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PHYSIOLOGICAL AND BIOCHEMICAL CHARACTERISTICS OF THE BROAD BEAN (*VICIA FABA* L.)

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SUMMARY

The physiological and biochemical parameters' evaluation of the broad bean (*Vicia faba* L.) exotic genotypes obtained from the ICARDA (International Center for Agricultural Research in the Dry Areas) became this study's aim. Particularly, when analyzing the plant leaf spectrophotometrically, the total water content in the plant leaf ranged from 74.9% to 88.9%**.** In the combing phase of broad bean, the leaf chlorophyll a was highest in the genotypes G-15 and G-29 (2.07 mg/g), chlorophyll b in G-29 was 1.27 mg/g, and carotenoid content in the genotype Bakla UNV-851 was 0.95 mg/g, while G-35 was higher for total pigment content (3.14 mg/g). At the flowering phase, the superior value recorded for chlorophyll a was in the genotype Bakla UNV-851 (2.10 mg/g), chlorophyll b was in G-35 (1.20 mg/g), carotenoid content was in Bakla UNV-851 (0.96 mg/g), and total pigment was in the genotype G-26 (3.22 mg/g). For chlorophyll a content, the supreme value resulted in the genotype Bakla UNV-851 (2.12 mg/g); chlorophyll b emerged to be higher in the genotype G-1 (1.47 mg/g), the carotenoid content was greater in Bakla UNV-851 (0.90 mg/g), and the total pigments were highest in the genotype Bakla UNV-852 (3.43 mg/g).

Keywords: Broad bean (*V. faba* L.), growth phases, photosynthetic

Key findings: The water deficiency in different growth phases of plants leads to disruption of physiological processes. The highest total water content resulted in the genotype G-22, while it was slightly lower in the G-50. The highest transpiration rate was evident in the genotype Bakla UNV-851 and the lowest in the genotype G-26.

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INTRODUCTION

Among beans, the broad bean (*Vicia faba* L.) is particularly important due to its exceptionally high protein content and quality forage. The said plant is native to the Mediterranean region, with its cultivation in Palestine since the first millennium BC. The broad bean has become a sacred plant in ancient Egypt and an object of high reverence in ancient Greece. Roasted faba bean powder serves as an ancient spice along with garlic and ginger in various dishes in Bulgaria, Macedonia, Ukraine, Romania, and Moldova. The global area under *Vicia faba* is 2,511,813 ha, with a production of 4,923,154 tons/year and an average annual yield of 1.960 kg/ha (FAO, 2018). China is the leading producer of *Vicia faba*, accounting for 36.7% of global production, followed by Ethiopia (20.1%), the UK (8.2%), and Australia (7.7%).

Along with chlorophyll, plants also contain other pigments called carotenoids. These pigments absorb light rays crucial for photosynthesis and releasing molecular oxygen and protecting the chlorophyll molecule (Costache *et al.,* 2012; Omonov *et al.,* 2023; Kodirova *et al.*, 2024). Photosynthetic pigments are substances with diverse chemical structures, as well as porphyrin pigments, chlorophyll a, b, and c and carotenoids (Maisura *et al.,* 2014). In chlorophyll assessment, ethanol is a safer solvent than acetone and methanol; however, its use is seldom in chlorophyll analysis, although it has both a and b equivalence. For its limited use, the several causes 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, considerably safe, practical, and economic advantages prevail in using ethanol as a solvent for chlorophyll extraction and analysis (Wright *et al.,* 1997).

Plants begin to shed their old leaves to maintain a moderate amount of water content in their leaves. The management of leaves management helps to improve adaptability to long-term environmental variations and water shortage (Maleki *et al.,* 2013, Buronov and Xamroev, 2022). During water stress conditions, the leaf shedding mainly occurs to increase the sensitivity of plants (Kabiri *et al.,* 2014; Muminov *et al.,* 2023). Transpiration is the evaporation of water through the leaves, with the moisture vaporized between leaf cells, diffused through the stomata, and released into the external environment. The transpiration rate depends upon the number and size of water-conducting tubes, the number of stomata, the thickness of the cuticle layer, the state of protoplasmic colloids, and the concentration of cell sap. Water moves up in the plant stem, resulting from transpiration, where a suction force appears in the leaf cell, which absorbs the water from the root hairs and transports it to the leaves (Ivanov *et al.,* 1950). In preventing water loss, it is necessary to reduce the evaporation through transpiration (Shekari, 2000).

