# EFFECT OF STAND DENSITY ON SUNFLOWER SEED YIELD AND QUALITY CHARACTERS OF OIL

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## INTRODUCTION

Plant number per area unit is one of the decisive factors in the realization of yielding potentials of the sunflower. Recently, new cultivars have been developed which vary in biological and productional characters. A better knowledge of these characters is important both for qualitative and quantitative improvements of sunflower yields and for further breeding work.

Recent studies have hinted at a complex interaction among plants grown at different stand densities. Besides the competition for soil moisture and nutrients (Dyakov, 1976; Ostrovsky, 1976), there occur considerable morphological changes which affect the microclimate in sunflower plots (Vrebalov, 1966). These occurrences are closely related to the photosynthetic process which, in turn, affects the productivity and other characters of the sunflower.

The biological value of fats has been studied intensively. Fatty acids and lipo-soluble vitamins are equally important for a correct human diet. It has been proved that poly-unsaturated fatty acids, especially the linoleic acid, reduce the cholesterol in blood. However, excessive quantities of linoleic acid may cause negative effects if there is an imbalance between the poly-unsaturated fatty acids and tocopherol (4).

A number of authors studied the ration alpha-tocopherol (vitamin E) vs. linoleic acid. Jager (1968) stated that a human organism

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requires a certain quantity of vitamin E which is not dependent on the quantities of linoleic acid in the diet. On the other hand, some authors declared that the increase in the quantities of linoleic acid must be followed by corresponding increases in alpha-tocopherol (5), specifically, that each gram of linoleic acid requires at least 0.5 mg of alpha-tocopherol. Weber et al. (6) also arrived at similar conclusions. Hove and Harris maintained that the value of vitamin E must exceed 0.79 mg, similarly as Viola (7). A human organism is capable of utilizing completely the consumed linoleic acid, i.e., this essential fatty acid is biologically valuable only if the above requirement for alpha-tocopherol has been met (4). Therefore, plant oils which satisfy this requirement are desirable for human nutrition. From this viewpoint, cotton and sunflower oil keep the leading position. Some authors believe that the daily requirement of human organism for vitamin E is 15 mg. Matijasevic and Turkulov (4) reported that the oil of Soviet sunflower varieties grown in ecological conditions of Vojvodina has a favorable ratio linoleic acid vs. alpha-tocopherol.

The objective of this investigation was to find eventual changes in productivity per area unit and in qualitative characters of oil, primarily the composition of fatty acids and tocopherol content, of domestic sunflower hybrids grown at different stand densities.

## MATERIALS AND METHODS

Experiments were conducted on two domestic hybrids, NS-H-26-RM and NS-H-67-RM, which differ in morphological and biological characters. The former is mid-early, short, with a well-developed foliage. The latter is later and taller. Field experiments with different stand densities were performed at the experimental field of the Agricultural Department in Zajecar, on smonitza soil. Three variants of stand density were examined: 66,666 plants/ha (50 x 30 cm), 40,816 plants/ha (70 x 35 cm) (standard), and 31,250 plants/ha (80 x 40 cm). The method of random blocks in five replications was used. The experimental plot was harvested when the crop reached the stage of technological maturity. The sampling for chemical analyses of oil was performed during the harvest.

After the extraction, oil samples were analysed for total content of tocopherol by the method of Emmery and Engel and for the contents of individual fatty acids by a gas-chromatographic method.

## CONDITIONS FOR THE FIELD EXPERIMENTS

The weather conditions during the sunflower growing season of 1977, 1978, and 1979 differed. Most favorable precipitation and temperatures were in 1977; 1978 was deficient in precipitation while 1979 had unfavorable temperatures (extremely high maximum temperatures and rather low minimum temperatures) at the stage of seed filling.

## RESULTS

The results show that seed yields varied in dependence of yearly weather conditions and stand density (Table 1).

Highest yields were obtained in 1977, the most favorable year. NS-H-67-RM was more productive than NS-H-26-RM in all experimental years and variants of stand density.

The difference between the three-year average seed yields of NS-H-26-RM in the variants with 66,666 and 40,816 plants/ha was not significant. However, a significant difference was found between the variants with 40,816 and 31,250 plants/ha. A similar pattern was expressed in 1977. in 1978, there were no significant differences in seed yields among the variants. Still, the standard variant had the highest yield which could be explained by the occurrence of a protracted drought at the stage of seed filling and the reaction of NS-H-26-RM to these conditions. In 1979, the standard variant brought the highest yield, the variant with 66,666 plants/ha the lowest.

NS-H-67-RM reacted differently to stand density. The standard variant had the highest productivity in all experimental years. Highly significant differences were found between the standard variant and the variant with 31,250 plants/ha. In relation to the variant with 66,666 plants/ha, the standard variant brought significantly higher yields in 1977 and 1979 whereas in 1978 the difference was non-significant.

