

RESEARCH ARTICLE

Comprehensive Evaluation of Sunflower (*Helianthus Annuus L.*) Collection Accessions Based on Vegetation Period, Individual Plant Productivity, And Seed Quality Indicators

Allanazarova Luyza Reipnazarovna

PhD, Research Institute of Plant Genetic Resources, Botanika, VIR-1, Kibray District, Tashkent Region, Uzbekistan

Yuldoshov O'tkir Khayitovich

PhD, Research and Experimental Station of Oilseed and Fiber Crops, Saxovat Street, Yukori Chirchiq District, Tashkent Region, Uzbekistan

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Abstract

In this study, 15 accessions from the global sunflower (*Helianthus annuus L.*) collection and one reference cultivar were evaluated for vegetation period, individual plant productivity, and the oil and protein content of seeds. The results showed that the vegetation period varied from 94 to 138 days, with accession K-8 identified as the earliest maturing genotype (94 days). Individual plant productivity ranged from 35 to 49 g, with the highest value recorded for accession K-91. The oil content of seeds ranged from 35.3 to 51.4%, with accessions K-83 and K-88 distinguished by their high oil accumulation capacity. Protein content varied between 16.9 and 22.1%, with relatively higher values observed in confectionery-type accessions. The obtained results revealed significant genetic variation among sunflower collection materials in terms of agrobiological and biochemical traits and demonstrated their potential as promising initial material for breeding programs.

KEYWORDS

sunflower global collection accessions, phenology, morphological traits, early maturity, productivity, oil content, protein content.

INTRODUCTION

Sunflower (*Helianthus annuus L.*) is an important field crop represented by both annual and perennial species. Several synonyms have been reported for this genus: *Helianthus pumilus Pers.* and *Helianthus cultus Wenzl.* are classified as annual forms, whereas *Helianthus tuberosus L.* is considered a perennial species (Amanova & Rustamov, 2010). One of the principal advantages of sunflower cultivation is its ability to ensure stable productivity even in regions with relatively low soil fertility. In addition, the crop does not require specialized

machinery, and satisfactory production results can be achieved using conventional agricultural equipment (Amanova, Rustamov, & Allanazarova, 2018).

The major biochemical characteristics of sunflower seeds include oil content ranging from 26–60% and protein content from 17–25%. Other quality indicators include an iodine value of 119–144, an acid value of 0.1–2.4, and a saponification value of 183–196. Vegetable oils play an important role as a source of energy and as regulators of metabolic processes in

the human body. Oleic acid, which is abundant in sunflower oil, contributes to strengthening blood vessels and reducing cholesterol levels, while linoleic acid is involved in maintaining visual function and promoting wound healing. Furthermore, the presence of vitamins A, D, E, and K contributes to the strengthening of bone and muscle tissues as well as intestinal cell structures (Beata & Adrian, n.d.).

Sunflower oil is widely used in the food industry, particularly in the canning and confectionery sectors. It also has considerable industrial significance, serving as a raw material for the production of varnishes, paints, linoleum, soaps, and lubricants. Due to its high caloric value, sunflower oil also has substantial nutritional importance: 100 g of oil provides approximately the same energy as 225 g of sugar, 400 g of flour, or 800 g of potatoes (Amanova & Rustamov, 2018).

Globally, sunflower is among the most widely cultivated oilseed crops. It is grown in more than 72 countries on an area exceeding 25–26 million hectares, with an average annual production of 40–42 million tons. The largest processing volumes are concentrated in Russia, Ukraine, Argentina, Turkey, and Kazakhstan, which together account for approximately 3–33% of global production (FAS, n.d.). In Uzbekistan, sunflower is cultivated both as a main and as a secondary crop across extensive areas. In 2024–2025, national production of sunflower oil reached approximately 31 thousand tons (Amanova & Rustamov, 2010).

In recent years, increasing attention has been devoted to the investigation of sunflower genotypic diversity, productivity, and biochemical composition of seeds. These studies are closely linked to global challenges related to food security and the efficient use of agricultural resources (Ivanov, 2018; Petrov et al., 2020). Differences in vegetation period and yield parameters among collection materials originating from different geographical regions have been identified as key indicators for assessing their agrobiological potential (Smirnova, 2019). At the same time, oil and protein contents of seeds are important selection criteria, since genotype-specific relationships between yield and oil content provide an opportunity to identify promising breeding material (Kuznetsov, 2021; Makarov et al., 2017).

From this perspective, the evaluation of sunflower accessions from the global collection in terms of vegetation period, individual plant productivity, and seed oil and protein content is of both scientific and practical significance. The primary

objective of this study is to determine the genetic variability of agrobiological and biochemical traits within the collection materials and to assess their potential use as initial breeding resources. Such an approach can contribute to improving the efficiency of breeding programs and to the selection of genotypes characterized by high productivity and elevated seed oil content.

Research site and conditions. The experiments were conducted in the Tashkent region, Yukori Chirchiq district, on the plain located on the left bank of the Chirchiq River at an altitude of approximately 550 m above sea level. The climate of the region is continental, characterized by cold winters and hot summers. The average temperature in January ranges from -1.5 to -2 °C, while in July it reaches approximately 25–28 °C. The annual precipitation amounts to 350–400 mm, and the average duration of the plant growing season is about 200 days.

The soils are of alluvial and proluvial origin and are characterized by a relatively high proportion of silt and clay particles (silt 40–50%, clay 20–30%). The upper 0–30 cm soil layer of the experimental fields is loose, light gray in color, and enriched with plant residues, which creates favorable conditions for normal crop growth and moisture retention.

