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VARIABILITY IN THE DYNAMICS OF PHOTOSYNTHETIC INDICATORS IN MELON PLANTS ACCORDING TO GROWTH AND DEVELOPMENT STAGES

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Abstract

This article examines the variability in the dynamics of key photosynthetic parameters in two promising melon (*Cucumis melo* L.) cultivars—Gunash and Sadaf—cultivated under open-field conditions in the Absheron region. The study evaluates several physiological and biochemical indicators, including leaf surface area, photosynthetic potential (PP), net photosynthetic productivity (NPP), specific leaf surface density (SLSD), plastid pigment concentrations, the coefficient of economic efficiency of photosynthesis (CEEP), overall economic efficiency (CEE), and the accumulation of both crude and dry biomass. The findings indicate that SLSD and total biomass (crude and dry) progressively increase from the onset of the vegetative stage through to fruit formation and mass ripening. The early-maturing cultivar Gunash exhibited the most pronounced increases during the initial fruit formation stage, whereas in the mid-maturing cultivar Sadaf, these increases peaked during the mass ripening phase. Substantial variation in NPP, SLSD, and CEE was observed throughout plant ontogenesis, with maximum values recorded during the mass ripening period in both cultivars. Furthermore, chlorophyll and carotenoid accumulation in melon leaves followed a tri-phasic peak pattern, with the timing of each peak being cultivar-specific.

Keywords: melon, promising varieties, photosynthetic indicators, plastid pigments, growth and development process.

Introduction.

Melon fruits, particularly those of the barberry plant, are recognized for their rich nutritional profile and valuable therapeutic and preventive properties. Although barberry fruits—botanically classified as "false" berries and belonging to the Berberidaceae family—are not true fruits in a strict botanical sense, they are commonly treated as such in everyday usage. The nutritional and health benefits of barberry are largely attributed to its chemical composition, which is approximately 90% water and contains a wide array of essential vitamins (including E, PP, A, B1, B2, B5, B9, β -carotene, and vitamin C), as well as microelements such as iron, silicon, zinc, iodine, copper, fluorine, and cobalt. It also includes mono- and disaccharides, organic acids, both saturated and unsaturated fatty acids, and dietary fiber [1–4]. Due to this comprehensive chemical makeup, barberry is considered an important component of the human diet. Its bioactive constituents support immune function, enhance nervous system stability, aid digestion, improve cardiovascular and circulatory health, and contribute positively to hair and skin condition. Additionally, they facilitate detoxification and promote skin elasticity and overall vitality. The growth and development of fruit-bearing crops, including melons and other vegetables, are strongly influenced by external environmental factors such as light,

water availability, temperature, and soil properties. Among these, water supply has been shown to play a particularly significant role. Studies demonstrate that increasing water availability by 18% during the growing season results in more vigorous plant growth and yield improvements of 25–30% [5, 6]. Furthermore, enhancing irrigation during the fruit formation and ripening stages led to measurable increases in plant height (by 17.2%), leaf surface area (by 20.7%), and overall biomass (by 12.5%). Increased water availability also promoted root development, with root mass observed to be 6.6% greater at a water input of 2300 m³/ha compared to 1795 m³/ha [7]. Additionally, a deeper placement (by 1–3 cm) of the primary root mass under higher moisture conditions allowed for more effective utilization of residual soil moisture, particularly under surface drying conditions. For melon cultivation, optimal irrigation ranges from 5000 to 7000 m³/ha [8]. The biological development cycle of the melon plant includes several distinct phases: seed germination, seedling establishment, scion formation, development of male and female flowers, pollination, and fruit growth and maturation. Key factors influencing these stages include ambient temperature, humidity, soil nutrient availability, light conditions, agronomic practices, cultivar selection, and other management interventions [9, 10]. According to existing literature, achieving optimal levels

of photosynthetic indicators—such as leaf area, crop photosynthetic potential, net photosynthetic productivity, specific leaf mass per area, and plastid pigment concentration—is critical for ensuring high yields and fruit quality. These parameters can be effectively optimized through targeted agronomic measures, including precise nutrient and water management strategies [11, 12]. Moreover, researchers have reported strong positive correlations between leaf area, photosynthetic potential, and crop yield in various species. For example, correlation coefficients have been reported as $r = 0.98$ and 0.95 in watermelon, 0.90 and 0.85 in potato, 0.85 and 0.80 in eggplant, and 0.87 and 0.82 in table beet, respectively [1, 13].