Table 2 shows that the oil of the new hybrids was rich with tocopherol; the hybrids were superior in relation to the variety Vniimk 8931 (4) grown in the same ecological conditions. The content of tocopherol was lowest in 1977 to jump highly in 1978 and to maintain that level, with small variations, in 1979. The standard variant had a somewhat increased tocopherol content in relation to the other variants. Our standpoint is that three experimental years

TABLE 1

*Seed yields of NS-H-26-RM and NS-H-67-RM grown at different stand densities in 1977, 1978, and 1979*

| No. of plants/ha | Yield of NS-H-26-RM | | | | Yield of NS-H-67-RM | | | |
|---|---|---|---|---|---|---|---|---|
| | 1977 | 1978 | 1979 | Average | 1977 | 1978 | 1979 | Average |
| 66, 666 (50 x 30) | 37.19 | 22.88 | 24.23 | 28.10 | 39.62 | 32.77 | 31.45 | 34.59 |
| 40,816 (70 x 35) | 35.16 | 24.99 | 26.57 | 28.91 | 42.62 | 34.12 | 39.08 | 38.61 |
| 31,250 (80 x 40) | 31.78 | 23.73 | 25.91 | 27.14 | 38.69 | 29.56 | 33.81 | 34.02 |
| TOTAL | 34.71 | 23.87 | 25.57 | 28.05 | 40.31 | 32.13 | 34.78 | 35.74 |
| LSD | 5% | | | 1.37 | | | | 1.38 |
| | 1% | | | 1.82 | | | | 1.83 |

TABLE 2

*Content of tocopherols in sunflower oil (mg/100 gr)*

| Hybrid | NS-H-26-RM | | | NS-H-67-RM | | |
|---|---|---|---|---|---|---|
| Year | No. of plants/ha | | | | | |
| | 31,250 | 40,816 | 66,666 | 31,250 | 40,816 | 66,666 |
| 1977 | 69.30 | 74.00 | 64.73 | 69.96 | 70.00 | 73.27 |
| 1978 | 78.71 | 79.28 | 79.09 | 74.72 | 78.54 | 74.17 |
| 1979 | 76.29 | 79.29 | 76.30 | 72.22 | 78.57 | 76.78 |

TABLE 3

*Composition of fatty acids in the oil of hybrids NS-H-26-RM and NS-H-67-RM**

| Fatty acid | No. of plants/ha | | | | | |
|---|---|---|---|---|---|---|
| | 31,250 | | 40,816 | | 66,666 | |
| | —26— | —67— | —26— | —67— | —26— | —67 |
| 14:0 | 0.074 | 0.060 | 0.063 | 0.060 | 0.070 | 0.001 |
| 14:1 | 0.031 | 0.019 | 0.021 | 0.014 | 0.019 | 0.014 |
| 15:0 | 0.026 | 0.016 | 0.012 | 0.014 | 0.013 | 0.011 |
| 16:0 | 6.709 | 5.758 | 6.584 | 5.702 | 6.841 | 5.829 |
| 16:1 | 0.136 | 0.126 | 0.129 | 0.128 | 0.173 | 0.119 |
| 17:0 | 0.077 | 0.070 | 0.071 | 0.078 | 0.066 | 0.069 |
| 16:2 | 0.036 | 0.035 | 0.035 | 0.034 | 0.037 | 0.036 |
| 18:0 | 4.708 | 5.957 | 4.888 | 5.963 | 4.169 | 6.010 |
| 18:1 | 21.621 | 25.601 | 21.758 | 25.810 | 20.286 | 24.767 |
| 18:2 | 64.801 | 64.529 | 64.519 | 60.436 | 66.322 | 61.393 |
| 20:0 | 0.416 | 0.482 | 0.429 | 0.450 | 0.334 | 0.464 |
| 18:3 | 0.301 | 0.246 | 0.320 | 0.266 | 0.323 | 0.244 |
| 22:0 | 0.680 | 0.691 | 0.727 | 0.684 | 0.501 | 0.705 |

* Three-year average values given in percents.

are an insufficient period to draw a general conclusion that the stand density of 40,816 plants/ha is most favorable for the synthesis of tocopherol.

Table 3 shows that the linoleic acid comprises over 60% of the total fatty acids. It is visible that NS-H-26-RM was richer in this acid than NS-H-67-RM in all variants. It may also be seen that the content of linolenic acid was low. Numerous authors have stated that this acid is one of the causes for the reversal of odor of soybean oil.

The contents of linolenic acid were always lower in NS-H-67-RM than in NS-H-26-RM. Effect of stand density on the composition of fatty acids was not observed with the examined hybrids.

The data in Tables 2 and 3 show that the oil of the examined hybrids had high biological values because the ratio between the linoleic acid in gr and the content of tocopherol in mg was higher than 0.79 in all cases.

It has already been mentioned that a human organism is considered to require about 15 mg of vitamin E daily. As we know that tocopherols are consumed mostly with plant oils, it is interesting to calculate how much oil should be consumed daily in order to satisfy the needs. The daily consumption of the examined sunflower oil should be 19-23 gr. In the case of soybean oil, which contains about 100 mg of tocopherols per 100 gr of oil out of which 50% are in the form of alpha-tocopherol, approximately 30 gr should be consumed daily. For oil and corn oil, these values should be 100 and 150 gr, respectively.

The above data show clearly the advantages of sunflower oil over the other oils. It is rich with tocopherols and essential fatty acids which justifies its high participation in the contemporary diet.

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