T1978AGRO28

EFFECT OF PLANTING DENSITY AND MODE ON BIOLOGICAL AND BIOCHEMICAL CHARACTERS OF SUNFLOWER

By

Velibor Jancic and Tihomir Vrebalov
Faculty of Agriculture Novi Sad
Institute of Field and Vegetable Crops
Novi Sad, Yugoslavia

Summary

Three-year research results showed that seed yields of the cultivar VNIIMK 8931 ranged from 34.24 mtc/ha, in the poorest variant of planting density, to 37.48 mtc/ha, in the best variant. Seed yields of the cultivar Peredovic ranged from 33.53 mtc/ha to 36.00 mtc/ha, of the cultivar Mayak from 33.38 mtc/ha to 36.73 mtc/ha. No significant differences were found among the seed yields. Oil yields of the cultivar VNIIMK 8931 ranged from 1437 kg/ha, in the poorest variant of planting density, to 1612 kg/ha, in the best variant. Oil yields of the cultivar Peredovic ranged from 1445 kg/ha to 1563 kg/ha, of the cultivar Mayak from 1426 kg/ha to 1610 kg/ha. There were significant differences in relation to the standard as well as among the variants. Leaf area depended on planting mode and density; largest leaf areas were found in the variants in which plant-to-plant distance was close to row-to-row distance. In the variant 50x40 cm, the leaf area of the cultivar Peredovic was 33,981 m.sq./ha, of the cultivar Mayak 33,510 m.sq./ha. An exception was the cultivar VNIIMK 8931 which had the largest leaf area of 34,738 m.sq./ha in the variant 70x25 cm. VNIIMK 8931 and Peredovic had the smallest leaf areas in the variant 70x40 cm, Mayak in the variant 60x50 cm. There were significant differences in relation to the standard as well as among the variants. Plant height varied in dependence of the planting density and the cultivar. There were no regularities between the plant height and the planting density. Significant differences were found in relation to the standard as well as among the variants.

Introduction

One of the problems in sunflower production is to achieve the optimal density of the stand. Which stand will prove to be the best depends on the agroecological conditions of the region growing. Whether the optimal stand will be achieved or not depends on the characters of the cultivar grown, its sensitivity to soil moisture, light, and other factors affecting a normal development of a sunflower plant. When dealing with this problem, various authors obtained different results because of different agroecological conditions they run their tests in. To mention some of the authors: J. Alessi, I.F. Power, and D.C. Zimmermand (1977), B. Radjenovic (1971), V.P. Stanev, St. Lingova (1971), L. Lopez (1972), Lukasev (1956), Silcenok (1952).

The objective of our research was to determine the optimal planting mode and density for the cultivars VNIIMK 8931, Peredovic and Mayak grown in the ecological conditions of Vojvodina, the major sunflower-producing region of Yugoslavia. We also wanted to determine the relationships between the planting mode and biochemical characters of the cultivars in question on the other.

Materials and Methods

A three-year experiment was conducted at the experimental field of the Institute of Field and Vegetable Crops in Novi Sad. The results obtained in 1967 could not be calculated because the experimental plants were damaged by hail. The experiment included three cultivars (VNIIMK 8931, Peredovic and Mayak) grown in the following 9 stands:

50 x 40 cm	60 x 50 cm	70 x 40 cm
60 x 35 cm	70 x 25 cm	80 x 25 cm
60 x 40 cm	70 x 35 cm	80 x 40 cm

The stand 70x35 cm was used as the standard. The experiment was conducted in five replications. The preceeding crop was wheat. The type of soil was chernozem. The following quantities of fertilizers were distributed in the course of the growing season: 65kg/ha of N, 80 kg/ha P_2O_5, and 70 kg/ha of K_2O. Seed yields were corrected at 13% moisture. The method of Ruskovsky was used to determine the content of oil in absolutely dry seed.

Results and Discussion

The climatic conditions during the growing season were favorable throughout the test period. The conditions were slightly worse in 1968 because of a lower precipitation and its unfavorable regimen during the growing season. Such climatic conditions affected negatively the leaf area and plant height. The temperatures were also favorable for sunflowers except in August 1968 when the temperature was somewhat lower 19,1°C) whan in the other two years.

