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Photosynthetic activity and yield of potato varieties in summer planting with freshly harvested tubers

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Abstract: The article presents the results of studying the growth, formation of leaf surface, productivity, and marketable yield of various very early, early, and mid-early potato varieties with double cropping: planting with freshly harvested tubers in summer. It was revealed that the studied varieties differ significantly in the germination of tubers, the formation of top stems, and leaf surfaces, as well as in marketable yield. The highest field germination of tubers (95.2-98.7%), stem formation (2.9-3.8 pcs.), leaf surface (33.6-39.9 thousand m^2 per 1 ha), photosynthetic potential on plantings (2590.0-3351.6 thousand m^2), powerful tops and root systems with intensively accumulating yield, as well as the largest commercial yield (29.1-34.3 t/ha) were obtained from the varieties: in very early – Latona, Binella, Karatop, Ultraeshim; in early – Arizona, American, Yangi Uzbekistan; in mid-early – Evolution, Pikasso, Sylvana, Saviola. At the same time, the yield increase was 2.6-8.7 t/ha compared to standard varieties.

Keywords: very early varieties, growing season, leaf surface area, tops, productivity, commercial yield.

INTRODUCTION

The concept of cultivating potatoes as a two-crop crop means that last year's seed tubers are planted in early spring, the resulting crop is re-used in the summer as seed material, and thus two generations are obtained per year. The most important thing is that this makes it possible to organize local potato seed production based on the effective use of irrigated lands.

The success of cultivating potatoes as a double-crop crop, obtaining full-fledged and vigorous seedlings largely depends on the correct selection of early and mid-early varieties with a short dormant period and quickly responding to the influence of growth stimulants.

Our long-term research has established that the suitability of new varieties or growth stimulants for double-crop crops is determined by the following indicators (Ostonakulov, 2020, 2021, 2023):

- Field germination of freshly harvested tubers on the 30th day after planting (90% and above);
- Stem formation on each bush (2.5 pieces or more);
- Marketable yield (22 t/ha and more).

Photosynthesis is the main process occurring in a plant; photosynthetic activity depends on the cultivated varieties and the applied agricultural technology techniques of crops, which determines the size of the crop produced.

It is known that under the influence of soil and climatic conditions and applied agricultural technologies, plants form the most optimal assimilation surface areas. Their optimal indicator for many crops is considered to be 4-5 m^2, and the

photosynthetic potential is at least 2-3 thousand m^2/ha. Typically, in crops, the photosynthetic potential changes during the period of plant growth and development. The most productive potato varieties have an assimilation surface area of 40-50 thousand m^2/ha (Ostonakulov & Kodirkhodzhaev, 2019; State register, 2022).

Establishment of introduced and bred very early, early and mid-early varieties cultivated in the republic with a growing season of 70-90 days as a double-crop crop, that is, in summer planting with freshly harvested tubers, while studying the formation of the stem and leaf surface area during the growing season on plantings photosynthetic potential has important scientific and practical significance and is relevant.

Taking this into account, in 2022-2023 we conducted special field experiments in the conditions of irrigated meadow-gray soils of the Samarkand.

MATERIALS AND METHODS

The purpose of the research is in summer planting with freshly harvested tubers a comprehensive assessment of introduced and bred collections of very early, early and mid-early potato varieties based on the germination of freshly harvested tubers, growth, plant development, stem formation, formation of leaf surface, tops, root system, tubers, photosynthetic potential, indicators productivity, total and marketable yield.

All agricultural technology activities for the cultivation and harvesting of potatoes complied with the agricultural recommendations "Approximate technological map for the cultivation and harvesting of agricultural crops". In field experiments, the object of research was 37 potato varieties, of which 14 were very early, 16 were early, 7 were mid-early. From the first early harvest, seed tubers weighing 30-50 grams were selected whole, and large ones weighing 60-100 grams were cut in half, then treated in a solution of growth stimulants, consisting of 1 kg of thiourea per 100 liters of water, 1 kg of potassium radonite, 0.5 grams of gibberellin, 2 grams of Succinic acid and 3-5 liters of Roslin solution (per 3500 kg of seed potatoes) with an exposure of 3-5 minutes. After treatment, the seed tubers were stored in the shade for 4-5 days with a humidity of 60-70%. When sprouts of 3-5 mm appeared in the tubers, planting was carried out on July 15-18 according to the 70x20 cm pattern with an incorporation of 8-10 cm (Ostonakulov, 2020). Before emergence, pre-irrigation soil moisture was maintained at 65-70%. Other methods of cultivation technology were carried out according to generally accepted recommendations for production.