Research objective.

The objective of this study was to identify effective strategies for optimizing the growth, development, and yield of fruit plant cultivars by examining a range of photosynthetic parameters across different ontogenetic stages. These parameters included leaf surface area, crop photosynthetic potential, net photosynthetic productivity (NPP), specific leaf surface density (SLSD), the coefficient of economic efficiency of photosynthesis (CEEP), overall economic efficiency (CEE), the content of plastid pigments in leaves, and the distribution of total moisture and dry biomass among various plant organs.

Materials and Methods.

The study focused on two promising fruit crop cultivars—Gunash (No. 80) and Sadaf (No. 81)—which were submitted in 2021 to the State Service for Plant Variety Registration and Seed Control under the Ministry of Agriculture of the Republic of Azerbaijan. Field experiments were conducted on the soils of the Absheron Auxiliary Farm of the “Vegetable Science Research Institute” Public Legal Entity (VSRİ AF). As the soils of Absheron, including those at VSRİ AF, are characterized by low humus content and insufficient mineral nutrient levels, 20 t/ha of organic manure and two-thirds of the planned dose of mineral fertilizers (excluding nitrogen) were incorporated during autumn plowing. The fertilization regime was based on a formulation of $N_{80}P_{80}K_{60}$ in terms of active ingredients. The remaining portions of nitrogen, phosphorus, and potassium were applied in two split doses—twenty days after planting and at the onset of fruit formation—using the compound fertilizer ammofoska ($N_{20}P_{20}K_{20}$).

The experimental design included plots measuring 20 meters in length and 2.8 meters in width, with 70 cm inter-row and intra-row spacing. The average area of a single experimental plot was 56 m^2 , and each treatment was replicated three times. During the study, the leaf surface area was measured using an L1-3000C portable leaf area meter. The photosynthetic potential (PP) was calculated as the product of the average leaf surface area (LA) and the duration of the vegetation period (T_v):

$$\begin{aligned} PP &= LA \times T_v \\ T_v PP &= LA \times T_v \\ PP &= La \cdot Tv \end{aligned} \quad (1)$$

During various phases of the vegetation period, the net photosynthetic productivity (NPP) was calculated using the following formula [13]:

$$NPP = (B_2 - B_1) / ((L_1 + L_2) \cdot 0.5n) \quad (2)$$

Here, B_1 and B_2 represent the total dry biomass of the plant (t/ha) at the beginning and at the end of the observation period, respectively; L_1 and L_2 denote the green leaf area (m^2/ha) at the beginning and end of the period; and n is the number of days in the observation period.

The specific density of leaf area (SDLS) is defined as the dry mass per unit leaf area and is expressed in mg/cm^2 :

$$SDLS = m / L \quad (3)$$

Here m is the dry mass of leaves, mg; L is the leaf surface area of a plant, cm^2 .

The coefficient economic of economic efficiency of photosynthesis (CEEP) is the ratio of the dry biomass of fruits (P_m) to the combined dry biomass of leaves, stems, and petioles (M_v) [14].

$$CEEP = P_m / M_v \quad (4)$$

The coefficient of economic efficiency (FEC) is the ratio of the dry biomass of fruits (P_m) to the total dry biomass of the plant (P_{db}) [13].

$$CEE = P_m / P_{ugb} \quad (5)$$

The amount of dry biomass in vegetative and generative organs was studied by A. I. Yermakova [15], while the amount of plastid pigments in leaves was examined by Gavrilenko V. F. and others [16].

