sulfate salts.

Nitrogenous organic matter + H_2SO_4 →
$(NH_4)_2SO_4 + CO_2 + H_2O$

Nitrogenous organic matter

After completing the hydrolysis, the ammonium sulfate formed received sodium hydroxide treatment to convert it to ammonia.

$$(NH_4)_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2NH_4OH \begin{matrix} \nearrow 2H_2O \\ \searrow 2NH_3 \end{matrix}$$

Ammonia or ammonium hydroxide formed from neutralization reached absorption into the sulfuric acid solution. The remaining acid's titration employed an alkaline solution. The formulated nitrogen came from the calculated amount of ammonia. Drawing an accurate sample for analysis from the average ground homogeneous specimen of the studied samples into a test tube must not exceed a 0.1% error rate. The sample quantification continued in a Kjeldahl flask. Afterward, the experiment progressed following the standard instructions (Control Methods, 2004).

Processing of the obtained results

In the analyzed sample, the mass fraction of nitrogen (X) calculation followed the formula as a percentage of the mass of the sample by the volume after the titration of the amount of ammonia passed through dilute sulfuric acid.

$$X = \frac{(V_1 - V_0) \times K \times 0{,}0014}{m} \times 100\%$$

V_0 - the volume of 0.1 mol/l sodium hydroxide solution used to titrate the excess 0.1 mol/l sulfuric acid solution in the sample.

RESULTS AND DISCUSSION

During the research, analyzing the germplasm of *Lathyrus sativus* L. species for chlorophyll a and b, total chlorophyll, and carotenoid content in plant leaves occurred at the bud formation, flowering, and ripening phases. Samples of the grass pea (*L. sativus* L.) species varied for the chlorophyll a amount during the bud formation phase (Table 1). In particular, the chlorophyll a contents were 17.49 mg/g and 17.43 mg/g in local cultivars Lalmikor and Polvon, respectively. The recorded highest value of chlorophyll a was in the exotic sample Bio 520 x 1330 (21.47 mg/g), while the lowest value for said trait was in the sample Ratan x 2125 (13.09 mg/g). The higher and lower levels of the chlorophyll pigment depend on the genetic makeup of the genotypes (Scheer, 1991).

In the grass pea samples at the flowering phase, the highest chlorophyll a amount was evident in the sample Ratan x IG 135481 (21.37 mg/g), and the lowest value resulted in the sample Bio (520 x Bio) x 273 (16.34 mg/g) (Table 1). According to chlorophyll a, the local grass pea cultivar Polvon showed a value of 20.51 mg/g, a little higher than the other local cultivar Lalmikor (21.34 mg/g). During the ripening phase, the chlorophyll a's higher value occurred from the sample Bio 520 x 1330 (11.92 ± 0.05 mg/g), with the lowest value exhibited by the exotic sample Bio (520 x Bio) x 273 (8.02 mg/g). In the local cultivars of grass peas, viz., Lalmikor and Polvon as control variants, the said trait varied from 8.72–10.19 mg/g. The higher and lower levels of the chlorophyll pigment depend on the genetic makeup of the genotypes (Rowan, 1989; Scheer, 1991).

In the studied grass pea landraces at the bud formation phase, the highest value of chlorophyll b was notable in Bio (520 x Bio) x

Table 1. Concentrations of chlorophylls a and b in the exotic collection and local cultivars of grass pea (*Lathyrus sativus* L.).

