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HERITABILITY OF OIL YIELD IN SUNFLOWER SEEDS IN F_3 HYBRIDS

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Annotation: The studied sunflower varieties and their F_3 progenies were analyzed for the heritability and phenotypic variability of oil content. The results showed that in the parental lines, the average oil content ranged from 36.6 to 51.0%, with a coefficient of variation of 0.6–1.6%, indicating high genetic stability of this trait. In the F_3 progenies, both oil content and its variability were high, with heritability values ranging from 20 to 75%. The high heritability of oil content in the F_3 generations allows for stable and efficient selection in breeding programs.

Keywords: sunflower, breeding, variety, samples, duration of vegetation period, earliness, seed, hybridization, genetic, F_3

Introduction

In recent years, there has been a global increase in demand for natural food products. In industrial production, sunflower oil is divided into three types depending on the oleic acid content: traditional, medium-oleic, and high-oleic [2].

The composition of sunflower seeds depends on the variety: they contain 0.7–1.0% phospholipids (phosphatides) and 0.23–0.24% sterols. Recently, tocopherols with vitamin E activity of 60–80 mg% in the seed oil have been identified in breeding varieties. High-oil sunflower varieties are also characterized by higher levels of water-soluble vitamins—nicotinic acid, thiamine, biotin, and riboflavin—reaching values comparable to peanut seeds [1].

To evaluate sunflower seed oil yield, methods developed by Academician V.S. Pustovoit are widely used. Pustovoit demonstrated in practice that the use of sunflower breeding methods makes it possible to increase both seed yield and oil content [3].

When sunflower varieties and hybrids are grown under identical soil and climatic conditions, seed yield and oil content vary significantly. Under the conditions of our republic, the recommended variety ‘Dzhakhongir’ provides an average yield of 28 t/ha. The hybrids ‘Krasotka’ and ‘Sunbred 254’, under full compliance with agrotechnical requirements, produce yields of 31.1–33.4 t/ha [Lukov M.K. Influence of variety on sunflower yield // Proceedings of the scientific conference “Prospects for the Development of Farms,” Samarkand, 2009, May 5–7, Part 1, pp. 65–66].

In 2023, only 61.7 thousand hectares were allocated for sunflower sowing in Uzbekistan, of which 25.7 thousand hectares were used for main crops, and 36.0 thousand hectares for repeated sowing. A total of 128 thousand tons of sunflower were harvested from these areas [9].

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In practical breeding, careful selection of parental pairs is the primary step in variety development. Achieving high efficiency through hybridization largely depends on the correct and targeted selection of parental forms [4].

The effectiveness of hybridization is directly related to scientifically justified parental selection at the crossing stage [6].

The developmental stages of sunflower varieties occur at different times depending on their biological characteristics. Each variety has its own specific growth rate and vegetation duration, which depend not only on genetic factors but also on environmental conditions. Therefore, accurate identification of developmental phases helps determine in which regions and conditions a variety can be grown [7].

During sunflower growth, several sequential developmental phases are observed. The seedling phase lasts 10–15 days; during this period, the adventitious root forms, the cotyledon emerges above the soil surface, and initial growth processes occur. The next phase—head (capitulum) formation—takes 30–40 days; during this time, the first true leaves develop, and when an average of 13 leaves has formed, head formation begins. The period from emergence to flowering lasts 25–30 days and is characterized by intensive plant growth and development of yellow ray flowers. Over the next 35–40 days—from flowering to seed maturation—bisexual tubular flowers develop, and seed ripening occurs. Biologically, sunflower is a cross-pollinated plant, although partial self-pollination may occur under natural conditions [10].

Materials and Methods

Field experiments were conducted in 2022–2024 on the experimental fields of the Samarkand Institute of Agroinnovations and Research. The experiments were carried out in accordance with the “Methods of Conducting Field Experiments” (Tashkent, 2014) and the “Methods of State Variety Testing of Agricultural Crops” (Moscow, 2019).