Results and discussion of research.

Given the central role of photosynthesis in the growth and productivity of autotrophic organisms, including melon plants, a comprehensive study was conducted during the 2021–2022 growing seasons to evaluate key photosynthetic parameters in two melon cultivars. The parameters examined included the dynamics of leaf surface area expansion throughout the vegetative period, photosynthetic potential (PP), net photosynthetic productivity (NPP), chlorophyll content index (CCI), photosynthetic efficiency coefficient (PEC), production efficiency coefficient (PEC), the concentration of plastid pigments in leaves, and the distribution and dynamics of total moisture and dry biomass during plant development. The study aimed to identify both commonalities and differences in these parameters across developmental phases. The results indicated that the trends in leaf surface area and photosynthetic potential followed similar patterns in both cultivars over the course of the vegetative cycle. These metrics were lowest during the seedling stage, increased steadily during active growth, and reached peak values at different stages for each variety. In the early-ripening Gunash cultivar, the maximum values were recorded at the technical ripeness stage of the first fruits (5.26 thousand m^2/ha and 620.9 thousand $\text{m}^2 \cdot \text{day}/\text{ha}$ for leaf area and PP, respectively). In contrast, the mid-ripening Sadaf cultivar reached its peak during the mass ripening phase

(7.46 thousand m^2/ha and 932.4 thousand $\text{m}^2 \cdot \text{day}/\text{ha}$). Following these peaks, both parameters declined in both cultivars. A notable feature observed in both varieties was the pronounced increase in these indicators during the transition from the seedling phase to the male flower formation stage—by 13.86 and 21.80 times in Gunash, and by 8.88 and 13.84 times in Sadaf, for leaf area and PP, respectively. In Sadaf, this rapid growth extended through to the female flower formation stage, after which the developmental pattern mirrored that of Gunash. Among the indicators evaluated, the chlorophyll content index (CCI) served as a critical marker for assessing the plants' adaptive responses to abiotic stressors such as drought and heat. In Gunash, the CCI increased linearly throughout the vegetation period, peaking at $77.89 \text{ mg}/\text{cm}^2$ at the end of the season. In contrast, Sadaf displayed a more variable trend: the CCI rose linearly until the pollination and early fruit formation phases, with an initial maximum of $9.27 \text{ mg}/\text{cm}^2$. This was followed by a decrease (to $7.77 \text{ mg}/\text{cm}^2$), and subsequently a sharp increase—approximately 3.2-fold—coinciding with the onset of

fruit ripening, when the highest value of $24.83 \text{ mg}/\text{cm}^2$ was recorded. In the later stages of development, CCI declined to a range of $15.12\text{--}15.32 \text{ mg}/\text{cm}^2$.

The dynamics of net photosynthetic productivity (NPP), the coefficient of photosynthetic efficiency (CEP), and the production efficiency coefficient (PEC) revealed both shared patterns and varietal differences. The most significant variation in NPP occurred during the seedling, pollination, and early fruit formation stages. In the Gunash cultivar, two peaks in NPP were observed—first during male flower formation ($3.69 \text{ g}/\text{m}^2 \cdot \text{day}$), and again during pollination/early fruit formation ($12.64 \text{ g}/\text{m}^2 \cdot \text{day}$). However, a sharp decline in NPP followed, with values even becoming negative ($-8.64 \text{ g}/\text{m}^2 \cdot \text{day}$), indicating a temporary reduction in photosynthetic performance. A dramatic increase in NPP was then recorded at the beginning of the technical ripeness stage ($62.85 \text{ g}/\text{m}^2 \cdot \text{day}$), with the highest value ($80.37 \text{ g}/\text{m}^2 \cdot \text{day}$) occurring during the mass ripening phase (Table 1).