No.	Genotypes	Chlorophyll - a (mg/ml)			Chlorophyll - b (mg/ml)		
		Bud formation	Flowering	Ripening	Bud formation	Flowering	Ripening
		$\bar{X}_{\pm S}\bar{X}$	$\bar{X}_{\pm S}\bar{X}$	$\bar{X}_{\pm S}\bar{X}$	$\bar{X}_{\pm S}\bar{X}$	$\bar{X}_{\pm S}\bar{X}$	$\bar{X}_{\pm S}\bar{X}$
1	Bio (520 x Bio) x 273	14.48 ± 0.69	16.34 ± 0.13	8.02 ± 0.26	12.79 ± 0.70	12.55 ± 0.55	12.91 ± 0.12
2	Prateek x IG 140034	18.87 ± 0.19	19.06 ± 0.32	9.67 ± 0.05	10.16 ± 0.19	7.48 ± 0.39	6.09 ± 0.29
3	Ratan x 2125	13.09 ± 0.44	20.63 ± 0.18	8.98 ± 0.06	8.07 ± 0.34	16.51 ± 0.31	16.63 ± 0.05
4	Jabbouleh	15.24 ± 0.05	17.95 ± 0.04	10.42 ± 0.09	8.52 ± 0.12	12.93 ± 0.10	4.93 ± 0.24
5	1330 x 2125	18.00 ± 0.35	19.38 ± 0.34	7.66 ± 0.29	8.78 ± 0.35	12.11 ± 0.48	11.04 ± 0.46
6	Ratan x 1307	19.53 ± 0.28	19.97 ± 0.16	9.19 ± 0.06	10.72 ± 0.39	10.44 ± 0.55	15.63 ± 0.08
7	Ratan x IG 135481	19.57 ± 0.37	21.37 ± 0.11	9.04 ± 0.08	5.28 ± 0.22	10.34 ± 0.30	15.42 ± 0.05
8	Bio (520 x Bio) x 274	20.82 ± 0.61	20.92 ± 0.25	8.10 ± 0.27	10.75 ± 0.44	13.55 ± 0.23	17.21 ± 0.17
9	Prateek x IG 140035	18.85 ± 0.44	20.49 ± 0.21	9.09 ± 0.01	10.41 ± 0.27	10.05 ± 0.36	15.23 ± 0.02
10	Bio 520 x 1330	21.47 ± 0.71	17.79 ± 0.50	11.92 ± 0.05	7.83 ± 0.24	9.75 ± 0.39	11.30 ± 0.04
	Control genotypes						
11	Lalmikor	17.49 ± 0.21	21.34 ± 0.33	8.72 ± 0.25	9.89 ± 0.50	8.28 ± 0.42	12.42 ± 0.20
12	Polvon	17.43 ± 0.38	20.51 ± 0.03	10.19 ± 0.01	4.08 ± 0.22	11.29 ± 0.15	7.02 ± 0.23

Table 2. Carotenoid content and concentration of total pigments in the exotic collection and local cultivars of grass pea (*Lathyrus sativus* L.).

No.	Genotypes	Carotenoid content (mg/ml)			Concentration of total pigments (mg/ml)		
		Bud formation	Flowering	Ripening	Bud formation	Flowering	Ripening
		$\bar{X}_{\pm S}\bar{X}$	$\bar{X}_{\pm S}\bar{X}$	$\bar{X}_{\pm S}\bar{X}$	$\bar{X}_{\pm S}\bar{X}$	$\bar{X}_{\pm S}\bar{X}$	$\bar{X}_{\pm S}\bar{X}$
1	Bio (520 x Bio) x 273	2.47 ± 0.12	4.32 ± 0.17	2.73 ± 0.14	27.27 ± 0.37	28.89 ± 0.45	20.93 ± 0.28
2	Prateek x IG 140034	3.55 ± 0.11	6.02 ± 0.26	5.33 ± 0.03	29.03 ± 0.04	26.54 ± 0.08	15.77 ± 0.34
3	Ratan x 2125	3.19 ± 0.15	3.18 ± 0.12	1.63 ± 0.02	21.16 ± 0.29	37.14 ± 0.12	25.62 ± 0.09
4	Jabbouleh	3.52 ± 0.10	2.17 ± 0.02	2.09 ± 0.08	23.75 ± 0.08	30.88 ± 0.10	15.35 ± 0.15
5	1330 x 2125	4.44 ± 0.18	3.64 ± 0.15	4.04 ± 0.16	26.78 ± 0.16	31.49 ± 0.39	18.69 ± 0.18
6	Ratan x 1307	4.78 ± 0.23	4.74 ± 0.10	1.21 ± 0.04	30.24 ± 0.56	30.42 ± 0.43	24.82 ± 0.03
7	Ratan x IG 135481	5.57 ± 0.13	4.59 ± 0.21	1.28 ± 0.02	24.85 ± 0.15	31.71 ± 0.35	24.46 ± 0.03
8	Bio (520 x Bio) x 274	5.37 ± 0.23	3.12 ± 0.11	1.38 ± 0.10	31.56 ± 0.56	34.47 ± 0.16	25.31 ± 0.09
9	Prateek x IG 140035	4.58 ± 0.13	4.89 ± 0.25	1.81 ± 0.03	29.26 ± 0.17	30.55 ± 0.15	24.31 ± 0.01
10	Bio 520 x 1330	5.33 ± 0.11	4.92 ± 0.16	2.59 ± 0.06	29.3 ± 0.95	27.54 ± 0.71	23.22 ± 0.05
	Control genotypes						
11	Lalmikor	4.05 ± 0.11	5.32 ± 0.19	2.51 ± 0.10	27.38 ± 0.59	29.62 ± 0.16	21.14 ± 0.10
12	Polvon	4.96 ± 0.07	4.64 ± 0.10	4.04 ± 0.15	21.51 ± 0.17	31.79 ± 0.13	17.21 ± 0.24