The standard was the varieties included in the State Register, widely cultivated - Quvonch-16/56m (very early), Red Skarlet (early) and Sante (mid-early) with a growing season of 74, 76 and 83 days, respectively.

For a comprehensive characteristic of the studied varieties, the field germination of tubers was determined on the 30th day after planting, the duration of the periods "planting-sprouting" and "sprouting-yellowing of tops"; during the flowering period, plant height, number of stems, leaf surface area of one plant, leaf area were measured, surface per 1 hectare, photosynthetic potential in planted potato varieties during the growing season, and assessed the total and marketable yield.

All records, measurements, analyzes and observations on the experimental plot were carried out according to generally accepted methods and agricultural recommendations (Azimov & Azimov, 2002; Ostonakulov, 2023; Methods of research, 1967; State variety, 2019; Semyukin & Pigorov, 2007; Tretyakov, 1982; Nichiporovich, 1961).

RESULTS AND DISCUSSION

The data obtained showed (Table 1), that the field germination of seed tubers in very early varieties ranged from 75.3 (Timo) to 98.6% (Karatop). Compared to the standard variety Kuvonch-16/56 m, high field germination of seed tubers was noted in the varieties Surkhan-1 (95.2%),

Impala (94.6%), Latona (96.7%), Binella (98.1%), Karatop (98.6%), Ultraeshim (96.2%). The lowest germination rate (75.3-81.7%) was in the varieties Timo, Zhukovsky early, Bronnitsky. In early varieties, the germination of freshly harvested seed tubers was 85.1-96.5%, compared to the standard variety Red Skarlet (94.5%), high yields were obtained in the varieties Gala (96.5%), Arizona (97.3 %), American (95.8%), Yangi Uzbekistan (95.7%).

In mid-early varieties, the germination of seed tubers was in the range of 84.1 - 98.7%; the highest germination of tubers (96.7-98.7%) was observed in the varieties Evolution, Sante (st.), Sylvana, Saviola.

According to biometric measurements during the flowering period of plants, it was revealed that tall (71-89 cm), multi-stemmed (2.9 - 3.8 pcs.), leaf surface area (33.6 - 39.9 thousand m^2 per 1 ha), powerful tops (310 - 386 g) and root system (27.8 - 29.8 g) and intensively developing productive (687 - 867 g tubers per plant) bushes were noted in the varieties Binella, Karatop, Ultraeshim, Kurado, Arizona, American , Yangi Uzbekistan, Turkestan, Evolution, Sylvana, Saviola.

Per unit area, the highest leaf surface area was formed in very early varieties - Latona (35.0 thousand m^2/ha), Binella (36.4 thousand m^2/ha), Karatop (38.5 thousand m^2/ha), Ultraeshim (37.8 thousand m^2/ha); in early varieties - Kurado (33.6 thousand m^2/ha). Arizona (35.0 thousand m^2/ha), Gala (34.3 thousand m^2/ha), American, Turkestan (36.4 thousand m^2/ha), Yangi Uzbekistan (37.8 thousand m^2/ha), for mid-early varieties - Evolution, Pikasso (36.4 thousand m^2/ha), Sylvana (38.5 thousand m^2/ha), Saviola (39.9 thousand m^2/ha).

During the growing season, the photosynthetic potential of the studied potato varieties during summer planting with freshly harvested tubers was 2146.2-2887.5; for early varieties - 2234.4 - 2912.0; and for mid-early ones - 2640.4 - 3351.6 thousand m^2/ha x day. The greatest photosynthetic potential was revealed in very early varieties (2590.0-2887.5 thousand m^2/ha) - Latona, Binella, Karatop, Ultraeshim; from early varieties (2620.8-2912.0 thousand m^2/ha) - Kurado, Arizona, Gala, American, Turkestan, Yangi Uzbekistan; from the mid-early ones (2856.0-3351.6 thousand m^2/ha) - Evolution, Pikasso, Sylvana, Saviola.

The yield of very early, early and mid-early potato varieties when planted in summer with freshly harvested tubers differs sharply from 19.2 (Timo) to 35.5 (Saviola) tons per 1 ha, of which the yield of marketable tubers is in the range of 16.6-34.3 tons per 1 ha, or from 86.2 to 96.7% (Figure 1).