The main biochemical indicators of the seeds—oil and protein content—were determined in the laboratory using the INFRALUM FT-12 analyzer. This method allows rapid and non-destructive determination of the total oil and protein content of seeds under standard laboratory conditions, ensuring a high level of measurement accuracy and reproducibility of the obtained data.

RESULTS

In this study, a total of 16 sunflower (*Helianthus annuus* L.) accessions from the global collection were examined, including 15 collection accessions and one reference cultivar. The samples were evaluated based on vegetation period, individual plant productivity, and the total oil and protein content in seeds.

Significant variation among the accessions was observed in terms of vegetation period. The growing period ranged from 94 to 138 days. The earliest maturing accession was K-8 (TUR), which reached maturity in 94 days. The longest vegetation period was recorded for accession K-36 (UZB, confectionery type), which required 138 days to complete its

growth cycle. The reference cultivar had a vegetation period of 96 days. Most of the remaining oil-type accessions matured within the range of 100–106 days. These results indicate the presence of considerable genetic variability in phenological traits among the studied collection materials.

Individual plant productivity ranged from 35 g to 49 g. The highest productivity was recorded for accession K-91 (UZB). Accessions K-27 (RUS) and K-8 (TUR) also demonstrated relatively high productivity, producing 45 g and 44 g per plant, respectively, which exceeded the value observed in the reference cultivar (38 g). The lowest productivity was recorded in accessions K-3 (TUR), K-83, and K-89 (UZB). Such variation in productivity suggests differences among genotypes in their ability to form yield components.

The total oil content in seeds varied from $35.3 \pm 0.43\%$ to $51.4 \pm 0.10\%$, with the highest value observed in accession

K-83 (UZB). Accession K-88 (UZB) also demonstrated a high level of oil accumulation ($49.0 \pm 0.17\%$). In the reference cultivar, the oil content was $48.3 \pm 0.07\%$. In contrast, the confectionery-type accessions K-36 and K-84 showed lower oil content, amounting to $38.3 \pm 0.48\%$ and $35.3 \pm 0.43\%$, respectively, compared with oil-type accessions. This difference reflects the direct relationship between seed biochemical composition and the economic type of the accession.

The total protein content ranged from $16.9 \pm 0.08\%$ to $22.1 \pm 0.80\%$, with the highest value recorded in accession K-36 (UZB). In some accessions characterized by high oil content, relatively lower protein levels were observed. This phenomenon can be interpreted as a biological feature associated with the proportional balance of storage compounds (oil and protein) in sunflower seeds.

Table 1

Vegetation Period, Individual Plant Productivity, and Seed Quality Indicators of Sunflower (*Helianthus annuus* L.) Collection Accessions

No	Catalog No.	Origin	Accession Type	Vegetation Period, days	Individual Plant Productivity, g	Total Oil Content, %	Total Protein Content, %
1	Andoza	UZB	Oil type	96	38	$48,3 \pm 0.07$	$17,2 \pm 0.03$
2	3	TUR	Oil type	106	35	$45,6 \pm 0.07$	$17,3 \pm 0.03$
3	8	TUR	Oil type	94	44	$45,7 \pm 0.02$	$17,5 \pm 0.02$
4	27	RUS	Oil type	100	45	$46,6 \pm 0.04$	$17,3 \pm 0.04$
5	35	RUS	Oil type	106	38	$47,7 \pm 0.12$	$17,4 \pm 0.08$
6	36	UZB	Confectionery type	138	43	$38,3 \pm 0.48$	$22,1 \pm 0.80$
7	74	UZB	Oil type	100	43	$47,9 \pm 0.21$	$17,2 \pm 0.02$
8	77	UZB	Oil type	100	43	$48,2 \pm 0.28$	$17,4 \pm 0.06$
9	78	UZB	Oil type	100	43	$46,3 \pm 0.10$	$17,1 \pm 0.13$
10	83	UZB	Oil type	106	35	$51,4 \pm 0.10$	$16,9 \pm 0.08$
11	84	UZB	Confectionery type	100	50	$35,3 \pm 0.43$	$19,8 \pm 0.40$
12	86	UZB	Oil type	100	43	$47,6 \pm 0.31$	$17,1 \pm 0.24$
13	87	UZB	Oil type	106	41	$47,8 \pm 0.21$	$17,2 \pm 0.03$
14	88	UZB	Oil type	100	40	$49,0 \pm 0.17$	$17,1 \pm 0.10$
15	89	UZB	Oil type	106	35	$47,7 \pm 0.14$	$17,2 \pm 0.02$
16	91	UZB	Oil type	106	49	$47,5 \pm 0.47$	$17,6 \pm 0.10$

Overall, the studied collection accessions demonstrated significant differentiation in terms of vegetation period,

productivity, and the biochemical composition of seeds. The high productivity or enhanced oil accumulation capacity observed in certain genotypes indicates their potential use as promising initial material in breeding programs.

CONCLUSION

The sunflower (*Helianthus annuus* L.) accessions from the collection differed in vegetation period, ranging from 94 to 138 days, which allowed the identification of both early- and late-maturing genotypes. Individual plant productivity varied from 35 to 49 g, with accessions K-91, K-27, and K-8 exhibiting the highest productivity levels. Seed oil content ranged from 35.3 to 51.4%, with genotypes K-83 and K-88 distinguished by their high oil accumulation capacity. Protein content varied between 16.9 and 22.1%, with relatively higher values recorded in confectionery-type accessions. Overall, the analyzed materials demonstrated considerable genetic variability, confirming their potential as valuable initial sources for sunflower breeding research.

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