273 (12.79 mg/g), while the lowest value resulted in the Ratan x IG 135481 sample (5.28 mg/g) (Table 1). In the control cultivars Lalmikor and Polvon, the chlorophyll b varied from 4.08 to 9.89 mg/g. At the flowering phase in the exotic accessions, the highest chlorophyll b was prominent in the Ratan x 2125 sample (16.51 mg/g), with the lowest value registered in the exotic sample Prateek x IG 140034 (7.48 mg/g). In the local cultivar Lalmikor, the value for the said trait was 8.28 mg/g. At the ripening phase, in foreign samples of grass peas, the highest chlorophyll b amount was evident in the sample Bio (520 x Bio) x 274 (17.21 mg/g), while the lowest value in this regard appeared in the sample Jabbouleh (4.93 mg/g). These pigments release molecular oxygen by absorbing the light rays necessary for photosynthesis and in protecting the chlorophyll molecule from strong light effects (Costache *et al.,* 2012; Nayek *et al.,* 2014).

At the bud formation phase in grass pea (*L. sativus* L.) landraces, the highest content of carotenoids emerged in the sample Ratan x IG 135481 (5.57 mg/g), while the lowest value prevailed in Bio (520 x Bio) x 273 (2.47 mg/g) (Table 2). At the flowering phase in the grass pea collection samples, the highest value (6.02 mg/g) was remarkable in the exotic sample Prateek x IG 140034, and the slightly lower value for carotenoids (2.17 mg/g) resulted in the sample Jabbouleh than other accessions. In the control genotypes, cultivar Polvon showed the lowest carotenoid value (4.64 mg/g). At the ripening phase of the grass pea samples, the highest carotenoid value (5.33 mg/g) emerged in the sample Prateek x IG 140034, with the lowest value of carotenoid recorded in the sample Ratan x 1307 (1.20 mg/g) compared to all other samples. In the local cultivar Lalmikor, the lowest indicator for carotenoid was at 2.51 mg/g.

The exotic landraces and local cultivars of grass peas at the bud formation phase had the total chlorophyll analyzed (Table 2). In particular, the total chlorophyll was highest in the sample Bio (520 x Bio) x 274 (31.56 mg/g), while the lowest value for the said variable occurred in the sample Ratan x 2125 (21.16 mg/g). In local cultivars of the local peas (control), the total chlorophyll content was highest in Lalmikor (27.38 mg/g) while lowest in cultivar Polvon (21.51 mg/g). Shavkiev *et al.* (2021) also reported similar findings in past studies of different crop plants.

Total chlorophyll content in the studied exotic collections and local cultivars at the flowering phase ranged from 26.54 to 34.47 mg/g (Table 2). According to this trait, the highest indicator prevailed in the sample Bio (520 x Bio) x 274 (34.47 mg/g), while the lowest value manifested in the sample Prateek x IG 140034 (26.54 mg/g). In the control cultivars of the local peas, the cultivar Polvon showed the highest value (31.79 mg/g), while the cultivar Lalmikor variety recorded the lowest indicator (29.62 mg/g). At the ripening phase in analyzing the total chlorophyll content of foreign grass pea samples and local cultivars, the highest value resulted in the accession Ratan x 2125 (25.62 mg/g), with the lowest value owned by the sample Jabbouleh (15.35 mg/g). In local cultivars of grass pea Polvon and Lalmikor, the total chlorophyll content varied from 17.21 to 21.14 mg/g. These pigments in total chlorophyll help release oxygen by absorbing the light rays during photosynthesis and protecting the chlorophyll from the intensive light effects (Costache *et al.,* 2012; Maisura *et al.,* 2014).

