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RELATIONSHIP BETWEEN STAND DENSITY AND MICROCLIMATE AND THEIR EFFECT ON SOME CHARACTERS OF SUNFLOWER

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Abstract

A three-year study on the relationship between stand density and microclimate in the plot and their effect on some characters of the domestic sunflower hybrid NS-H-26-RM showed that stand density affected some microclimatic factors, e.g., temperature and relative air humidity. Sunflower plants modified the temperature and relative air humidity in the plot, the extent of modification depending on stand density and stage of plant development. In the period from flower to the beginning of slow oil synthesis, the mean air temperature in the variants with 47,000 and 55,000 plants was lower by 2.6°C than in the control.

Relative air humidity was increased in the period from budding to slow oil synthesis, to decrease considerably after that stage.

The modified microclimate affected the progress of photosynthesis. Significant differences were found among the variants of stand density in the content of tocopherol and the ratios of essential fatty acids in sunflower oil. The content of linoleic acid was positively correlated with increased density, i.e., lower air temperature in the plot. The highest yield of seed was obtained in the variant with 47,000 plants/ha in which the air temperature was considerably lowered and the relative air humidity did not exceed 75%.

Introduction

There have been few studies on the ecophysiology of cultivated phytocoenoses. Geiger (1975) studied the effect of plant coenoses on some microclimatic factors. There is, however, a limited number of papers which deal with the relationship between sunflower plants and the microclimate in the plot. Bregetov (1958) stated that sunflower plants fight sudden temperature variations by intensifying the transpiration which, in turn, lowers the air temperature in the plot. Discussing the importance of microclimate in sunflower plots, Vrebalov (1978) mentioned that temperature and relative air humidity undergo large variations in the course of the growing season, affecting indirectly the yield of seed.

The objective of this study was to find the relationship between plant number per unit area on one side and important microclimatic factors on the other as well as to estimate the effects of plant number and microclimatic factors on the main characters of sunflower seed.

Material and Method

Field trials, on smonitza soil, were carried out after the method of random blocks in five replications. We used the domestic hybrid NS-H-26-RM which was planted in the following variants of stand density: 66,000, 55,000, 47,000, 40.000, and 31,000 plants/ha.

Microclimatic measurements, i.e., the variations of temperature and relative air humidity in the experimental plot, were made by sheltered thermohygrographs, in three densities: 55,000, 47,000, and 31,000 plants/ha. The measurements were done at two heights: 50 cm above soil surface and at the height of the heads.

Fatty acids were determined gas chromatographically, tocopherol by the method of Emerie-Engel.

Results

Effect of plant number on the phytoclimatic factors

Tables 1 and 2 show that stand density did bear effect on the temperature and relative air humidity in the plot.

Air temperature

All variants, at all development stages, had lower mean air temperatures at 50 cm above the ground in relation to the control. The actual values depended on the variant and development stage. Largest differences were found at the stages of flower and intensive seed filling, 1.5-2.6^{o}C lower than in the control. The differences were smaller at the stage of intensive plant growth (June) and slow oil synthesis (August), from 0.2 to 2.3^{o}C. The observed pattern may be explained by the development of sunflower foliage. In the period of 18-20 days after flower, sunflower plants reach their maximum size and they have the maximum leaf area which modifies the micro environmental factors by its physiological activity.

The extent of temperature variation was dependent on plant number. The variants with increased stand density (55,000 and 47,000 plants/ha) were more different from the control regarding the mean air temperature than the variant with 31,000 plants/ha. In the period from flower to slow oil synthesis, the mean temperature in the former variants was significantly lower than in the control, by 2.6^{o}C. The mean temperature in the latter variant was lower by 1.8^{o}C. A detailed analysis of the temperature variations showed that the differences in mean air temperature were even larger when considered for a shorter interval. For example, the mean air

Tab. 1. Air temperature variations per stages of plants development and stand densites in relation to the control

Stage of development	Mean (+-)			Max (+-)			Min (+-)		
	1	2	3	1	2	3	1	2	3
At 0,5 m									
Intensive growth-flowering	-2,3	- 2,1,5		-2,3	-2,1	1,8	-0,1	-0,3	-o,2
Flovering-1st stage of filling	-2,6	-2,6	-1,8	-2,2	-2,2	- 1,6	+0,2	+0,1	-0,3
2nd stage of seed filling	-1,7	-1,9	-1,8	-1,1	-0,6	-0,8	-1,1	-1,0	-1,0
At the level of top leaves									
Flowering-1st stage of filling	-0,9	-0,8	-0,6	+2,5	+1,3	+1,7	-0,6	-0,6	-0,7
2nd stage of filling	-0,8	-0,1	-0,9	+1,9	+2,6	+2,7	-0,9	-1,0	-0,8

- Planting variants: 1 = 55.000 planis/ha
2 = 47.000 "
3 = 31.000 "

Tab. 2. Relative air humidity variations per stages od plant development and stand densities in relation to the gontrol