TABLE 1. Meteorological data for the test period.

Month	1966		1968		1969	
	Prec. mm.	Temp. °C	Prec. mm.	Temp. °C	Prec. mm.	Temp. °C
April	49.6	13.1	14.7	14.1	25.1	16.7
May	45.4	16.1	23.5	18.4	23.7	25.7
June	73.5	19.3	38.6	20.9	136.1	23.8
July	121.1	20.7	69.7	21.3	54.4	26.6
August	46.2	20.4	114.9	19.1	76.1	25.9
Total	335.8	-	261.4	-	315.4	-

Seed Yield

Data on the effects of planting mode and stand density on seed yields differ from cultivar to cultivar and variant to variant. These differences are particularly highly expressed in case of maximum yields. The cultivar VNIIMK 8931 had the highest yield in the variant 60x35 cm (47,600 plants/ha), the cultivar Peredovic in the variant 80x40 cm (31,250 plants/ha), the cultivar Mayak in the variant 70x25 cm (57,142 plants/ha). VNIIMK 8931 and Mayak had the lowest yields in the variant 70x40 cm (35,714 plants/ha), Peredovic in the variant 80x25 cm (50,000 plants/ha).

Differences in seed yields among the variants were not large -- there were no significant differences. Nevertheless, the results indicate that the yields increased with the increase of row-to-row distance (to 70 cm) and the increase of plant-to-plant distance to 35 cm, or 2,450 cm. sq. per plant. This planting mode enables the planting of more than 40,000 plants/ha. The results also indicate that higher sunflower yields may be achieved in the conditions of Vojvodina if the stand provides 40-45,000 plants/ha to be harvested.

Leaf Area

Planting mode and density had a higher effect on leaf area than on seed yields. There were large differences among the variants. The cultivars Peredovic and Mayak had the largest leaf areas (33,890 m.sq./ha and 33,510 m.sq./ha respectively) in the variant 50x40 cm (50,000 plants/ha). The cultivar VNIIMK 8931 had the largest leaf area in the variant 70x25 cm (57,142 plants/ha). Our results indicate that the largest leaf areas were found in the variant in which plant-to-plant distance was close to row-to-row distance (50x40 cm). The cultivar VNIIMK 8931 was an exception. It had the largest leaf area in the variant 70x25 cm. The planting mode 50x40 cm enables a large number of seeds to be planted per area unit (50,000 plants/ha). Also, this mode provides a good exposure of plants to sunrays which prevents a rapid loss of bottom leaves. This planting mode enables thus the development of a large leaf area which, in turn, increases the yields of sunflower. Further increases in row-to-row distance, besides decreasing the number of plants, tend also to decrease the leaf area. The cultivars VNIIMK 8931 and Peredovic had the smallest leaf areas in the variant 70x40 cm (35,714 plants/ha). Similar results were not obtained with the cultivar Mayak. Further increases in the row-to-row distance in the plant-to-plant distance brought a slight increase of the leaf area. The results of the variance showed that there were significant differences in relation to the standard as well as among the variants. Besides, the variance of stand density was large while the variance of cultivar was not. There was no interaction between the stand density and the cultivar.

Oil Yield

Oil yield differed in dependence of planting mode and stand density. As the oil yield depends on percentage of oil and seed yield, it is difficult to determine the factors which directly affect the oil yield. In any case, the stand density is an important factor. The difference between the variant with the highest oil yield and the variant with the lowest oil yield was 175 kg for the cultivar VNIIMK 8931, 118 kg for the cultivar Peredovic, and 184 kg for the cultivar Mayak. VNIIMK 8931 had the highest oil yield of 1612 kg/ha in the variant 60x35 cm (47,600 plants/ha), the lowest in the variant 70x40 cm (35,714 plants/ha). Peredovic had the highest oil yield in the variant 80x40 cm (31,250 plants/ha) the lowest in the variant 80x25 cm (50,000 plants/ha). Mayak had the highest oil yield in the variant 70x25 cm (57,142 plants/ha), the lowest in the variant 70x40 cm (35,714 plants/ha). The above data show that there was no correlation between the stand density and oil yield. The cultivars Peredovic and Mayak had the lowest oil yield in the variant 70x40 cm (35,714 plants/ha). The results of the analyses of variance show that the variance of stand density was large whereas the variance of cultivar was not. There was no interaction

between the cultivar and the stand density. Significant differences were found in relation to the standard as well as among the variants.