Determination of nitrogen and total protein content in the seeds of exotic and local genotypes of grass peas (*L. sativus* L.) also ensued (Table 3). Results of the analysis showed nonsignificant quantitative variations for nitrogen and total protein content in the seeds of the foreign collection and local cultivars. The total protein content varied from 17.1% to 26.3% in the sample seeds. The protein has a crucial role, performing more than 100 essential functions in the human body (Williams and Senders, 2000). However, in particular, the highest indicators for the total protein content were substantial in the exotic landraces of grass pea, i.e., Prateek x IG 140035 (26.3%), Bio (520 x Bio) x 273 (26.1%), Ratan x 1307 (26.0), while a low value for the said trait emerged in the local cultivar Lalmikor (17.1%). Past studies also reported that protein performs numerous

Table 3. Nitrogen and total protein content in the exotic collection and local cultivars of grass pea (*Lathyrus sativus* L.).

No.	Genotypes	Nitrogen content (%)	Total protein content (%)
1	Bio (520 x Bio) x 273	4.18	26.1
2	Prateek x IG 140034	4.06	25.4
3	Ratan x 2125	4.10	25.7
4	Jabbouleh	4.07	25.5
5	1330 x 2125	4.15	25.9
6	Ratan x 1307	4.16	26.0
7	Ratan x IG 135481	4.03	25.1
8	Bio 520 x Bio x 274	3.93	24.5
9	Prateek x IG 140035	4.21	26.3
10	Bio 520 x 1330	3.95	24.6
	Control genotypes		
11	Lalmikor	2.70	17.1
12	Polvon	3.18	19.88

viable functions in the human body (Polesskaya, 2007; Ganiev *et al.,* 2021).

It is a given that determining the concentration of macro- and microelements in plant tissues and cells is of theoretical and practical importance in understanding their response to environmental stress factors. Biochemical mechanisms of homeostasis life and autotrophic nutrition of the plant organism have led to authenticating considerable adaptation traits in its biological and ecological properties. Another characteristic of each plant species is that such crop plants can significantly modify their morphological and anatomical structures in response to biotic and abiotic stress factors (Omonov *et al.,* 2023).

Food from plant and animal products is the main source of microelements entering the human body. Drinking water provides only 1%–10% of the human body's daily need for trace elements, such as iodine, copper, zinc, manganese, and cobalt. In the biochemical composition of the seeds of exotic collection and local cultivars of grass peas (*L. sativus* L.), the 61 chemical elements were also distinctive for the first time (Table 4). Some recorded metals were significantly higher, and some elements appeared in large quantities in the local cultivars of the common pea. In particular, the seeds of some exotic samples contain higher chemical elements, viz., 1330 x 2125 (Li, B, Na, Cu, and As), Ratan x 2125 (Mg, K, Ca, Ti, Sr, and Ba), and the sample Prateek x IG 140034 (Al, Fe, and Ag) than other samples. Besides, the seeds of sample 1330 x 2125 contained more Li, B, Na, Cu, and As; Ratan x 2125 had more Mg, K, Ca, Ti, Sr, and Ba, and the sample Prateek x IG 140034 seeds had more Al, Fe, and Ag chemical elements than other samples of the grass pea. The analysis validated that in the seeds of grass pea samples, the macro-microelements meet freely. However, in the seeds of grass pea samples, the quantitative index of macro-microelements indicates that the nutritional value is high. Past studies also reported biochemical elements, nutritional values, and their importance in grass pea and other crop plants (Kudryashova, 2000).