Table 1.
Dynamics of changes in photosynthetic indicators in fruit varieties during the growing period (average for 2021-2022 years)

Development phases	Leaf surface area, min m ² /ha	Photosintetic potential min m ² gün/ha	SDLS, mq/sm ²	PEC, q/m ² gün	CEEP	CEE	Pigments of plastids, mq/100 q in wet mass				Σ xl̄a/xl̄b	Σ xl̄/karotinoid
							Xlorofil ā	Xlorofil b̄	Karotinoidlar	Σ pigmentlar		
80-Gunash												
Seedling phase (formation of 4-5 leaves)	0,22	9,1	3,07	2,86	-	-	112,8	35,8	33,1	181,7	3,15	4,49
Formation of male flowers	3,05	198,4	6,47	3,69	-	-	122,1	38,8	28,1	189,0	3,15	5,73
Formation of female flowers	3,75	273,4	6,53	1,18	-	-	110,1	35,0	28,0	173,1	3,15	5,18
Fertilization and the formation of the first fruits	5,08	411,1	7,23	12,64	0,223	0,169	117,5	41,6	31,0	190,1	2,83	5,13
Formation of the first fruits	5,19	422,2	8,05	-8,64	0,469	0,312	108,9	40,5	30,0	179,4	2,69	4,98
Technical maturity of the first fruits	5,26	620,9	18,62	62,85	2,486	0,709	92,0	34,0	28,0	154,0	2,71	4,50
Mass maturation	2,85	356,4	48,66	80,37	3,056	0,751	91,1	33,8	33,3	158,2	2,70	3,75
End of vegetation	2,66	353,5	77,89	33,13	1,440	0,599	100,5	37,5	26,8	164,8	2,68	5,15
81-Sadaf												
Seedling phase (formation of 4-5 leaves)	0,24	10,0	1,96	1,80	-	-	135,3	45,3	44,5	225,1	2,99	4,06
Formation of male flowers	2,13	138,4	5,75	2,76	-	-	146,8	47,3	34,3	228,4	3,10	5,66
Formation of female flowers	4,16	303,4	6,86	11,30	-	-	137,0	46,0	32,0	215,0	2,98	5,72
Fertilization and the formation of the first fruits	4,85	392,5	9,27	16,29	0,286	0,221	117,3	44,0	28,0	189,3	2,67	5,76
Formation of the first fruits	4,64	431,9	7,77	0,90	0,803	0,440	123,3	47,3	30,5	201,1	2,61	5,59
Technical maturity of the first fruits	5,18	575,5	24,83	39,35	2,493	0,711	94,3	27,8	30,8	152,9	3,39	3,96
Mass maturation	7,46	932,4	15,12	93,23	3,023	0,783	82,8	31,0	26,8	140,6	2,67	4,25
End of vegetation	6,13	815,8	15,32	-6,25	3,426	0,772	97,0	40,5	31,8	169,3	2,40	4,32

By the end of the vegetation period, the coefficient of photosynthetic efficiency (CEP) decreased approximately 2.43-fold, a decline attributed to leaf yellowing and senescence. Unlike the Gunash cultivar, where the first CEP peak occurred earlier, the Sadaf cultivar exhibited its initial maximum CEP value during the pollination and early fruit formation phase (16.29 g/m²·day). Similar to Gunash, the transition to the first fruit formation phase in Sadaf was accompanied by a marked decline in CEP (0.90 g/m²·day). However, at the onset of technical maturity of the first fruits, Sadaf's CEP experienced a sharp surge, mirroring Gunash, reaching its highest maximum during the mass ripening phase (93.23 g/m²·day). Notably, unlike Gunash, the CEP in Sadaf declined steeply at the end of the vegetation period, even dropping to negative values (-6.25 g/m²·day).

The dynamics of both the photosynthetic efficiency coefficient (CEP) and the production efficiency coefficient (PEC) displayed cultivar-specific differences primarily toward the end of the vegetation period. In Gunash, both CEP and PEC decreased sharply as the season concluded, whereas in Sadaf, CEP continued to rise and PEC remained relatively stable. The highest recorded values of CEP and PEC for Gunash were 3.056 and 0.751, respectively, at the mass ripening phase; for Sadaf, these maxima were observed at the end of the vegetation period (3.426 and 0.772–0.783, respectively), reflecting the distinctive productivity profiles of the two cultivars.