	Mean (+-)			Max (+-)			Min (+-)		
	1	2	3	1	2	3	1	2	3
At 0,5 m									
Intentensive growth-flowering	+5	+2	+1	+1	0	+12	+12	+9	+10
Flowering-1st stage of filling	+7	+3	+2	0	+1	0	+8	+2	+3
2nd stage of seed filling	-5	-5	-5	-1	+1	-1	-1	-1	-2
At the level of top leaves									
Flowering-1st stage of filling	-8	-8	-9	-5	-6	-9	-3	-2	-2
2nd stage of filling	-8	-10	-10	-5	-7	-9	-2	-2	-3

Plabting variants: 1=55.000 plants/ha
2=47.000 "
3=31.000 "

temperatures in the variants with 47,000 and 31,000 plants/ha at the stage of flower were lower by 6.2 and 4.6°C, respectively, in relation to the control.

The maximum temperatures of the lower air strata in the plot were lower than in the control by 1.6-2.3°C. At shorter intervals (e.g., the stage of oil synthesis), the differences were 4°C or more, and these could affect the normal functioning of sunflower leaves.

Air temperatures at the level of sunflower heads varied from those at 50 cm from the ground. The mean temperatures were fairly uniform among the variants and in relation to the control.

Relative air humidity

Plant number per unit area bore effect on the relative air humidity in the experimental plot. The variants had an increased relative air humidity at 50 cm from the ground in relation to the control. The relative air humidity stayed high from the stage of intensive growth until the bottom leaves ceased to function.

The situation was different at the level of the heads. The mean, maximum, and minimum relative air humidities were lower in all variants than in the control.

It was concluded that there exists a relationship between stand density and the microclimatic factors which could affect certain physiological processes in sunflower plants.

Quality characters of sunflower seed

The yield of seed varied in dependence of the variant of stand density and, consequently, of the microclimatic conditions in the plot (Table 3). The three-year average yield of seed increased to the variant of 47,000 plants/ha and then decreased so that the average yield in the variant with the highest density equaled the yield of the variant with the lowest density.

Tab. 3 - Quantitative characters of sunflower seed (NS-H-26-RM) depending on stand density and microclimate

Plant no. per ha		Seed yield kg/ha	Oil content %	Tocopherol cont. in oil (mg/100 gr)	Linoleic acid cont. in oil (%)
66,000		2.810	48,74	73,37	66,322
55,000		2.956	47,27	-	-
47,000		3.262	46,88	80,05	65,838
40,000		2.891	46,47	77,52	64,519
31,000		2.715	45,57	74,76	64,801
Average		2.927	46,98	76,42	65,370
LSD	5%	137	1,47	3,95	1,02
	1%	182	1,95	5,84	2,25

Plant number per unit area affected the tocopherol content in sunflower oil (Table 3). The highest three-year average tocopherol content, 78.05 mg/100 gr oil, was found in the variant with 47,000 plants/ha. The content in the variant with 40,000 plants/ha was nonsignificantly lower, 77.52 mg. The content in the variant with 66.000 plants/ha was significantly lower than the highest, at LSD 1%, by 6.68 mg.

It was characteristic for the content of tocopherol in oil that it went down in the extreme variants (66,000 and 31,000 plants/ha) and remained steady with the medium densities (47,000 and 40,000 plants/ha). The latter variants obviously create favorable microclimatic conditions for the synthesis of tocopherol.

In general, stand density did not affect largely the contents of fatty acids. The only exception was linoleic acid whose content increased with higher stand density (Table 3). The difference between the highest and the lowest content of linoleic acid was 1.801%.

A number of authors agree that the content of linoleic acid depends primarily on genetic factors (Ćupina, 1977; Škorić et al., 1978), but also on climatic factors (Borudilina, 1974). Among the latter factors, the most important is the air temperature at the stage of oil synthesis. In this experiment, we found that the variant with the lowest density (31,000 plants/ha) had the lowest mean and maximum air temperatures in the course of seed filling. That may explain the increased contents of linoleic acid in the variants with high density.

Optimum stands for maximum yields of seed and oil are variables which depend on a number of factors. One of them is microclimate, formed by environmental factors and stand density. Thus, plant number per unit area regulates not only the size of vegetation area for the sake of improved nutrition but also the microclimate in sunflower plots. Our results indicate that the stand of 47,000 plants/ha creates most favorable temperature and relative air humidity for the functioning of sunflower leaves, i.e., the process of photosynthesis which in turn determines the quality characters of sunflower seed, i.e., oil.

Conclusion

Plant number per unit area affects largely the phytoclimatic factors, temperature and relative air humidity in the plot. Sunflower plants modify the environmental conditions, the degree of modification depending on stand density, stage of plant development, and the position of air strata in relation to plants.

A relationship was found between stand density and microclimatic factors (temperature and relative air humidity) which affects some important physiological processes in sunflower plants.

The ratio tocopherol vs. linoleic acid in oil was more favorable in the variants of stand density which brought highest seed yields, i.e., in the variants with most favorable temperature and relative air humidity in the plot during the growing season.

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