CONCLUSIONS

The spectrophotometric analysis of chlorophyll a and b, total chlorophyll, and carotenoid contents in the leaves of exotic collection and local cultivars of grass pea (*L. sativus* L.) species revealed that at the bud formation phase, the sample Bio 520 x 1330 showed the highest content of chlorophyll a (21.47 mg/ml), while Bio (520 x Bio) x 273 had high chlorophyll b content (12.79 mg/ml). In the sample, Ratan x IG 135481, the carotenoid amount was 5.57 mg/ml, while in Ratan x 1307 the total pigments were high (30.24 mg/ml). In the flowering phase, the sample Ratan x IG 135481 has a chlorophyll a content of 21.37 mg/ml, while chlorophyll-b content in

Table 4. Chemical element content in seeds of the exotic collection and local cultivars of grass pea (*Lathyrus sativus* L.) (mg/gb, g/t).

No	Genotypes	Li	Be	B*	Na*	Mg*	Al*	P*	K*	Ca*	Sc	Ti*	V	Cr	Mn	Fe*	Co
Measurement range elements		0.05-4000	0.05-4000	0.10-4000	0.004-11%	0.004-11%	0.002-20%	1.0-4000	0.008-30%	0.005-28%	0.10-4000	0.0006-9%	0.10-4000	1.0-4000	0.002-10%	0.006-30%	0.10-4000
1	Bio 520 x Bio x 273	0.790	<0.05	6.30	150	1400	17.0	5200	10000	1300	0.028	14.0	0.068	<1.0	13.0	51.0	0.110
2	Pratek x IG 140034	3.10	<0.05	15.0	420	3200	83.0	9000	20000	2800	0.059	19.0	0.096	<1.0	33.0	99.0	0.110
3	Ratan x 2125	2.10	<0.05	13.0	610	3900	26.0	12000	22000	4500	0.068	23.0	0.110	1.10	30.0	100	0.240
4	Jobbouleh	0.960	<0.05	8.30	200	2500	40.0	6500	15000	2100	0.081	14.0	0.110	<1.0	32.0	72.0	0.100
5	1330 x 2125	6.40	<0.05	13.0	470	2900	34.0	8300	19000	2100	0.082	17.0	0.180	<1.0	27.0	110	0.190
6	Ratan x 1307	1.70	<0.05	9.60	240	2200	10.0	7500	15000	2200	0.042	14.0	0.064	<1.0	30.0	73.0	0.320
7	Ratan IG 135481	0.880	<0.05	12.0	300	2800	14.0	9800	20000	2100	0.037	18.0	0.070	1.10	31.0	82.0	0.190
8	Bio 520 x Bio x 274	1.80	<0.05	8.50	190	1600	12.0	6300	13000	1900	0.046	12.0	0.055	<1.0	17.0	56.0	0.140
9	Pratek x dg 140035	1.30	<0.05	11.0	370	2800	18.0	9500	19000	2100	0.046	18.0	0.092	<1.0	19.0	88.0	0.140
10	Bio 520 x 1330	0.850	<0.05	9.00	180	1800	8.90	7200	12000	2200	0.045	15.0	0.061	<1.0	17.0	65.0	0.110
11	Lalmikor	3.50	<0.05	15.0	280	3200	49.0	8400	21000	2600	0.047	17.0	0.092	<1.0	58.0	95.0	0.150
12	Polvon	2.30	<0.05	7.10	230	2000	27.0	6200	14000	4300	0.046	13.0	0.069	<1.0	13.0	93.0	0.081

