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PHYTOTRON STUDIES OF SUNFLOWER

The phytotron of the V. S. Pustovoit All-Union Research Institute for Oil Crops in Krasnodar is mainly intended for breeding work and applied studies in physiology, biochemistry and plant protection against diseases and pests, involving oil crops such as sunflower, soybean, castor bean, linseed, mustard, and rapeseed.

Wide utilization of the phytotron method in oil crops breeding and genetic research became possible only after the technical characteristics of the phytotron had been studies and special methods of growing oil crops in artificial environment had been elaborated.

One of the first problems is the determination of the most suitable sources of permanent artificial radiation for the light culture of oil crops. Soviet and foreign made electric lamps were tested. The results of experiments have shown that the high pressure arc mercury luminescent lamps of 400 and 700 W are most suitable for the growth and development of sunflower and other oil crops. The subsequent series of studies was geared to studying the influence of certain factors of the controlled environment on the growth and yield formation of the plants. Experimental data have shown the importance of the light intensity and duration for growing sunflower in artificial environment. It was found that light intensity under 25-30 Klux, that is, when the power of the light flow is under 100-120 wt/sq m, adversely influences sunflower growth and productivity. Furthermore, sunflower reaction to the duration of daily illumination was also studied (Table 1).

Experiments were conducted to ascertain the influence of photoperiods in which the light period in the day cycle was changed, the dark period remaining constant at 8 hours.

Table 1

Influence of Photoperiods in the Daily Cycle on Sunflower Productivity

Duration in hours			Seed quantity in the head		Seed weight per one plant	Oil content of seed, %	Dry matter of plants, g
daily cycle	light period	dark period	total	including valid, %			
-	24	0	2479	50	48	50.9	181
18	16	2	2347	41	41	48.7	165
20	16	4	2524	52	56	50.7	189
22	16	6	2538	56	45	52.2	156
24	16	8	2194	60	46	51.9	179

It was found that sunflower rather easily adapts itself to different photoperiods and may be grown to obtain quality seed both under 16 and 12 hours of daily illumination provided the power of the luminous flow is at least 100 wt/sq m. Under phytotron conditions the 20 hours day cycle may be established to grow sunflower.

Drawing on the studies of the power of luminous flow and the duration of illumination at different periods of sunflower onthogenesis we have designed a method of preliminary light stimulation of seedlings for further growing at lower illumination levels in the greenhouse in winter (Table 2).

Preliminary radiation of sunflower seedlings in vegetation chambers during 15 days and their further transfer into ground greenhouses help reduce the vegetation period by 13 days and increase their productivity by 80% compared with the plants sown directly in the greenhouses.

Table 2

Influence of Preliminary Luminous Stimulation of Sunflower Seedlings in Vegetation Chambers on the Subsequent Growth and Yield in Ground Greenhouses

Length of illumination in chamber, days	Vegetation period, days	Plant height, cm	Number of leaves	Leaf area per plant, sq cm	Dry weight per plant, g	Number of seeds per head		Mass of seed, g
						total	including good seed, %	
0	120	332	39	12094	263	1406	26	26
15	107	206	27	8630	232	1367	46	47
20	101	183	27	6739	173	1043	58	43
30	95	168	25	4842	110	771	66	33

Further increase of preliminary growing of seedlings in chambers to 20-30 days resulted in a further reduction of the vegetation period by 25 days, though plant productivity decreased.

Among the data obtained in the series of experiments to determine the influence of temperature on sunflower growth and development importance attaches to the data on sunflower reaction when growing it at elevated temperatures, as well as data on the temperature factor in the daily cycle (Table 3).

Elevated temperatures (+38 +40°C) during the light period of the day reduce sunflower productivity and adversely affect the process of oil formation.

Table 3

Sunflower Productivity in Relation to the Temperature in the Day Cycle

Air temperature in the chamber, °C		Seed quantity in the head		Seed weight per plant, g	Oil content, %	Dry weight of the plant, g
light period	dark period	total	valid among them			
27	22	1805	66	59	46.7	171
27	-27	2402	45	37	38.6	193
22	-22	1798	65	44	44.9	162

The results obtained show that the plant productivity grows under alternating temperatures of day and night.

The phytotron is intended for the production of two or three generations of valuable breeding and genetic material during one year. For this it is necessary to develop special means of soil management specific to the conditions of climatic chambers of the phytotron. The laboratory of ar-

tificial climate has determined the optimal dates of autumn and winter sowing of sunflower breeding material in ground greenhouses, and the optimal plant densities (nutrition areas). The latter considerably affect sunflower productivity. To obtain large seeds with the 1000 seed weight of about 60-70 g it is necessary to grow 2 plants per 1 square meter of the greenhouse soil. If the task is set to obtain a larger quantity of seed from a unit area, in the case of multiplication of valuable breeding samples, 7 plants may be grown per one square meter. At such a density the multiplication coefficient increases 50% as compared with 2 plants per 1 square meter, but the seeds are in this case smaller in size.

Results of these and other experiments (which are not reflected in this paper) serve as grounds for developing optimal illumination, temperature and other regimes and in general a technology of growing valuable breeding and genetic sunflower in artificial environment.

Other laboratories of the Institute use special methods geared to the phytotron conduct to evaluate during autumn and winter, sunflower breeding material for resistance to broomrape (Orobanche cumana Wallr.), downy mildew (Plasmopara helianthi Nowot), verticillium wilt (Verticillium dahliae Kled.), phoma sp. (Phoma sp.), rust (Puccinia helianthi Schw.), and ash rot (Sclerotium bataticola Taub.). In sum, over 50,000 breeding samples are evaluated in autumn and winter. During the same period sterile inbreds and their fertile counterparts are developed on the basis of cytoplasmic male sterility in ground climatic greenhouses, and the type of inheritance of male nuclear or cytoplasmic sterility is studied.