In the study, oil content in sunflower seeds was determined using the Skoclet and Gronalizer devices. The integrated productivity indicator—oil yield—was calculated using the following formula:

$$S = R \times M \times (100 - v)$$

where:
S — oil yield, t/ha;
R — seed yield, t/ha;
M — seed oil content, %;
v — standard seed moisture, %
[Anashchenko, A.V. Methodological Guidelines for Studying the World Collection of Oilseed Crops. Sunflower. Issue II / A.V. Anashchenko. Leningrad, 1976. 39 p.].

Results and Discussion

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The study of the heritability of oil yield and the indicators of phenotypic variability in F_3 generations of the examined sunflower varieties and hybrid combinations made it possible to determine the stability and controllability of this trait in the breeding process.

According to the results, the average oil yield in the parental samples ranged from 36.6% to 51.0%, while the coefficient of variation (V) in all varieties was 0.6–1.6%, indicating a high level of genetic stability. In the F_3 generations, oil yield ranged from 37.3% to 50.0%, and trait variability remained within V = 0.5–1.4%. The heritability coefficient (h^2) varied widely — from 20% to 75%.

The highest h^2 values were recorded in the following hybrid combinations:

- ♀L2016/23 × ♂L2015/20 — 75%
- ♀L2016/23 × ♂Sur — 69%
- ♀AS-504 × ♂L2015/20 — 67%
- ♀Pomor × ♂L2015/20 — 63%
- ♀Zarya × ♂Sunbred-254 — 65%

In contrast, the lowest heritability levels were observed in:

- ♀Saratov-2 × ♂Enisey — 20%
- ♀Sur × ♂Enisey — 35%
- ♀Sunbred-254 × ♂Rossvet — 36%

In F_3 sunflower generations where the heritability coefficient for oil yield exceeded 60%, the trait was expressed particularly clearly, which enabled the selection of these hybrid plants for further breeding work.

Heritability of Oil Yield in Sunflower Seeds in F_3 Hybrid Generations (Samarkand, 2024)

№	Variety Names, Samples, and Hybrid Combinations	Heritability and Variability of Oil Yield in F_3 Hybrid Generations			
		X	V	ẍ±	h^2 %
1	Pomor	46,8	1,6	1,5	
2	AS-504	39,0	0,9	0,8	
3	L2015/20	49,5	0,6	0,6	
4	K-22-29	49,0	0,8	0,7	
5	L 2016/23	51,0	0,9	0,8	
6	Саратов-2	36,6	0,7	0,6	
7	Енисей	40,4	0,8	0,7	
8	Заря	37,8	0,7	0,7	
9	Sanbred-254	47,4	0,7	0,7	

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10	Россвет	49,6	0,8	0,7	
11	Sur	48,0	0,6	0,6	
1	♀Pomor x ♂AS-504	42,9	0,9	0,8	52
2	♀AS-504 x ♂L2015/20	44,8	1,1	1,0	67
3	♀Pomor x ♂L2015/20	48,0	0,8	0,7	63
4	♀K-22-29 x ♂Pomor	48,0	0,6	0,6	38
5	♀AS-504 x ♂K-22-29	44,0	1,0	0,9	55
6	♀L 2016/23 x ♂L2015/20	49,8	1,4	1,3	75
7	♀Саратов-2 x ♂Енисей	38,7	0,6	0,5	20
8	♀Саратов-2 x ♂Россвет	43,1	0,6	0,5	39
9	♀Россвет x ♂Енисей	44,7	0,9	0,8	55
10	♀Заря x ♂Sanbred-254	42,5	1,0	0,9	65
11	♀Sanbred-254 x ♂Россвет	48,5	0,7	0,6	36
12	♀Заря x ♂Россвет	43,3	0,7	0,6	43
13	♀Sur x ♂Енисей	44,2	0,6	0,5	35
14	♀L 2016/23x ♂Sur	49,3	1,0	0,9	69
15	♀Sur x ♂K-22-29	48,5	0,6	0,5	44
16	♀Россвет x ♂L 2016/23	50,0	1,1	1,0	62
17	♀ K-22-29 x ♂Россвет	49,2	0,8	0,7	55
18	♀Саратов-2 x ♂Pomor	42,0	0,7	0,6	55
19	♀ Sanbred-254x ♂ K 22-29	47,9	0,8	0,8	57
20	♀Саратов-2 x ♂ Заря	37,3	0,7	0,6	56

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