		Ni	Cu	Zn	Ga	As	Se	Rb	Sr	Y	Zr*	Nb	Mo	Ag	Cd	In
		0.05-4000	0.05-4000	0.10-4000	0.004-11%	0.004-11%	0.002-20%	1.0-4000	0.008-30%	0.005-28%	0.10-4000	0.0006-9%	0.10-4000	1.0-4000	0.002-10%	0.006-30%
1	Bio 520 x Bio x 273	1.00	7.20	26.0	0.023	0.910	0.450	5.90	6.10	<0.10	0.110	0.008	10.0	0.740	0.032	<0.005
2	Pratek x IG 140034	2.10	13.0	44.0	0.064	0.440	0.800	10.0	9.90	<0.10	0.320	0.012	14.0	42.0	0.040	<0.005
3	Ratan x 2125	2.50	14.0	48.0	0.089	1.50	0.750	9.50	16.0	<0.10	0.059	0.008	18.0	0.078	0.061	<0.005
4	Jobbouleh	1.10	11.0	41.0	0.031	0.670	0.670	8.50	8.40	<0.10	0.068	0.010	20.0	0.050	0.058	<0.005
5	1330 x 2125	1.90	15.0	37.0	0.071	1.60	0.710	8.40	7.90	<0.10	0.080	0.008	15.0	0.085	0.046	<0.005
6	Ratan x 1307	2.10	9.80	36.0	0.046	0.390	0.540	7.40	9.20	<0.10	0.087	0.006	15.0	0.010	0.040	<0.005
7	Ratan IG 135481	2.00	13.0	47.0	0.043	0.210	0.700	11.0	8.20	<0.10	0.039	0.005	24.0	0.012	0.075	<0.005
8	Bio 520 x Bio x 274	1.30	8.80	29.0	0.036	0.280	0.540	5.80	7.90	<0.10	0.085	0.019	9.90	0.730	0.051	<0.005
9	Pratek x IG 140035	1.70	18.0	50.0	0.041	0.750	0.830	10.0	7.50	<0.10	0.031	0.004	14.0	0.190	0.039	<0.005
10	Bio 520 x 1330	1.60	9.20	33.0	0.046	0.360	0.510	7.10	10.0	<0.10	0.087	0.043	12.0	0.083	0.027	<0.005
11	Polvon	1.40	13.0	37.0	0.071	0.610	0.630	5.40	17.0	<0.10	0.060	0.004	18.0	0.068	0.052	<0.005
12	Lalmikor	1.50	12.0	47.0	0.031	0.640	0.720	11.0	9.20	<0.10	0.080	0.007	16.0	70.0	0.030	<0.005

Table 4. (cont'd).

No.	Genotypes	Sn	Sb	Te	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho
Measurement range elements		0.05-4000	0.05-4000	0.10-4000	0.004-11%	0.004-11%	0.002-20%	1.0-4000	0.008-30%	0.005-28%	0.10-4000	0.0006-9%	0.10-4000	1.0-4000	0.002-10%	0.006-30%
1	Bio 520 x Bio x 273	<0.10	<0.10	<0.30	0.023	3.80	0.011	0.028	<0.01	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2	Pratek x IG 140034	<0.10	<0.10	<0.30	0.051	5.70	0.018	0.034	<0.01	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
3	Ratan x 2125	<0.10	<0.10	<0.30	0.100	8.50	0.015	0.031	<0.01	0.013	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
4	Jobbouleh	<0.10	<0.10	<0.30	0.024	3.20	0.027	0.040	<0.01	0.019	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
5	1330 x 2125	<0.10	<0.10	<0.30	0.097	5.70	0.080	0.220	0.019	0.081	0.013	<0.01	<0.01	<0.01	<0.01	<0.01
6	Ratan x 1307	<0.10	<0.10	<0.30	0.023	4.90	<0.01	0.016	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
7	Ratan IG 135481	<0.10	<0.10	<0.30	0.041	4.10	<0.01	0.024	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
8	Bio 520 x Bio x 274	<0.10	<0.10	<0.30	0.018	4.60	<0.01	0.019	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
9	Pratek x IG 140035	<0.10	<0.10	<0.30	0.050	4.10	0.011	0.027	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
10	Bio 520 x 1330	<0.10	<0.10	<0.30	0.018	5.50	<0.01	0.017	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
11	Lalmikor	<0.10	<0.10	<0.30	0.027	2.80	0.026	0.049	<0.01	0.019	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
12	Polvon	<0.10	<0.10	<0.30	0.017	8.40	0.020	0.036	<0.01	0.011	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		Er	Tm	Yb	Lu	Hf	Ta	W	Re	Pt*	Au*	Tl	Pb	Bi	Th	U
		0.05-4000	005-4000	0.10-4000	0.004-11%	0.004-11%	0.002-20%	1.0-4000	0.008-30%	0.005-28%	0.10-4000	0.0006-9%	0.10-4000	1.0-4000	0.002-10%	0.006-30%
1	Bio 520 x Bio x 273	<0.01	<0.01	<0.01	<0.01	<0.05	<0.04	<0.08	<0.01	<0.05	<0.05	<0.05	0.620	<0.01	<0.01	0.010
2	Pratek x IG 140034	<0.01	<0.01	<0.01	<0.01	<0.05	<0.04	<0.08	<0.01	<0.05	<0.05	<0.05	0.700	<0.01	<0.01	0.013
3	Ratan x 2125	<0.01	<0.01	<0.01	<0.01	<0.05	<0.04	<0.08	<0.01	<0.05	<0.05	<0.05	0.600	<0.01	<0.01	0.013
4	Jobbouleh	<0.01	<0.01	<0.01	<0.01	<0.05	<0.04	<0.08	<0.01	<0.05	<0.05	<0.05	0.770	<0.01	0.012	0.010
5	1330 x 2125	<0.01	<0.01	<0.01	<0.01	<0.05	<0.04	<0.08	<0.01	<0.05	<0.05	<0.05	0.770	<0.01	0.049	0.018
6	Ratan x 1307	<0.01	<0.01	<0.01	<0.01	<0.05	<0.04	<0.08	<0.01	<0.05	<0.05	<0.05	0.230	<0.01	<0.01	<0.01
7	Ratan IG 135481	<0.01	<0.01	<0.01	<0.01	<0.05	<0.04	<0.08	<0.01	<0.05	<0.05	<0.05	0.260	<0.01	<0.01	<0.01
8	Bio 520 x Bio x 274	<0.01	<0.01	<0.01	<0.01	<0.05	<0.04	<0.08	<0.01	<0.05	<0.05	<0.05	0.290	<0.01	0.029	0.011
9	Pratek x IG 140035	<0.01	<0.01	<0.01	<0.01	<0.05	<0.04	<0.08	<0.01	<0.05	<0.05	<0.05	0.530	<0.01	<0.01	<0.01
10	Bio 520 x 1330	<0.01	<0.01	<0.01	<0.01	<0.05	<0.04	<0.08	<0.01	<0.05	<0.05	<0.05	0.200	<0.01	<0.01	<0.01
11	Lalmikor	<0.01	<0.01	<0.01	<0.01	<0.05	<0.04	<0.08	<0.01	<0.05	<0.05	<0.05	0.380	<0.01	0.011	0.010
12	Polvon	<0.01	<0.01	<0.01	<0.01	<0.05	<0.04	<0.08	<0.01	<0.05	<0.05	<0.05	0.340	<0.01	0.006	0.010