The highest commercial yield was provided by very early varieties - Latona (29.1 t/ha), Binella (35.1 t/ha), Karatop (32.7 t/ha), Ultraeshim (30.0 t/ha), from early varieties - Arizona (30.6 t/ha), American (33.0 t/ha), Yangi Uzbekistan (30.3 t/ha), from mid-early varieties - Picasso (30.5

Table 1. Growth and development of very early, early, and mid-early potato varieties in a double cropping (planting dates: July 15-18, planting pattern: 70x20 cm)

№	Name and origin of the variety	Field germination of tubers on 30 days after planting, %	Periods, in days		Plants in the flowering period				Photosynthetic potential on plantings during the growing season, ths. m^2/ha x day
			Planting-seedlings	Sprouting-yellowing of the tops	Height, cm	Number of stems, pcs.	Leaf area, m^2	Leaf surface area per 1 ha, thousand m^2	
In very early varieties (70-75 days)									
1.	Quvonch-16/56m (UZ)-**ct**	93,7	23	74	70	2,8	0,45	31,5	2331,0

2.	Surxon - 1 (UZ)	95,2	22	72	65	2,4	0,43	30,1	2167,2
3.	Alyona (RU)	78,1	24	70	72	3,0	0,44	30,8	2156,0
4.	Jukovskiy ranniy RU)	81,8	22	73	63	2,6	0,44	30,8	2248,4
5.	Impala (NL)	94,6	20	75	71	2,9	0,47	32,9	2467,5
6.	Lileya (RU)	90,5	20	74	68	2,5	0,45	31,5	2331,0
7.	Latona (NL)	96,7	22	75	71	3,2	0,50	35	2590,0
8.	Binella (NL)	98,1	21	74	84	3,6	0,52	36,4	2693,6
9.	Karatop (NL)	98,6	20	75	82	3,8	0,55	38,5	2887,5
10.	Signal (RU)	94,1	22	72	75	3,3	0,48	33,6	2419,2
11.	Timo (FI)	75,3	25	73	66	2,5	0,42	29,4	2146,2
12.	Belosnejka (RU)	83,0	23	75	68	2,9	0,42	29,4	2205,0
13.	Bronniskiy (RU)	81,7	25	73	65	2,6	0,42	29,4	2146,2
14.	Ultraeshim (UZ)	96,2	18	74	73	3,6	0,54	37,8	2797,2
In early varieties (76-80 days)									
15.	Red Skarlet (NL) **ct.**	94,5	21	76	73	3,0	0,48	33,6	2553,6
16.	Udacha (RU)	92,2	22	78	77	3,2	0,47	32,9	2566,2
17.	Ulador (RU)	85,1	25	76	69	2,7	0,45	31,5	2394,0
18.	Ariel (RU)	90,4	24	76	71	3,3	0,43	30,1	2287,6
19.	Izora (RU)	85,5	23	79	70	3,0	0,44	30,8	2433,2
20.	Bolotonii (HU)	89,2	24	78	73	2,8	0,42	29,4	2293,2
21.	Botonia (HU)	92,5	23	76	70	2,5	0,42	29,4	2234,4
22.	Etinw (HU)	86,0	24	78	73	2,4	0,43	30,1	2347,8
23.	Demon (HU)	87,2	25	80	70	2,1	0,42	29,4	2352,0
24.	Aripsi Arany (HU)	91,8	26	80	79	2,7	0,48	33,6	2688,0
25.	Kurado (NL)	97,3	25	78	75	2,4	0,48	33,6	2620,8
26.	Arizona (NL)	96,5	22	76	80	3,0	0,50	35,0	2660,0
27.	Gala(DYe)	95,8	25	79	69	3,5	0,49	34,3	2709,7
28.	Amerikanes (USA)	96,4	22	80	72	3,4	0,52	36,4	2912,0
29.	Yangi Uzbekistan (UZ)	95,7	20	76	70	3,2	0,54	37,8	2872,8
30.	Turkistan (TR)	93,2	20	80	68	2,9	0,52	36,4	2912,0
In mid-early varieties (81-90 days)									
31.	09.688 (HU)	84,1	24	82	74	2,4	0,46	32,2	2640,4
32.	Romano (NL)	93,8	28	83	72	2,5	0,47	32,9	2730,7
33.	Pikasso (NL)	92,5	27	85	84	2,8	0,48	33,6	2856,0
34.	Evolution (NL)	96,7	24	81	83	3,3	0,52	36,4	2948,4
35.	Sante (NL) **ct.**	98,3	25	83	65	3,1	0,48	33,6	2721,8
36.	Sylvana (NL)	97,4	19	81	84	3,5	0,55	38,5	3118,5
37.	Saviola (NL)	98,7	18	84	89	3,8	0,57	39,9	3351,6