Plant Height

Although the plant height depends on the cultivar grown, it also depends on the planting mode and stand density. The results of Table 5 show that the height of plant varied from variant from variant. The variations depended on the cultivar. In case of VNIIMK 8931, the difference was 12.6 cm (196.3 cm in the variant with the tallest plants, 183.7 cm in variant with the shortest plants). In case of Mayak, the difference was only 5 cm. The plants were elongated in the variant with small plant-to-plant distance. These plants were taller than those grown in the variants with larger plant-to-plant distance. The results of the analyses of variance show that there was an interaction between the cultivar and the stand density regarding the plant height. Significant differences were also found. However, the variance of cultivar and the variance of stand density were not significant.

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TABLE 2. Effect of Planting Mode and Density on Seed Yields

Cultivar	Planting Density	Seed Yield in mtc/ha 1966	1968	1969	Average
VNIIMK 8931	50 x 40	37.30	37.98	35.25	36.84
	60 x 35	38.92	40.08	33.44	37.48
	60 x 40	38.69	38.10	34.38	37.05
	60 x 50	36.27	38.88	31.71	35.62
	70 x 25	38.34	38.91	32.72	36.65
	70 x 35*	37.81	39.36	33.59	36.92
	70 x 40	34.95	35.81	31.96	34.24
	80 x 25	37.09	36.78	32.03	35.30
	80 x 40	35.20	37.17	32.38	34.92
Peredovic	50 x 40	32.64	35.03	34.21	33.96
	60 x 35	34.65	37.80	33.81	35.42
	60 x 40	32.54	37.06	32.33	33.98
	60 x 50	33.31	37.31	31.86	34.16
	70 x 25	33.98	37.26	34.45	35.23
	70 x 35*	34.80	34.33	33.49	34.20
	70 x 40	34.57	35.91	32.45	34.31
	80 x 25	35.01	33.64	31.95	33.53
	80 x 40	34.73	37.69	35.57	36.00
Mayak	50 x 40	35.96	34.23	34.86	35.02
	60 x 35	36.84	36.55	34.26	35.88
	60 x 40	34.74	36.02	32.29	34.35
	60 x 50	35.78	36.04	32.74	34.85
	70 x 25	38.54	37.65	34.01	36.73
	70 x 35*	34.32	36.41	32.93	34.55
	70 x 40	37.52	32.14	30.49	33.38
	80 x 25	37.29	35.48	33.38	35.38
	80 x 40	39.05	35.11	34.48	36.21

* Standard for the conditions of Vojvodina - 70 x 35 cm.

LSD 5% = 3.77 mtc
1% = 5.05 mtc

TABLE 3. Effect of Planting Mode and Density on the Size of Leaf Area

Cultivar	Planting Density	Leaf Area in m.sq./ha 1966	1968	1969	Average
VNIIMK 8931	50 x 40	38.090	26.835	31.335	32.087
	60 x 35	36.281	27.608	31.221	31.703
	60 x 40	36.723	30.859	33.132	33.571
	60 x 50	34.893	26.516	38.786	33.398
	70 x 25	41.038	26.197	36.978	34.738
	70 x 35*	32.685	26.063	30.820	39.856
	70 x 40	28.421	25.365	28.178	27.321
	80 x 25	30.922	31.159	32.283	31.455
	80 x 40	37.369	27.150	35.862	33.460
Peredovic	50 x 40	35.425	30.395	35.855	33.891
	60 x 35	32.468	23.667	30.902	29.012
	60 x 40	30.917	26.599	30.462	29.326
	60 x 50	34.043	22.646	32.633	29.774
	70 x 25	32.564	23.925	37.703	31.397
	70 x 35*	33.750	19.894	28.356	27.333
	70 x 40	31.959	22.930	28.913	27.934
	80 x 25	31.058	22.274	40.176	31.169
	80 x 40	36.194	20.812	29.269	32.092
Mayak	50 x 40	33.280	30.345	36.905	33.510
	60 x 35	35.133	27.112	34.691	32.312
	60 x 40	31.716	25.900	30.220	29.279
	60 x 50	27.840	25.967	25.426	26.411
	70 x 25	28.030	26.123	40.352	31.502
	70 x 35*	25.569	23.366	32.526	27.154
	70 x 40	37.035	26.100	24.247	29.127
	80 x 25	26.803	25.431	32.521	28.252
	80 x 40	32.712	22.587	37.368	30.889