Protein discovery happened at the end of the 19th century, and the word 'protein' came from the Greek word 'proeios,' meaning 'first important.' Since the discovery of protein, scientists believe that it is essential for the body, and its deficiency can lead to various diseases. In vital processes of the human body, the protein’s role is crucial. If considering the body without water, one can conclude that half of the body mass consisted of protein. Protein performs more than a hundred important functions in the human body (Polesskaya, 2007).

Faba beans have the highest protein content and a well-balanced amino acid profile, with low levels of methionine and cysteine (Raikos *et al.,* 2014), and are particularly rich in lysine (Hood-Niefer *et al.*, 2012). Faba bean seeds contain 17.6%–34.5% protein, as well as anti-nutritional compounds, such as saponins, lectins, tannins, vicine, and phytic acid (Hendawey and Younes, 2013; Multari *et al.,* 2015). Reports on faba beans have stated these to have the highest potential as a functional food, as they provide macro, micro, and non-nutrient phytochemicals. Brauckmann and Latté (2010) reported that faba beans contain the L-3,4-dihydroxyphenylalanine (L-DOPA), a precursor of the catecholamine neurotransmitter, and a drug used in the treatment of Parkinson's disease. Based on the foregoing, the presented study aimed at evaluating the physiological and biochemical parameters of the broad bean (*Vicia faba* L.) exotic genotypes obtained from the International Center for Agricultural Research in the Dry Areas (ICARDA).

MATERIALS AND METHODS

The pertinent research commenced on the broad bean (*V. faba* L.) in the experimental field at the Chirchik State Pedagogical University, Tashkent, Uzbekistan. The research object was the broad bean germplasm containing 18 exotic genotypes (entries), i.e., G-1, G-15, G-19, G-22, G-26, G-29, G-35, G-40, G-41, G-46, G-50, G-55, G-56, G-57, G-59, G-62, Bakla UNV-851, and Bakla UNV-852 obtained from ICARDA.

The amounts of chlorophyll a and b and carotenoids in leaves of different genotypes acquired detection. The said process comprised samples from 3–4 leaves, counting from the plant's growing point under field conditions. Upon filling 50 mg of leaf specimen of each broad bean genotype in a test tube, each leaf sample incurred 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, b) and carotenoid content in the resulting extract's determination used an Agilent Cary60 UV-Vis spectrophotometer at 664, 649, and 470 nm. For calculating the amounts of chlorophyll a and b and carotenoids in plant leaves, the equations used were as follows (Nayek *et al.,* 2014):

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

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

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

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

In the studies, determining the important physiological variables of water exchange in an exotic collection of broad beans used the methodology of the following past studies: total water content in leaves (Tretyakov *et al.,* 1990); water retention capacity of leaves (Kushnirenko *et al.,* 1970); and transpiration rate (Ivanov *et al.,* 1950).

Protein content determination

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

$$\text{Nitrogenous organic matter} + H_2SO_4 \rightarrow (NH_4)_2SO_4 + CO_2 + H_2O$$

Nitrogenous organic matter

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

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

The ammonium hydroxide formed from the 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 broad bean genotypes 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).

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

$$X = \frac{(\mathbf{V_1} - \mathbf{V_0}) * \mathbf{K} * \mathbf{0.0014}}{m} * 100\%$$

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 each sample.

RESULTS AND DISCUSSION

In the presented study, an analysis of the leaf samples of exotic genotypes of broad beans (*V. faba* L.) was successful. Parameters included total water content, water retention properties, transpiration rate, chlorophyll a and b, total chlorophyll, and carotenoid content during the budding, flowering, and ripening phases, and the total protein content in the seed composition.

