INNOVATIONS IN TECHNOLOGY AND SCIENCE EDUCATION
ISSN 2181-371X
https://sr-journals.org/index.php/ITSE

UDC: 633.85.631.5.

Results of evaluation of safflower (*Carthamus tinctorius l.*) Varieties and breeding samples based on productivity indicators

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Annotation. In this study, the productivity indicators, major agronomic traits, and yield components of safflower (Carthamus tinctorius L.) varieties and breeding samples were investigated under dryland conditions. The number of capitula per plant, number of seeds per capitulum, 1000-seed weight, and yield characteristics of the studied genotypes in the selection nursery were analyzed. The results demonstrated significant differences among the studied safflower samples in terms of productivity-related traits. The highest yield was recorded in the samples SP-2024/51 and SP-2024/112, reaching 8.7 c/ha, followed by SP-2024/138 with 8.6 c/ha and SP-2024/41 with 8.5 c/ha. The samples SP-2024/41, SP-2024/51, SP-2024/101, SP-2024/106, SP-2024/112, and SP-2024/138, which exhibited high productivity and valuable agronomic characteristics, were identified as promising breeding materials for further safflower improvement programs.

Key words: safflower, oilseed crops, breeding, varieties and breeding samples, productivity, yield, agronomic traits, 1000-seed weight, dryland conditions.

Introduction. Ensuring global food security has become one of the major challenges of modern agriculture due to rapid population growth, climate change, and the increasing demand for high-quality food products. According to international estimates, more than 2 billion people worldwide continue to experience food insecurity, highlighting the urgent need to improve agricultural productivity and diversify crop production systems. Consequently, increasing the productivity of oilseed crops has become a strategic priority in many countries.

Oilseed crops are among the most important agricultural commodities because they provide edible vegetable oils, high-protein meal for livestock, and valuable raw materials for the food, pharmaceutical, cosmetic, and biofuel industries. According to the Food and Agriculture Organization (FAO), oilseed crops occupy more than 140 million hectares globally. Soybean accounts for the largest cultivated area, followed by groundnut, sunflower, sesame, safflower, and oilseed flax. The leading producers of oilseed crops include the United States, Canada, Brazil, Argentina, China, India, Pakistan, Russia, Ukraine, and Kazakhstan.

The development and introduction of high-yielding, climate-resilient safflower varieties require a comprehensive evaluation of productivity-related traits under local agro ecological conditions. Comparative studies of varieties and breeding lines provide essential information for identifying promising genetic resources and improving breeding efficiency. Therefore, the present study aimed to investigate the productivity characteristics of safflower varieties and breeding lines and to identify promising genotypes with superior agronomic performance under the environmental conditions of Uzbekistan.

Samples belonging to the Pamir ecotype are considered valuable initial sources for breeding high-yielding varieties due to their superior plant height, higher number of capitula per plant, and greater seed production. Samples belonging to the Northern Afghanistan ecotype are also regarded as

promising genetic resources for breeding programs because of their higher 1000-seed weight, strong plant stems, upper position of primary branches, and spineless capitula characteristics [1].

Safflower oil has medicinal properties and is easily absorbed by the human body. Another important advantage of safflower oil is that the production of 1 ton of vegetable oil requires 18–20 times less cost compared with the production of animal fats [2].

According to T.N. Luchkina (2016), newly developed varieties should be well adapted to specific natural and climatic conditions. The author determined through experiments that when appropriate and high-quality agro technical practices are applied during cultivation, both yield and quality indicators increase, while the loss of valuable agronomic traits can be prevented [3].

It has been emphasized that one of the most important challenges in modern plant breeding is the development of varieties with stable yield potential, suitability for mechanized harvesting, early maturity, drought tolerance, and resistance to diseases and pests. These characteristics represent the main requirements for newly developed crop varieties by modern breeders [4].