Data from Table 1 highlight clear cultivar differences in the dynamics of total plastid pigments and chlorophyll content. In Gunash, chlorophyll content fluctuated with alternating maxima and minima until early fruit formation, followed by a decline toward ripening, and a final maximum (138.0 mg/100 g fresh weight) at the end of the vegetation period. Conversely, Sadaf exhibited its second chlorophyll maximum during the early fruit formation phase (170.6 mg/100 g), followed by a similar decline and a third maximum at the vegetation period's end (137.5 mg/100 g).

Distinct differences between cultivars in total plastid pigment content emerged from early fruit formation through to the mass ripening phase. Gunash displayed a decrease in plastid pigments during this interval, while Sadaf showed a second maximum (201.1 mg/100 g). Both cultivars then followed comparable trends, culminating in a third maximum (169.3 mg/100 g) at the end of the vegetation period.

A common feature in both cultivars was a tri-phasic pattern of total plastid pigment dynamics, with higher chlorophyll and plastid pigment concentrations during early growth stages (seedling to early fruit formation) relative to later phases. The variations in individual plastid pigments, chlorophyll a and b, largely paralleled overall chlorophyll trends, each characterized by three peaks and greater concentrations during early vegetative stages.

In contrast, carotenoids, which absorb short-wavelength solar radiation (420–452 nm), displayed distinct variation patterns. The first carotenoid maximum occurred during the seedling phase (33.1 mg/100 g in

Gunash and 44.5 mg/100 g in Sadaf). Subsequent cultivar-specific differences became more pronounced: Gunash's second maximum arose during pollination and early fruit formation (31.0 mg/100 g), whereas Sadaf's was observed during the technical maturity phase (30.8 mg/100 g). The third maximum was recorded during the mass ripening phase in Gunash (33.3 mg/100 g) and at the end of the vegetation period in Sadaf (31.8 mg/100 g).

Ontogenetic changes in the chlorophyll a/b ratio (xl.a/xl.b) and the total chlorophyll/carotenoid ratio (Σxl /carotenoid) revealed cultivar-specific patterns. In Gunash, the xl.a/xl.b ratio remained stable at its highest level (3.15) from seedling to female flower formation, then gradually declined, stabilizing within a narrow range (2.68–2.71) until the end of vegetation. Sadaf exhibited a two-peak curve with maxima at male flower formation (3.10) and initial fruit technical maturity (3.39), reaching its lowest ratio at vegetation end (2.40). The decline late in the season is attributed to the reduced need for long-wavelength solar radiation (660–700 nm).

The Σxl /carotenoid ratio also demonstrated varietal specificity. In Gunash, the highest peak (5.73) occurred during male flower formation, followed by a gradual decrease until mass ripening, with a secondary peak (5.15) at vegetation end. Sadaf's highest initial peak (5.76) was during fertilization and first fruit formation, followed by a decrease to its minimum (3.96) at initial fruit maturity, and a second peak (4.32) near vegetation end, similar to Gunash. The lowest Σxl /carotenoid ratio in Gunash (3.75) appeared during mass ripening, correlating with increased demand for short-wavelength solar radiation in late development stages.

As with all crops, the ultimate product of photosynthetic activity in melon plants is the accumulation of moist and dry biomass. Both cultivars exhibited similar patterns in biomass accumulation during vegetation, differing only in magnitude. Maximum moist and dry biomass values were recorded at the vegetation period's end: 821.31 and 100.41 t/ha in Gunash, and 707.45 and 78.41 t/ha in Sadaf. A sharp increase in biomass occurred from the initial fruit technical maturity phase through to the end of vegetation—5.75- and 6.71-fold increases in Gunash for moist and dry biomass, respectively, and 2.68- and 3.17-fold increases in Sadaf (Table 2).