By analyzing the total water content of the leaves of exotic broad bean genotypes, nonsignificant differences resulted in some specimens (Table 1). The average total water content of the broad bean genotypes was 74.9%–88.9%. However, the highest total water content appeared in the genotype G-22 (88.9%) with a coefficient of variation (2.7%), while a slightly lower value for the said parameter emerged in the genotype G-50 (74.9%). In the remaining bean genotype samples, there existed nonsignificant differences (Table 1).

It is a well-known fact that water-holding capacity (WHC) of the leaves is one of the most critical traits for studying the physiological processes in crop plants. In the latest research, the water-holding capacity of plant leaves also sustained scrutiny. Notably, the higher the numerical value obtained, the lower the BSUX (bioclimatic stress index), and the lower the value, the higher the BSUX. This indicator shows how much water has reached evaporation after two hours compared with the initial amount of water found in the leaves.

Table 1. Characteristics of water exchange in the leaves and total protein content in the exotic genotypes of *Vicia faba.*

No.	Genotypes	Characteristics of water exchange in leaves			Total protein content (%)
		Total water content (%)	Water retention capacity (%)	Transpiration rate (mg/g hour)	
		$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$	$\bar{x} \pm S\bar{x}$
1	G-1	86.2 ± 2.4	12.3 ± 0.7	98.6 ± 3.5	28.89 ± 0.70
2	G-15	85.7 ± 2.6	15.9 ± 2.2	114.3 ± 1.6	28.70 ± 0.70
3	G-19	87.9 ± 0.7	34.7 ± 3.3	111.1 ± 1.7	30.86 ± 0.87
4	G-22	88.9 ± 0.7	25.0 ± 1.0	153.9 ± 2.2	26.35 ± 0.26
5	G-26	85.6 ± 0.8	22.7 ± 4.8	63.1 ± 3.8	25.54 ± 0.35
6	G-29	85.7 ± 0.7	21.8 ± 2.4	88.4 ± 4.8	24.94 ± 0.36
7	G-35	86.6 ± 1.3	13.1 ± 1.4	115.3 ± 1.3	30.14 ± 0.54
8	G-40	85.4 ± 0.6	31.8 ± 4.7	136.0 ± 4.1	29.42 ± 0.42
9	G-41	86.9 ± 0.8	19.4 ± 4.2	140.6 ± 3.7	29.26 ± 1.00
10	G-46	85.1 ± 0.8	28.6 ± 3.4	96.7 ± 1.9	27.66 ± 0.41
11	G-50	74.9 ± 7.0	21.4 ± 3.8	101.8 ± 3.1	27.70 ± 0.70
12	G-55	87.6 ± 0.6	23.1 ± 2.3	126.5 ± 3.4	28.29 ± 0.68
13	G-56	86.8 ± 0.7	26.7 ± 4.0	116.5 ± 1.8	28.32 ± 0.62
14	G-57	87.0 ± 1.1	23.0 ± 2.3	99.6 ± 3.7	29.38 ± 0.65
15	G-59	85.3 ± 0.3	25.6 ± 2.4	102.6 ± 2.6	26.17 ± 0.74
16	G-62	82.7 ± 0.5	18.9 ± 1.9	106.4 ± 3.2	26.38 ± 0.73
17	Bakla UNV-851	85.8 ± 0.4	33.1 ± 3.4	214.2 ± 4.6	27.98 ± 0.54
18	Bakla UNV-852	87.9 ± 1.4	19.0 ± 1.7	79.9 ± 4.5	26.03 ± 0.58

According to study results, the water retention properties of leaves, as determined after two hours, gave the highest BSUX index (34.7%), recorded in the broad bean genotype G-19, with a corresponding coefficient of variation of 16.6%. Meanwhile, the low BSUX index (12.3%) was evident in the G-1 sample, with a coefficient of variation of 10.7%. Organic compounds formed through photosynthesis are the main life source of the living organisms. In photosynthesis, the oxygen released into the atmosphere is crucial for the respiration of living organisms (Loggini *et al.,* 1999*;* Lu and Zhang, 1999; Beknazarov, 2009).