The object and methods of the research. The study of the global collection of oilseed crops and breeding processes was conducted based on the methods developed by the All-Union Institute of Plant Industry (1976). Phenological observations, field and laboratory evaluations, and analyses of various traits were carried out according to the *Methodology of State Variety Testing of Oilseed Crops* developed by the State Variety Testing Commission. The studies on safflower (*Carthamus tinctorius L.*) varieties and samples were conducted in accordance with methodological guidelines for assessing distinctness, uniformity, and stability, including the analysis of morphological traits.

During the reporting year, 12 varieties and breeding samples of safflower were studied in the competitive variety testing nursery, 10 samples in the preliminary variety testing nursery, 206 samples in the breeding nursery, and 56 samples in the collection nursery. The research activities were conducted in accordance with the approved research program and calendar plan. Phenological observations were recorded in field journals from emergence to full maturity stages, including assessments of emergence, branching, budding, flowering, and ripening periods.

In the initial material nursery, samples were sown in single rows with a row length of 2 m and a spacing of 40 cm, according to the required seed quantity. In the breeding nursery, sowing was carried out on 1 m² plots with 40–45 cm row spacing and 18–20 viable seeds per row; a standard variety was placed after every 10 lines. Preliminary variety trials were conducted on 25 m² plots with a sowing depth of 4–5 cm in two replications. Competitive variety trials were conducted under dryland conditions on plots of 30 m², with a harvested area of 25 m², in four replications.

Results obtained and their analysis. Based on the evaluation of 39 safflower breeding samples in the selection nursery, important agronomic traits, yield components, 1000-seed weight, and yield indicators were analyzed. The results demonstrated significant variation among the studied genotypes in terms of morphological and agronomic characteristics.

The number of capitula per plant ranged from 12 to 26. The highest value was recorded in the SP-2024/32 sample, which formed 26 capitula per plant. In addition, SP-2024/51 produced 25 capitula per plant, while SP-2024/23, SP-2024/89, SP-2024/103, and SP-2024/138 produced 24 capitula per plant. A higher number of capitula is considered one of the main components determining the yield potential of plants, reflecting a higher level of generative development.

Differences among the studied samples were also observed in the number of seeds per capitulum. This trait varied from 20 to 41 seeds per capitulum. The highest value (41 seeds) was recorded in SP-2024/32, SP-2024/94, SP-2024/106, SP-2024/112, and SP-2024/134 samples. These genotypes demonstrated better seed formation within capitula and showed high reproductive potential.

Main indicators of agronomic traits, 1000-seed weight and yield of safflower varieties and breeding lines in the selection nursery (Gallaorol, 2025)

№	Variety / sample number	Number of capitula per plant, pcs	Number of seeds per capitulum, pcs	1000-seed weight, g	Yield, c/ha
1	Jizzakh-1 (standard)	19	24	32,8	5,7

2	SP-2024/2	20	28	33,8	6,2
3	SP -2024/4	12	26	33,4	6,5
4	SP -2024/7	14	20	34,2	7,5
5	SP -2024/10	21	28	32,7	6,4
6	SP -2024/14	18	34	34,5	6,4
7	SP -2024/16	22	36	34,0	5,2
8	SP -2024/21	19	28	33,9	7,2
9	SP -2024/23	24	32	34,2	6,4
10	SP -2024/29	21	38	32,8	6,8
11	SP -2024/32	26	41	33,6	5,7
12	SP -2024/41	18	40	35,2	8,5
13	SP -2024/44	21	38	33,4	7,6
14	SP -2024/48	23	37	34,4	7,5
15	SP -2024/51	25	36	35,0	8,7
16	SP -2024/54	19	28	33,8	5,9
17	SP -2024/56	17	32	34,2	6,2
18	SP -2024/57	19	34	32,6	6,9
19	SP -2024/61	22	30	33,9	7,2
20	SP -2024/71	23	34	34,1	7,6
21	SP -2024/76	18	28	36,0	6,4
22	SP -2024/84	17	32	33,8	6,8
23	SP -2024/86	23	38	32,5	7,5
24	SP -2024/89	24	35	34,6	6,9
25	SP -2024/94	14	41	32,8	5,7
26	SP -2024/98	18	36	32,0	6,4
27	SP -2024/101	16	28	35,4	7,9
28	SP -2024/103	24	35	33,8	6,4
29	SP -2024/106	22	41	31,9	7,8
30	SP -2024/109	23	37	34,2	7,6
31	SP -2024/112	19	41	33,6	8,7
32	SP -2024/115	17	24	32,7	5,7
33	SP -2024/117	18	35	35,4	6,5
34	SP -2024/120	16	38	31,8	7,6
35	SP -2024/123	19	29	33,4	6,6
36	SP -2024/128	17	34	34,5	7,8
37	SP -2024/131	23	37	33,6	6,9
38	SP -2024/134	22	41	32,8	7.6
39	SP -2024/138	24	32	33,4	8,6
40	**Maximum value**	**24**	**41**	**35,4**	**8,7**
41	**Average value**	**19**	**33,4**	**33,7**	**7,2**
42	**Паст кўрсаткич**	**17**	**35**	**32,0**	**5,2**
43	**$LSD_{0.05}$**	**0,16**	**0,18**	**33,6**	**0,23**
44	**$LSD_{0.01}$**	**1,64**	**2,15**	**1,67**	**3,40**