Table 2. Productivity indicators of potato varieties as a double cropping crop under field conditions

№	Variety name and origin	At the end of flowering, 1 per bush, per gram				Comprehensive productivity indicators				
		weight of bush	Root mass in the 0-25 cm layer	a tuber yield	the ratio of bush to tuber	Tuber yield from 1 bush, g	The number of tubers on 1 bush, pcs	Average weight of tubers in 1 bush, g	Small tubers of 25 grams	
									pcs	weight, g
In very early varieties (70-75 days)										
1.	Quvonch-16/56m (UZ)-**ct**	303	26,3	592	1:2,0	648	6,0	108	-	-
2.	Surxon - 1 (UZ)	276	25,1	564	1:2,0	621	5,2	119	-	-
3.	Alyona (RU)	274	24,5	440	1:1,6	493	5,6	88	2	45
4.	Jukovskiy ranniy RU)	245	24,0	435	1:1,8	481	5,8	83	1	28
5.	Impala (NL)	283	26,8	486	1:1,7	536	6,2	86	-	-
6.	Lileya (RU)	256	25,4	422	1:1,7	472	6,0	79	-	-
7.	Latona (NL)	310	28,4	598	1:1,9	646	8,0	81	-	-
8.	Binella (NL)	336	28,8	641	1:1,9	702	6,4	110	-	-
9..	Karatop (NL)	328	29,0	632	1:1,9	687	6,6	104	-	-
10.	Signal (RU)	283	27,4	464	1:1,6	513	5,7	90	-	-
11.	Timo (FI)	251	24,1	402	1:1,6	438	5,7	77	1	24
12.	Belosnejka (RU)	258	24,7	418	1:1,6	447	7,4	60	1	20
13.	Bronniskiy (RU)	278	25,1	431	1:1,6	488	7,0	70	1	22
14.	Ultraeshim (UZ)	342	28,9	742	1:2,2	796	5,7	140	-	-
In early varieties (76-80 days)										
15.	Red Skarlet (NL) **ct.**	314	27,1	520	1:1,7	571	6,3	91	-	-
16.	Udacha (RU)	315	27,9	505	1:1,6	549	6,3	87	-	-
17.	Ulador (RU)	274	26,3	488	1:1,8	527	5,8	91	2	36
18.	Ariel (RU)	284	27,2	590	1:2,1	634	6,3	101	-	-
19.	Izora (RU)	276	25,4	480	1:1,7	539	5,8	93	1	31
20.	Bolotonii (HU)	294	25,8	444	1:1,5	496	6,2	80	2	50
21.	Botonia (HU)	272	26,0	415	1:1,5	472	6,0	79	2	43
22.	Etinw (HU)	296	26,4	462	1:1,6	504	5,7	88	-	-
23.	Demon (HU)	304	26,4	474	1:1,6	520	6,0	87	1	23
24.	Aripsi Arany (HU)	308	26,3	473	1:1,5	513	7,0	73	2	43
25.	Kurado (NL)	319	27,1	627	1:2,0	687	5,6	123	-	-
26.	Arizona (NL)	356	28,8	676	1:1,9	742	7,5	99	-	-
27.	Gala(DYe)	323	29,0	619	1:1,9	648	8,0	81	-	-
28.	Amerikanes (USA)	363	27,4	704	1:1,9	747	5,2	144	-	-
29.	Yangi Uzbekistan (UZ)	368	28,3	716	1:2,0	778	6,0	130	-	-
30.	Turkistan (TR)	346	27,5	613	1:1,8	659	5,7	116	-	-
In mid-early varieties (81-90 days)										
31.	09.688 (HU)	318	27,5	658	1:2,0	702	8,0	87	-	-
32.	Romano (NL)	265	25,5	403	1:1,5	444	6,5	68	1	24
33.	Pikasso (NL)	333	27,7	642	1:1,9	687	6,5	106	-	-
34.	Evolution (NL)	348	28,6	685	1:2,0	724	6,4	113	-	-
35.	Sante (NL) **ct.**	365	29,4	690	1:1,9	763	6,7	114	-	-
36.	Sylvana (NL)	375	29,4	786	1:2,1	825	8,2	101	-	-
37.	Saviola (NL)	386	29,8	798	1:2,1	867	8,4	103	-	-