In the research, the transpiration rate study of the broad bean genotypes continued during the flowering to harvest period. Overall, the transpiration rate of leaves of exotic broad bean genotypes ranged from 63.1 to 214.2 mg/g.h (Table 1). The highest transpiration rate resulted in the leaf sample of genotype Bakla UNV-851 (214.2 mg/g.h), corresponding to a coefficient of variation of 3.7%, while the lowest transpiration rate manifested in the genotype G-26 (63.1 mg/g.h), with a coefficient of variation of 10.5%. The remaining genotypes differed significantly for their transpiration rates. The high and low levels of the chlorophyll pigment depended on the genetic makeup of the crop genotypes (Singh *et al.*, 2013; Fayziev *et al.,* 2020; Francesca *et al.,* 2023).

The total protein content in the seeds of the foreign collection of broad beans also reached detection. The protein analysis revealed nonsignificant quantitative variations in the content of nitrogen, including total protein in the seeds of exotic genotypes and local cultivars. On average, the total protein content of the seeds ranged from 24.94% to 30.86%. In particular, the highest total protein content was prominent in the genotypes G-35 (30.14%) and G-19 (30.86%), while the lowest was evident in the genotype G-29 (24.94%). Faba beans have exceptionally high protein content and a well-balanced amino acid profile, with low levels of methionine and cysteine (Raikos *et al.,* 2014); however, they are particularly rich in lysine content (Hood-Niefer *et al.,* 2012).

In the *Vicia faba* bean genotypes, the amount of chlorophyll a varies during the combing phase. The highest value of chlorophyll a (2.07 mg/g) appeared in the broad bean genotypes G-15 and G-29, while the lowest value (1.52 mg/g) was notable in the genotype G-26. In broad bean samples, at the flowering phase, the topmost chlorophyll-a content (2.27 mg/g) was existent in the exotic genotype G-29, while the lowermost chlorophyll-a content emerged in the genotype G-40 (1.70 mg/g). The broad bean genotypes at the ripening phase revealed the maximum chlorophyll-a content in the genotype Bakla UNV-851 (2.12 mg/g), while the minimum chlorophyll-a content surfaced in the genotype G-50 (1.41 mg/g) (Table 2).

The results further revealed the highest chlorophyll-b content was abundant in the genotype G-26 (1.27 mg/g), and the lowest value appeared in the genotype G-62 (0.49 mg/g) at the combing phase. At the flowering phase, the premier chlorophyll-b content materialized in the genotype G-26 (1.20 mg/g), while the lowest value was apparently in the G-29 (0.55 mg/g). During the ripening phase, the optimum chlorophyll-b content thrived in the genotype G-1 (1.47 mg/g), and the minimum value for the said trait resulted in the genotype G-40 (0.45 mg/g). The ratio of chlorophyll a to chlorophyll b in the crop plants served as an indicator of their response to different shaded conditions (Porra, 1991; Nayek *et al.,* 2014).

Among the exotic *Vicia faba* bean genotypes at the combing phase, the highest carotenoid content resulted in the genotype Bakla UNV-851 (0.95 mg/g), while the lowest value was evidently in the genotype G-1 (0.58 mg/g). At the flowering phase, the genotype Bakla UNV-852 had the most carotenoid content (0.96 mg/g), while the G-62 had a slightly lower value (0.75 mg/g) than other genotypes. During the ripening phase, the genotype Bakla UNV-852 had a superior carotenoid content (0.90 mg/g), while the three broad bean genotypes, G-15, G-50, and G-57, showed slightly lower values (0.67 mg/g) (Table 3) than the rest. Along with chlorophyll pigments, the plants also contain red, yellow, and deep yellow pigments called

Table 2. Chlorophyll a and b concentrations in the exotic genotypes of *Vicia faba.*