Ratan x 2125 was 16.51 mg/ml, and the Prateek x IG 140034 had the carotenoids content of 6.02 mg/ml. In the sample, Ratan x 2125, the total pigments amounted to 37.14 mg/ml. In the ripening phase, in the sample Bio 520 x 1330, chlorophyll a was 11.92 mg/ml, while in Ratan x 2125, chlorophyll b was 16.63 mg/ml. In the sample 1330 x 2125 and local cultivar Lalmikor, the carotenoid content was 4.04 mg/ml, while in Ratan x 2125 the total pigment content was high (25.62 mg/ml).

ACKNOWLEDGMENTS

Verdana Size 8. The authors are grateful to the Faculty of Agriculture for providing the facilities for DNA analysis and funding support for this research.

REFERENCES

Amanov BK, Muminov K, Samanov S, Arslanov D, Tursunova N (2022). Cotton introgressive lines assessment through seed cotton yield and fiber quality characteristics. *SABRAO J. Breed. Genet*. 54(2): 321–330.

Amanov BK, Abdiev F, Muminov K, Shavkiev J, Mamedova F (2020). Valuable economic indicators among hybrids of Peruvian cotton genotypes. *Plant Cell Biotechnol. Mol. Biol.* 21(67-68): 35–46.

Baboev S, Muminjanov H, Turakulov K, Buranov A, Shepelev S, Morgounov A (2021). Diversity and sustainability of wheat landraces grown in Uzbekistan. *Agron. Sus. Dev.* 41(3): 34.

Baboev SK, Buranov AK, Bozorov TA, Adylov BS, Morgunov AI, Muminzhonov KH (2017). Biological and agronomical assessment of wheat landraces cultivated in mountain areas of Uzbekistan. *Sel' skokhozyaistvennaya Biol.* 52(3): 553–560.

Beknazarov BO (2009). Physiology of Plants. "Aloqachi" Publishing House. Tashkent. pp. 536.