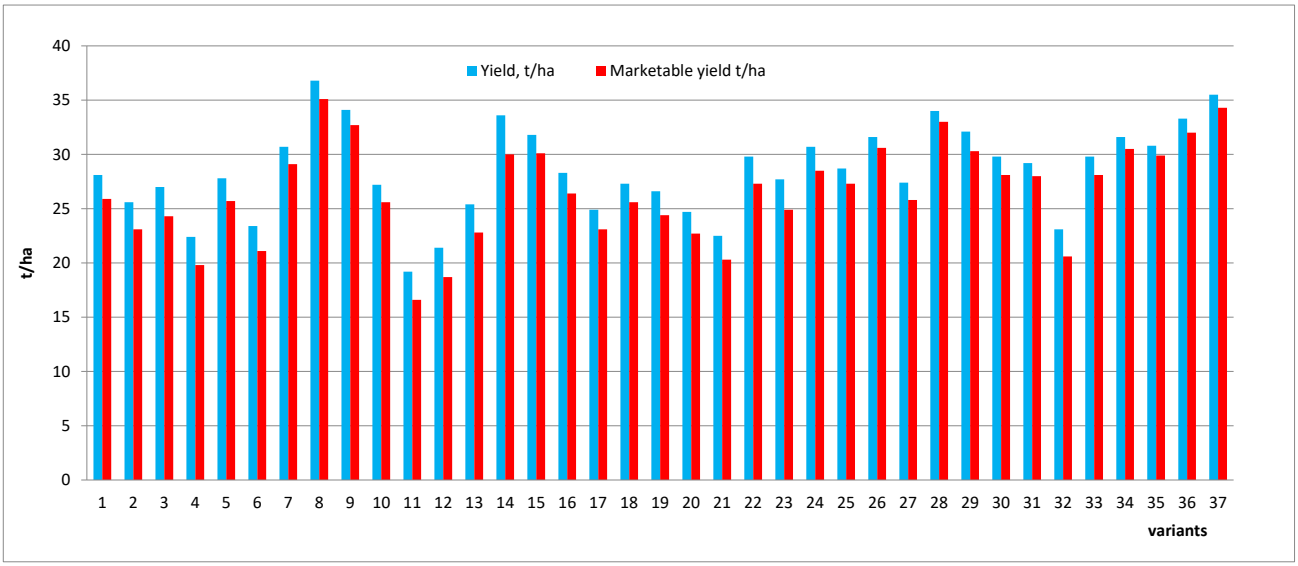

Figure 1. Productivity and marketability of potato varieties with a double-cropping

Picture 1. Shape, color, and closure of the tip of the seed tuber. Yangi Uzbekistan verity (B), Ultraeshim verity (A)

t/ha), Sylvana (32.0 t/ha), Saviola (34.3 t/ha). These varieties, compared to standard varieties, contributed to an increase in yield of 2.6-8.7 tons per hectare.

CONCLUSIONS

1. The studied potato varieties when planted with freshly harvested tubers in summer differ

significantly in the germination of seed tubers, the formation of tops, stems, leaf surface, photosynthetic potential on plantings, as well as in marketable yield. It was revealed that the studied varieties differ significantly in the germination of tubers, the formation of top stems, and leaf surfaces, as well as in marketable yield. The highest field germination of tubers (95.2 - 98.7%), stem formation (2.9 - 3.8 pcs.), leaf surface (33.6 - 39.9 thousand m^2 per 1 ha), photosynthetic potential on plantings (2590.0 - 3351.6 thousand m^2), powerful tops and root systems with intensively accumulating yield.

2. The highest field germination of tubers (95.2 - 98.7%), multi-stemmed (2.9 - 3.8 pieces), tall (71 - 89 cm), leaf surface area (33.6 - 39.9 thousand m^2/ha), photosynthetic potential on plantings (2590.0 - 3351.6 thousand m^2/ha x day), powerful tops and root system, as well as intensively developing productive bushes (687 - 867 g tuber yield), the greatest the harvest of marketable tubers was obtained from the varieties: in very early – Latona, Binella, Karatop, Ultraeshim; in early – Arizona, American, YangiUzbekistan; in mid-early – Evolution, Pikasso, Sylvana, Saviola. At the same time, the yield increase was 2.6 - 8.7 tons per hectare compared to standard potato varieties.

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