No.	Genotypes	Chlorophyll - a (mg/g)			Chlorophyll - b (mg/g)		
		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	G-1	1.58 ± 0.03	1.76 ± 0.01	1.51 ± 0.02	0.73 ± 0.01	0.61 ± 0.02	1.47 ± 0.04
2	G-15	2.07 ± 0.044	2.09 ± 0.03	1.73 ± 0.05	0.70 ± 0.02	0.92 ± 0.03	0.95 ± 0.03
3	G-19	1.58 ± 0.015	1.84 ± 0.04	1.51 ± 0.01	0.97 ± 0.01	0.80 ± 0.04	0.78 ± 0.04
4	G-22	1.86 ± 0.04	2.01 ± 0.02	1.91 ± 0.07	0.88 ± 0.03	0.69 ± 0.02	096 ± 0.05
5	G-26	1.52 ± 0.004	2.01 ± 0.02	1.93 ± 0.11	1.27 ± 0.01	1.20 ± 0.02	0.50 ± 0.02
6	G-29	2.07 ± 0.013	2.27 ± 0.03	1.75 ± 0.02	0.89 ± 0.03	0.55 ± 0.01	0.64 ± 0.03
7	G-35	2.00 ± 0.03	1.87 ± 0.03	1.46 ± 0.06	1.06 ± 0.05	1.10 ± 0.02	0.89 ± 0.04
8	G-40	1.59 ± 0.007	1.70 ± 0.01	1.79 ± 0.04	0.97 ± 0.01	1.14 ± 0.005	0.45 ± 0.02
9	G-41	1.62 ± 0.02	1.71 ± 0.007	1.57 ± 0.04	0.72 ± 0.04	0.88 ± 0.01	1.23 ± 0.03
10	G-46	1.73 ± 0.007	1.78 ± 0.04	1.82 ± 0.04	0.91 ± 0.01	0.84 ± 0.03	0.79 ± 002
11	G-50	1.62 ± 0.01	1.78 ± 0.04	1.41 ± 0.05	0.79 ± 0.03	0.83 ± 0.03	1.05 ± 0.05
12	G-55	1.71 ± 0.01	2.01 ± 0.007	1.82 ± 0.07	0.89 ± 0.01	0.62 ± 0.01	1.37 ± 0.07
13	G-56	1.86 ± 0.05	1.75 ± 0.09	1.89 ± 0.02	1.05 ± 0.06	1.13 ± 0.02	0.53 ± 0.03
14	G-57	1.63 ± 0.006	1.81 ± 0.01	1.71 ± 0.01	0.73 ± 0.02	1.03 ± 0.02	0.91 ± 0.02
15	G-59	1.91 ± 0.03	1.84 ± 0.01	1.80 ± 0.02	0.68 ± 0.04	0.80 ± 0.01	0.80 ± 0.04
16	G-62	2.03 ± 0.01	1.83 ± 0.05	1.74 ± 0.04	0.49 ± 0.04	1.16 ± 0.05	1.11 ± 0.05
17	Bakla UNV-851	1.81 ± 0.004	2.10 ± 0.03	2.12 ± 0.05	1.06 ± 0.01	0.90 ± 0.01	1.02 ± 0.05
18	Bakla UNV-852	1.98 ± 0.005	2.07 ± 0.03	2.10 ± 0.08	0.79 ± 0.006	0.72 ± 0.01	1.33 ± 0.06

carotenoids. These pigments absorb the light rays necessary for photosynthesis and release molecular oxygen, as well as to protect the chlorophyll molecule from strong light (Costache *et al.,* 2012; Omonov *et al.,* 2023; Muminov *et al.,* 2025).

In the combing phase of *Vicia faba* bean genotypes, the maximum value of total pigment concentration succeeded determination in the genotype G-35 (3.14 mg/g), with the lowest value determined in the genotype G-1 (2.32 mg/g). At the flowering phase, the highest total pigment concentration appeared in the sample G-26 (3.22 mg/g), while a slightly lower concentration was evident in the genotype G-1 (2.37 mg/g). During the ripening phase, the broad bean genotype Bakla UNV-852 showed the greater total pigment concentration (3.43 mg/g), while the genotype G-40 gave a slightly lower value (2.24 mg/g) (Table 3) than the others.