Buronov A, Amanov B, Muminov Kh, Tursunova N, Umirova L (2023). Polymorphism and inheritance of gliadin proteins in wheat landraces of Uzbekistan. *SABRAO J. Breed. Genet.* 55(3): 671–680.

Control Methods (2004). Chemical Factors. Guide to methods of quality control and safety of biologically active food additives. Guide R 4.1.1672-03. M.: Federal Center for State Sanitary and Epidemiological Supervision of the Ministry of Health of Russia.

Costache MA, Campeanu G, Neata G (2012). Studies concerning the extraction of chlorophyll and total carotenoids from vegetables. *Romanian Biotechnol. Letters* 17(5): 7702–7708.

Fedichkina NV (2000). Fortification of food products with minerals. *Meat Industry* 2: 21–22.

Ganiev SE, Muminov KM, Bakiev DT, Kurbanov IG (2021). Effectiveness of some elements of agro technics to increase the productivity of saline glacial soils and cotton yields. *Plant Cell Biotechnol. Mol. Biol.* 22(9-10): 105–110.

https://www.icarda.org/research/climate-smart-crops/grass-pea.

Kudryashova AA (2000). The influence of nutrition on human health. *Food Industry*. 2: 67.

Lichtenthaler HK, Wellburn AR (1983). Determinations of total carotenoids and chlorophylls a and b of leaf extracts in different solvents. *Biochem. Soc.Trans.* 11: 591–592.

Loggini B, Scartazza A, Brugnoli E, Navari-Izzo F (1999). Antioxidative defense system pigment composition and photosynthetic efficiency in two wheat cultivars subjected to drought. *Plant Physiol*. 119: 1091–1100.

Maisura M, Achmad Ch, Iskandar L, Ahmad J, Hiroshi E (2014). Some physiological character responses of rice under drought conditions in a paddy system. *ISSAAS. J.* 20(1): 104–114.

Muminov K, Amanov B, Buronov A, Tursunova N, Umirova L (2023). Analysis of yield and fiber quality traits in intraspecific and interspecific hybrids of cotton. *SABRAO J. Breed. Genet*. 55(2): 453–462.

Nayek S, Choudhury IH, Jaishee N, Roy S (2014). Spectrophotometric analysis of chlorophylls and carotenoids from commonly grown fern species by using various extracting solvents. *Int. Sci. Cong. J. Chem. Sci*. pp. 63–69.

Omonov O, Amanov B, Muminov K, Buronov A,Tursunova N (2023). Physiological and biochemical composition of sunflower (*Helianthus annuus* L.). *SABRAO J. Breed. Genet*. 55(6): 2159–2167.

Polesskaya OG (2007). Plant Cell and Active Forms of Oxygen. Moscow. pp. 140.

Qulmamatova DE, Baboev SK, Buronov AK (2022). Genetic variability and inheritance pattern of yield components through diallel analysis in spring wheat. *SABRAO J. Breed. Genet*. 54(1): 21–29.

Rowan KS (1989). Photosynthetic Pigments of Algae. Cambridge University Press, Cambridge.

Scheer H (1991). Chlorophylls. CRC Press Boca Raton, Ann Arbor, Boston, Landon. pp. 31–57.

Shatnyuk LN, Yudina AV (2004). Vitamin and mineral fortifiers for bakery and flour confectionery products. *Food Industry* 6: 94–97.

Shavkiev J, Azimov A, Nabiev S, Khamdullaev Sh, Amanov B, Kholikova M, Matniyazova H, Yuldashov U (2021). Comparative performance and genetic attributes of upland cotton genotypes for yield-related traits under optimal and deficit irrigation conditions. *SABRAO J. Breed. Genet.* 53(2): 157–171.

Sytnikov DM (2012). Biotechnology of microorganisms, nitrogen fixers and prospects for the use of drugs based on them. *Biotechnology* 5(4): 34–44.

Williams K, Sanders T (2000). The relationship between health and the consumption of protein, carbohydrates and fat. *Nutr. Issues* 3: 54–56.

Wright SW, Jeffrey SW, Mantoura FRC (1997). Evaluation of methods and solvents for pigment analysis. In: Phytoplankton Pigments in Oceanography: Guidelines to Modern Methods. UNESCO Publ., Paris. pp. 261–282.