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## LEAF AREA AND PHOTOSYNTHESIS POTENTIAL OF THE SUNFLOWER CROPS DEPENDING ON THE CONDITIONS OF CULTIVATION

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*The research results of the study of peculiarities of leaf area formation and photosynthesis potential of the sunflower hybrids of different terms of ripening in the Right-Bank Forest-Steppe of Ukraine are observed.*

The main photosynthetic organs of plants are leaves, and photosynthesis, which occurs in them is a unique process of converting light energy into energy of chemical bonds necessary for the overall metabolism of plants and includes sequential photosynthetic reactions that occur in the plant due to the energy of photosynthetically-active spectrum of solar radiation [5-7].

Photosynthesis of sowing is irregular at different periods of crops vegetation.

The total accumulation of vegetative mass depends both on the leaf surface, which is formed during the interfacial periods of growth and development of plants in sowing and duration of this period. The product of such values as the average leaf area in the interphase period and the length of this period will show interfacial potential of crop capacity (IPC) [6-9].

In the result we obtain overall index of photosynthetic potential of sowing (PPS) for individual plant [3, 4, 10]. This magnitude allows predicting crop capacity, influencing on this variety (hybrid) index and cultivation techniques [1, 3, 10 and others].

**The purpose of the research** is to study the dynamics of leaf area formation and photosynthetic potential according to the cultivation methods of sunflower in the southern part of the Right-bank Forest-Steppe of Ukraine.

**Objectives of the research are:**

- to determine the length of interfacial vegetative periods of sunflower hybrids which mature in different time;
- to examine the leaf surface formation depending on the methods of cultivation;
- to study the impact of hybrid, row spacing and sowing density on photosynthetic potential of sowing of sunflower hybrids which mature in different time.

**Methods of the research.** This research was conducted in 2011-2012 on the experimental field in field crop rotation of Department of Plant Growing. The field belongs to educational-scientific production department of Uman National University of Horticulture. The soil layer of crop rotation was represented by podzolized black soil low-regraded heavy loamy on carbonate loess which is typical for steppe zone.

On average for the years of the research nitrogen content before sunflower sowing after winter wheat was 32.1 mg/kg, phosphorus was 146 mg/kg, potassium – 165 mg/kg of completely dry soil. Cultivation technology of sunflower is common for the southern part of the Right-bank Forest-Steppe of Ukraine except the questions under studying.

Weather conditions during the research were relatively favorable for sunflower growing. At this time these conditions characterized by a relatively rapid increase in air temperature, which in turn led to reduction in the first half of crops vegetation period, and ultimately had a significant impact on crops vegetation in general [4-5].

Sowing of sunflower hybrids which mature in different time – Zahrava (early maturing) and Ukrainskyi F1 (medium-early maturing) was conducted in the second decade of April with a row spacing of 45 and 70 cm. Sowing density is 50, 70 and 90 th./ha. Experiment was triple, section location is systematic.

Area of the research plot is 120 m<sup>2</sup>, area for accounting is 50m<sup>2</sup>. Harvesting was done with a combine "Yenysei-950" but with previous plants sampling in the territory of 1 m<sup>2</sup> at two noncontiguous repetitions for structural analysis.

Vegetation phase was determined by the occurrence of 75% of plants and the duration of interphase period of the plant was counted.

Dynamics of leaf surface was determined in phases of 6-8 and 12-14 leaves, the phase of 12-14 leaves – calathidium formation and calathidium formation – flowering. On this basis taking into consideration the duration of the interphase periods and average leaf area we defined photosynthetic potential of sowing (PhPS).

At the area in phases mentioned before we counted the number of plants by measuring their height, selected 10 plants at variants, defined wet and dry weight.

Area of green leaves was calculated by the formula:

$S_n = 0,74ab$ , where  $S_n$  is area of one leaf, cm<sup>2</sup>;  $a$  is maximum width of a leaf, cm;  $b$  is a leaf length cm; 0,74 – coefficient that represented the leaf configuration.

Interfacial photosynthetic potential was determined by the next formula:

$PhP = \frac{L1+L2}{2 \times 1000} D$ , where  $L1, L2$  is leaf area during certain phases of development, thousand m<sup>2</sup>/ha,  $D$  – duration of interphase period, day [2, 10-11].

**Results of the research.** Speaking about the duration of sowing, the seedlings in both hybrids differed slightly, but middle-early hybrid Ukrainskyi F1 took two more days longer (Table 1).

During the subsequent crop vegetation the difference in the duration of the interphase periods increased, especially in the flowering stage, when it was 10-11 days. It mainly caused general difference in duration of vegetation period of hybrids.

Width of row spacing also affected the duration of the interphase periods. Thus, interphase period of seedlings – calathidium formation in early maturing hybrid Zahrava at sowing with 45 cm row spacing was shorter for three days, during the formation of calathidium – flowering – for two days. But in this period of vegetation the difference in duration of interphase period in middle-early hybrid Ukrainskyi F1 was not observed.

The main effect on duration of vegetation period in hybrids had interfacial period of flowering – full ripeness. The difference in duration of vegetation period

depending on the width of row spacing was preserved: the early maturing hybrid Zahrava at the sowing area with row spacing of 45 cm was shorter for five days, in middle-early hybrid Ukrainskyi F1 for three days. Sowing density did not affect the duration of the interphase periods of plants.