CONCLUSIONS

The results showed the total water content in the leaves of the exotic broad bean collection ranged from 74.9% to 88.9%. However, the highest total water content surfaced in the genotype G-22 (88.9%), while the lowest value was evident in the G-50 (74.9%). This indicates the total water content in plant leaves also depends on the genetic makeup of the genotypes. Based on the leaf water retention, the water deficiency in plants at different stages (flowering to harvesting) leads to a disruption of physiological processes in crop plants.

Table 3. Carotenoid content and total pigment concentration in the exotic genotypes of *Vicia faba.*

No.	Genotypes	Carotenoid content (mg/g)			Concentration of total pigments (mg/g)		
		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	G-1	0.58 ± 0.007	0.76 ± 0.01	0.78 ± 0.10	2.32 ± 0.02	2.37 ± 0.02	2.98 ± 0.04
2	G-15	0.86 ± 0.02	0.88 ± 0.01	0.67 ± 0.04	2.77 ± 0.03	3.02 ± 0.002	2.68 ± 0.07
3	G-19	0.85 ± 0.011	0.82 ± 0.003	0.68 ± 0.07	2.55 ± 0.003	2.65 ± 0.02	2.30 ± 0.03
4	G-22	0.83 ± 0.01	0.84 ± 0.01	0.74 ± 0.06	2.75 ± 0.08	2.71 ± 0.01	2.87 ± 0.08
5	G-26	0.94 ± 0.01	0.92 ± 0.03	0.83 ± 0.06	2.79 ± 0.01	3.22 ± 0.01	2.48 ± 0.09
6	G-29	0.90 ± 0.006	0.91 ± 0.02	0.81 ± 0.03	2.96 ± 0.23	2.82 ± 0.02	2.39 ± 0.01
7	G-35	0.93 ± 0.002	0.92 ± 0.01	0.83 ± 0.05	3.14 ± 0.08	2.97 ± 0.04	2.35 ± 0.09
8	G-40	0.76 ± 0.004	0.88 ± 0.02	0.73 ± 0.01	2.56 ± 0.01	2.85 ± 0.01	2.24 ± 0.02
9	G-41	0.70 ± 0.01	0.79 ± 0.01	0.70 ± 0.15	2.35 ± 0.02	2.59 ± 0.01	2.80 ± 0.03
10	G-46	0.77 ± 0.007	0.89 ± 0.01	0.69 ± 0.05	2.64 ± 0.02	2.68 ± 0.02	2.61 ± 0.06
11	G-50	0.75 ± 0.01	0.79 ± 0.02	0.67 ± 0.05	2.42 ± 0.03	2.62 ± 0.02	2.46 ± 0.004
12	G-55	0.85 ± 0.003	0.82 ± 0.004	0.88 ± 0.07	2.60 ± 0.006	2.63 ± 0.01	3.20 ± 0.06
13	G-56	0.93 ± 0.01	0.90 ± 0.01	0.85 ± 0.02	2.92 ± 0.03	2.89 ± 0.10	2.42 ± 0.01
14	G-57	0.83 ± 0.008	0.77 ± 0,01	0.67 ± 0.05	2.37 ± 0.02	2.85 ± 0.03	2.62 ± 0.02
15	G-59	0.91 ± 0.02	0.90 ± 0.02	0.81 ± 0.07	2.59 ± 0.07	2.65 ± 0.004	2.64 ± 0.01
16	G-62	0.83 ± 0.007	0.75 ± 0.02	0.83 ± 0.06	2.52 ± 0.03	3.00 ± 0.07	2.85 ± 0.03
17	Bakla UNV-851	0.95 ± 0.01	0.93 ± 0.02	0.86 ± 0.04	2.87 ± 0.021	3.00 ± 0.03	3.14 ± 0.10
18	Bakla UNV-852	0.94 ± 0.016	0.96 ± 0.03	0.90 ± 0.03	2.77 ± 0.004	2.80 ± 0.03	3.43 ± 0.04

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