* Standard for the conditions of Vojvodina - 70 x 35 cm.

LSD 5% = 3.373
1% = 4.509

TABLE 4. Effect of Planting Mode and Density on Oil Yield

Cultivar	Planting Density	Oil Yield in kg/ha 1966	1968	1969	Average
VNIIMK 8931	50 x 40	1529	1652	1515	1565
	60 x 35	1627	1751	1458	1612
	60 x 40	1570	1645	1500	1572
	60 x 50	1459	1705	1342	1502
	70 x 25	1606	1708	1423	1579
	70 x 35*	1559	1700	1450	1570
	70 x 40	1432	1536	1342	1437
	80 x 25	1517	1620	1392	1510
	80 x 40	1458	1655	1407	1507
Peredovic	50 x 40	1340	1586	1515	1480
	60 x 35	1416	1708	1451	1525
	60 x 40	1323	1668	1406	1466
	60 x 50	1325	1655	1364	1448
	70 x 25	1395	1688	1489	1524
	70 x 35*	1373	1543	1423	1446
	70 x 40	1419	1568	1375	1454
	80 x 25	1447	1500	1387	1445
	80 x 40	1434	1707	1548	1563
Mayak	50 x 40	1505	1437	1525	1522
	60 x 35	1538	1643	1507	1563
	60 x 40	1379	1595	1363	1445
	60 x 50	1460	1571	1409	1480
	70 x 25	1640	1701	1489	1480
	70 x 35*	1400	1622	1415	1479
	70 x 40	1570	1406	1301	1426
	80 x 25	1566	1588	1463	1539
	80 x 40	1665	1596	1510	1590

* Standard for the conditions of Vojvodina - 70 x 35 cm.

LSD 5% = 54
1% = 73

TABLE 5. Effect of Planting Mode and Density on Plant Height

Cultivar	Planting Density	Plant Height in cm 1966	1968	1969	Average
VNIIMK 8931	50 x 40	195	192	199	195.3
	60 x 35	194	189	194	192.3
	60 x 40	191	195	203	196.3
	60 x 50	194	184	197	191.7
	70 x 25	186	183	207	192.0
	70 x 35*	187	183	192	187.3
	70 x 40	178	183	194	185.0
	80 x 25	178	186	187	183.7
	80 x 40	184	183	190	185.6
Peredovic	50 x 40	188	175	196	186.3
	60 x 35	176	168	190	178.0
	60 x 40	180	174	194	182.7
	60 x 50	186	181	193	186.7
	70 x 25	189	182	202	191.0
	70 x 35*	172	168	188	176.0
	70 x 40	181	180	189	183.3
	80 x 25	178	175	201	184.7
	80 x 40	184	177	199	186.7
Mayak	50 x 40	185	181	206	190.7
	60 x 35	186	186	188	186.7
	60 x 40	185	179	194	186.0
	60 x 50	170	186	170	175.3
	70 x 25	186	167	202	185.0
	70 x 35*	182	183	198	187.7
	70 x 40	182	175	176	177.7
	80 x 25	180	194	202	192.0
	80 x 40	191	183	190	188.0

* Standard for the conditions of Vojvodina - 70 x 35 cm.

LSD 5% = 5.57 cm
1% = 7.45 cm