The 1000-seed weight of safflower samples varied from 31.8 to 36.0 g. The highest seed weight was recorded in the SP-2024/76 sample, with a 1000-seed weight of 36.0 g. High values were also observed in SP-2024/101 and SP-2024/117 (35.4 g), SP-2024/41 (35.2 g), and SP-2024/51 (35.0 g). A higher 1000-seed weight indicates not only improved seed quality but also greater potential for the development and productivity of subsequent plant generations.

The yield of the studied safflower breeding samples in the selection nursery ranged from 5.2 to 8.7 c/ha. The highest yield was recorded in SP-2024/51 and SP-2024/112 samples, reaching 8.7 c/ha. In addition, SP-2024/138 produced 8.6 c/ha, SP-2024/41 produced 8.5 c/ha, SP-2024/101 produced 7.9 c/ha, while SP-2024/106 and SP-2024/128 produced 7.8 c/ha.

Oilseed flax samples collected from all regions of the Republic are considered valuable sources of initial material for folk breeding. These initial materials represent local varieties that have adapted to specific natural and climatic conditions over many years. Based on targeted research, it is possible to develop early-maturing, cold-resistant, drought-tolerant, disease-resistant, high-oil-content, and high-yielding varieties using these genetic resources [5].

It has been emphasized that one of the urgent challenges in modern breeding is the development of new varieties that meet current production requirements, including stable yield potential, suitability for mechanized harvesting, early maturity, drought tolerance, and resistance to diseases and pests [6].

The standard variety Jizzakh-1 had a yield of 5.7 c/ha, whereas the high-yielding breeding samples exceeded this value by 2.8–3.0 c/ha. This indicates that these samples can be used as valuable initial genetic materials for the development of new high-yielding safflower varieties.

According to the statistical analysis of the obtained results, the least significant difference ($LSD_{0.05}$) values were 0.16 for the number of capitula per plant, 0.18 for the number of seeds per capitulum, and 0.23 for yield. These values confirm the reliability of the experimental results. The differences among the studied genotypes were associated with their genetic characteristics, allowing the selection of highly productive genotypes for further breeding programs.

Conclusion

The results of the study revealed significant differences among safflower breeding samples in terms of the number of capitula per plant, number of seeds per capitulum, 1000-seed weight, and yield characteristics. Among the evaluated samples, the highest yield was recorded in SP-2024/51 and SP-2024/112 (8.7 c/ha), followed by SP-2024/138 (8.6 c/ha) and SP-2024/41 (8.5 c/ha). These samples demonstrated well-developed yield components and favorable seed quality characteristics, indicating their potential as promising breeding materials. Statistical analysis confirmed the reliability of differences among the studied genotypes. The samples SP-2024/41, SP-2024/51, SP-2024/101, SP-2024/106, SP-2024/112, and SP-2024/138 were identified as valuable genetic resources with high productivity and are recommended for further utilization in safflower breeding programs.

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