Organ-specific moist and dry biomass dynamics mirrored overall trends, peaking at mass ripening except in flowers, where Gunash peaked during fertilization and early fruit formation (2.10 and 0.39 t/ha), and Sadaf during mass ripening (1.09 and 0.33 t/ha), with slight declines thereafter (Table 2).

The distribution of moist biomass among vegetative and reproductive organs revealed three distinct periods:

1. Formation of male and female flowers,
2. Pollination, coinciding with first fruit formation,
3. Technical maturity of first fruits, corresponding to vegetation end.

In the first period, both cultivars displayed a stem–leaf–root distribution pattern. During pollination, Gunash exhibited a stem–leaf–fruit–flower (or root) pattern, while Sadaf showed a stem (or fruit)–fruit (or stem)–leaf–root–flower pattern. In the final period, both cultivars demonstrated a fruit–stem–leaf–flower distribution (Table).

Dry biomass distribution varied slightly by organ dry matter content. Gunash's pattern, paralleling moist biomass, included three phases:

- Male and female flower formation: leaf–stem–root (or flower),
- Pollination and first fruit formation: leaf–stem–fruit–flower (or root),
- Technical maturity of first fruits: fruit–leaf–stem–root–flower.

Sadaf exhibited two dry biomass distribution phases:

Female flower formation: leaf–stem–root–flower,
Pollination to vegetation end: fruit–leaf–stem–root–flower.

In all cases, leaves, stems, and fruits dominated biomass allocation, while roots and flowers held minor shares, underscoring leaves' role as “productive” organs and stems/shoots as “conductive” structures critical to fruit development and maturation.

Conclusion.

Conclusion based on these findings:

1. Both Gunash and Sadaf cultivars exhibited similar leaf area and photosynthetic potential dynamics during vegetation, characterized by linear increases from the bud stage to mass maturity. Maximum values occurred at the technical maturity of first fruits— $5.26 \times 10^3 \text{ m}^2/\text{ha}$ leaf area and $620.9 \times 10^3 \text{ m}^2 \cdot \text{day}/\text{ha}$ photosynthetic potential in Gunash, and $7.46 \times 10^3 \text{ m}^2/\text{ha}$ and $932.4 \times 10^3 \text{ m}^2 \cdot \text{day}/\text{ha}$, respectively, in Sadaf.

2. A notable feature in both cultivars is the sharp increase—by a factor of 8.86 to 21.80—in leaf area and photosynthetic potential during the transition from the bud phase to the flowering phase. The dynamics of specific density of leaf area (SDLA) in the Gunash cultivar followed a strictly linear pattern throughout the vegetation period, reaching a maximum of $77.89 \text{ mg}/\text{cm}^2$ at the end. In contrast, the Sadaf cultivar maintained linearity only until the pollination and first fruit formation phase, where it exhibited a first maximum, followed by a second and highest maximum of $24.83 \text{ mg}/\text{cm}^2$ during the technical maturity phase of the first fruits.

3. The accumulation patterns of total chlorophylls, plastid pigments, and individual pigments (chlorophyll a, chlorophyll b, and carotenoids) displayed similar characteristics in both cultivars. Except for carotenoids, all pigments showed an initial maximum and followed a three-peaked curve over the vegetation period. Carotenoids also exhibited three maxima; however, these occurred simultaneously during the bud phase in both cultivars. Additionally, the dynamics of the chlorophyll a/chlorophyll b (Chl a/Chl b) ratio and total chlorophyll/carotenoid ratio—important indicators of plant adaptability to environmental stresses such as drought and high temperatures—were found to be cultivar-specific.