### 1. Duration interphase periods of the sunflower hybrids of different terms, days (average for 2011-2012)

Hybrid	Row spacing, cm	Planting–germination	Seedlings – calathidium formation	Calathidium formation – flowering	Flowering – full ripeness	The growing season
Zahrava	45	10	31	17	37	95
	70	10	28	15	31	90
Ukrainskyi F1	45	12	36	17	47	108
	70	12	32	17	42	105

We also found that depending on the sowing density the leaf area in different phases changed and varied from year to year (Table 2).

In the period of 6-8 and 12-14 leaves the average area of mature sunflower leaf surface during the vegetation period in 2011-2012 was the lowest in both hybrids at plants density of 50 thousand/ha and depending on the width of row spacing was 21,0 – 27,3 in Zahrava hybrid, and 20,8 – 24,7 in hybrid Ukrainskyi F1.

Later in the phase of 12-14 leaves – calathidium formation area of leaf surface increased and was 50,8 in hybrid Zahrava with density of 50 thousand/ha and with row spacing of 70 cm, but it was 54,8 with density of 90 thousand/ha and with row spacing of 70 cm, that in comparison with the control density of 70 thousand/ha and row spacing of 70 cm was 53,0, higher in 1,8 respectively. The same tendency was noticed at variants with the width of 45 cm between rows.

Leaf area during our research formed before the end of flowering phase. Thus, on average, greater leaf area with plants density of 90 thousand/ha and row spacing of 70 cm in the phase of calathidium formation – flowering was observed in early maturing hybrid Zahrava – 80,7 thousand m<sup>2</sup>/ha, less in medium-early Ukrainskyi F1 – 78,0 thousand m<sup>2</sup>/ha.

For interphase photosynthetic potential of sowing (IPhPS), these values were also higher in the above mentioned phase and was 1139,0 in hybrid Zahrava with a width of 45 cm between rows and density of 50 thousand/ha which is 3,4 greater than 1135,6 in hybrid Ukrainskyi F1. With a width of 70 cm between rows and density of 50 thousand/ha hybrid Zahrava provided 1276,7 which is 188,7 greater than 1088 in hybrid Ukrainskyi F1, but this difference is more significant, which shows the dependence of row spacing from the value of IPhPS.

During the research the value of photosynthetic potential of sowing was also found. Thus, during growing sunflowers after winter wheat with row spacing of 70 cm and plant density of 90 thousand/ha PPS was 2,6 million m<sup>2</sup>/ha days in hybrid

Ukrainskyi F1, the worse rate was observed at row spacing of 45 cm and plant density of 50 thousand/ha – 2,1 million m<sup>2</sup>/ha days.

## 2. Dynamics of leaf surface growth and interfacial photosynthetic potential in sowing of sunflower hybrids which mature in different time, depending on the width of row spacing and density, thousand m<sup>2</sup>/ha.

Hybrid	Row spacing, sm	Density of plants, thousand / ha	Interphase periods						
			6–8 leaves – 12–14 leaves		12–14 leaves – calathidium formation		calathidium formation – flowering.		6–8 leaves – flowering
			15 days		16 days		17 days		48 days
			average leaf area, thousand m <sup>2</sup> /ha	*IPhPS	average leaf area, thousand m <sup>2</sup> /ha	IPhPS	average leaf area, thousand m <sup>2</sup> /ha	IPhPS	PPS
Zahrava	70	50	27,3	409,5	50,8	812,8	75,1	1276,7	2,5
		70(C <sub>1</sub> )	28,4	426,0	53,0	848,0	78,0	1326,0	2,6
		90	30,1	451,5	54,8	876,8	80,7	1371,9	2,7
	45	50	21,0	315,0	40,6	649,6	67,0	1139,0	2,1
		70	23,6	354,0	43,4	694,4	67,8	1152,6	2,2
		90	25,6	384,0	45,9	734,4	69,9	1188,3	2,3
Ukrainskyi F1	70	50	24,7	370,5	46,3	740,8	64,0	1088,0	2,2
		70(C <sub>1</sub> )	26,0	390,0	51,3	820,8	69,9	1188,3	2,4
		90	28,5	427,5	52,9	846,4	78,0	1326,0	2,6
	45	50	20,8	312,0	40,5	648,0	66,8	1135,6	2,1
		70	23,4	351,0	43,5	696,0	67,8	1152,6	2,2
		90	25,3	379,5	45,8	732,8	69,5	1181,5	2,3

\*IPhPS- interfacial photosynthetic potential crop

Better photosynthetic potential of sunflower sowing, through the active growth of leaf apparatus, was received in hybrid Zahrava with plant density of 90 thousand/ha and row spacing of 70 cm – 2,7 million square meters/ha days.

**Conclusions.** The results of the conducted research prove that in the phase of heads formation–flowering time the average leaf area had higher indices with the crops density 90 thousand plants per hectare and row–width spacing of 70 cm: early ripening hybrid Zahrava had 80,7 thousand square meters per hectare while mid-ripening hybrid Ukrainskyi F1 had 78,0 thousand square meters per hectare in comparison with the control which had the crops density 70 thousand square meters per hectare and row-width spacing 70 cm where the leaf area comprised 78,0 and 69,9 thousand square meters per hectare.

Photosynthesis potential of the sunflower in the phase of heads formation–flowering time was also higher with the crops density 90 thousand per hectare and row-width spacing of 70 cm: early ripening hybrid Zahrava comprised 2,7 million square meters per hectare days while mid-ripening hybrid Ukrainskyi F1 had 2,6 mln. square meters/hectare days in comparison with the control, where the density was 70 thousand plants per hectares and row–width spacing was 70 cm, photosynthesis potential comprised 2,6 and 2,4 mln. square meters/hectare days correspondingly.

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