4. The net photosynthetic productivity (NPP) dynamics differed markedly between the cultivars: Gunash exhibited a three-peaked curve, whereas Sadaf showed a two-peaked curve. A common critical feature was that the highest production efficiency coefficient (PEC) values were recorded during the pollination/first fruit formation and mass maturity phases. Divergences in the dynamics of the coefficient efficiency of photosynthesis (CEP) and PEC became evident only at the end of the vegetation period. In Gunash, both coefficients decreased sharply, whereas in Sadaf, CEP continued to increase and PEC remained nearly constant. These distinct dynamic patterns likely underpin the observed differences in yield characteristics between the cultivars.

5. In both cultivars, the maximum levels of total wet and dry biomass, including that of vegetative organs, were recorded at the end of the vegetation period. Transitioning into the first fruit formation phase triggered a sharp increase in these parameters in each cultivar. The distribution of wet and dry biomass among vegetative and reproductive organs can be categorized into three periods:

First period (bud phase): Formation of male and female flowers, characterized by a distribution pattern of stem/shoot (or leaf) – leaf (or stem/shoot) – root.

Second period: Pollination and first fruit formation, with a pattern of stem/shoot (or fruit) – leaf – fruit (or stem/shoot) – flower (or root).

Third period (end of vegetation): Technical maturity of the first fruits, characterized by a pattern of fruit – stem/shoot (or leaf) – leaf (or stem/shoot) – root – flower.

This distribution pattern further confirms the decisive role of “creative” leaves and “transmitting” stems and shoots in fruit formation and maturation, compared with other plant organs

Table 2.
Dynamics of distribution of wet and dry biomass in fruit varieties by individual plant organs during the vegetation period (average for 2021-2022)

Development phases	Wet biomass, s/ha						Dry biomass, s/ha					
	general	leaves	stems	roots	flowers	fruits	general	leaves	stems	roots	flowers	fruits
80-Gunash												
Seedling phase (formation of 4-5 leaves)	1,36	0,56	0,63	0,17	-	-	0,13	0,07	0,04	0,02	-	-
Formation of male flowers	29,31	10,85	17,33	0,64	0,49	-	3,84	1,98	1,65	0,11	0,10	-
Formation of female flowers	35,43	12,73	20,92	1,20	0,58	-	4,65	2,45	1,86	0,15	0,19	-
Fertilization and the formation of the first fruits	70,70	18,92	30,19	1,59	2,10	17,90	8,80	3,67	3,02	0,23	0,39	1,49
Formation of the first fruits	80,80	22,43	34,69	1,64	0,18	21,86	8,97	3,92	3,23	0,24	0,07	1,51
Technical maturity of the first fruits	145,44	36,96	64,60	2,07	-	41,81	59,94	9,80	7,36	0,32	-	42,46
Mass maturation	697,11	42,30	65,17	2,23	-	587,41	86,99	13,87	10,51	0,34	-	62,27
End of vegetation	821,31	68,55	134,99	2,34	0,47	614,96	100,41	20,70	20,11	0,38	0,18	59,04
81-Sadaf												
Seedling phase (formation of 4-5 leaves)	1,32	0,55	0,62	0,15	-	-	0,09	0,05	0,03	0,01	-	-
Formation of male flowers	17,28	6,28	10,44	0,29	0,27	-	2,21	1,23	0,89	0,05	0,04	-
Formation of female flowers	38,32	14,33	22,36	1,96	0,57	-	5,05	2,85	1,95	0,17	0,08	-
Fertilization and the formation of the first fruits	73,36	17,95	29,59	1,88	0,32	23,62	11,37	3,61	2,46	0,23	0,11	4,96
Formation of the first fruits	131,27	18,54	30,55	2,47	1,04	78,67	14,77	4,28	3,73	0,25	0,22	6,29
Technical maturity of the first fruits	352,16	22,96	50,07	2,67	-	276,46	46,78	7,90	5,41	0,29	-	33,18
Mass maturation	656,65	32,40	63,19	3,11	1,09	556,86	81,40	11,27	8,48	0,62	0,33	60,70
End of vegetation	707,45	40,70	78,11	3,19	1,03	584,42	78,41	9,40	7,90	0,64	0,27	60,20

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