EFFECT OF SPACING AT OPTIMUM PLANT DENSITY ON YIELD AND QUALITY OF SUNFLOWER (*Helianthus annuus* L.) SEED

Crnobarac J., Marinković B. and Dušanić N.
Institute of Field and Vegetable Crops, Maksima Gorkog 30
21000 Novi Sad, Yugoslavia

SUMMARY

Crop uniformity as an important factor of yield depends on plant spacing of every plant. The effect of plant spacing and the size of empty places was studied in a field trial lasting for two years. A control plot was established with the plants that had an optimal plant spacing in row (70 x 30 cm). The ratio of plants with superposed plant spacing (70 x 15 cm) increased regularly for 1/12 in other 5 variants, which was the value of the increase of unavailable plant spacing. Within the above mentioned variants, the empty spaces are grouped into small, medium and large entities.

According to F-test, years, plant distribution and the size of the unavailable plant spacing significantly affected all characteristics analyzed ($p<1\%$) except protein content and hectolitre mass. With the increase of plant ratio with superposed i.e., unavailable plant spacing for 1%, seed yield declined 13.1 kg/ha, oil yield for 5.1 kg/ha, 1000-seed mass for 0.11 g. Other characteristics were not so affected by this: oil content declined 0.022%, protein content for 0.0097% and hectolitre mass increased for 0.0013 kg/ha. The increase of the size of unexploited plant spacing in ratio 1:4, the yield of seed declined 226 kg/ha, oil yield for 108 kg/ha, oil content for 0.75%, hectolitre mass for 0.2 kg/hl and 1000 seed mass increased for 1.81 g. Although the differences between the years are large for all characteristics, the same tendency for the studied characteristics occurred in both years.

Key words: sunflower, plant spacing, yield, seed quality

INTRODUCTION

Additionally to genetic factors, seed quality and others, the uniformity is also affected by plant spacing of each plant. As it is well known, the uniformity of plant spacing increased by reducing row spacing, but row spacing variation from 50 to 80 cm did not affect yield of sunflower (Crnobarac and Popi, 1990). This fact suggests that uneven stand of sunflower may not affect yield, contrary to corn (Krall et al., 1977) and pearl millet (Soman et al., 1987). Efforts to measure effect of uniformity have been confounded with plant population differences. Crnobarac et al., (1992) concluded that reduction of plant population by one sixth and also size and regularity of empty spaces significantly reduced yield of sunflower. Wade et al., (1988) concluded that decline of sunflower yield was attributed mainly to lack of plants at low density and to unevenness at high density. This reduction at density less than 5.00/m^2 was 7.4% and at density greater than 5.00/m^2 it was 5.6% (Wade, 1990). Remussi et al. (1974) concluded that uniformity at constant population of 70000/ha had significant effect on yield and lodging. The same results, but with population 49420/ha was obtained by Robinson et al. (1982).

MATERIAL AND METHODS

A field experiment was performed with no irrigation on a chernozem soil type in the Institute of Field and Vegetable Crops in Novi Sad in the period from 1991 trough 1992. Two- factorial trial was established according to randomized block design. The hybrid NS-H-45 was sown on April 10, in both years. Three to four seeds per hill were planted at stand density of 70 x 15 cm. The basic plot was 10.08 m². The plants were tinned to one per hill at the stage of two-leaf pairs (Figure 1). At a control variant, all plants had optimum plant spacing (70 x 30 cm). In other five variants, the ratio of plants increased regularly for 1/12 with superposed plant spacing (70 x 15 cm), increasing the unavailable plant spacing according to same value. In the 6th variant, there were 2/12 plants with optimum, 5/12 with superposed plant spacing, i.e., 5/12 of plant spacing was free. In the second factor, unavailable plant spacing was grouped into small, medium and large entities in the size ratio of 1:2:4 in all variants.

Seed yield is presented in kg/ha with respect to 11% moisture and oil yield in kg/ha. Oil content was determined using NMR and proteins using Trebor. Hectolitre mass was obtained measuring seed mass in a 250-ml cylinder and expressed in kg/hl, and 1000-seed mass in g, measuring 4x100 seeds. The data were statistically analyzed in Mstatc (FACTOR Experiment Model Number 19: Two Factor Randomized Complete Block Design Combined over Locations (or combined over Years) and graphically presented in Origin 3.5.

Figure. 1

RESULTS AND CONCLUSION

According to F-test, the years affected significantly ($p<1\%$) all studied traits, except protein content. This means that the effect of the studied factors is susceptible to the influence of weather conditions. Plant spacing and the size of unavailable plant spacing had very significant effect on all characteristics except hectolitre mass which was affected significantly ($p>1\%$ and $p>5\%$). The exception is also the non-existence of significant effect of the size of unavailable space on protein content.

Seed yield in 1991 was 462.11 kg/ha higher than in 1992 which is above the LSD value for $P=1\%$ (Figure 2a). The difference in seed yield in the 0 variant with optimal density and in the variant with 41.65% of superposed and unavailable plant spacing is 536.4 kg/ha. The increase of the ratio of superposed and unavailable plant spacing for 1%, seed yield in 1991 declined 10.35 kg/ha, in 1992 for 15.83 kg/ha and averaged 13.10 kg/ha. In all three cases correlation coefficient was high (-0.97 to -0.99) with probability $P<1\%$. The size of unavailable plant spacing affected seed yield in 1991 less than in 1992. The average for two years showed that significantly highest seed yield was in the variant with small and the lowest in the variant with large unavailable space. This difference was 226 kg/ha.

Oil content in 1991 was 3.37% lower than in 1992, which is above the LSD value for $P=1\%$ (Figure 2b). The difference in oil content between the variant 0 with optimum stand and the variant with 41.65% of superposed and free space is 1.00%. The increase of the ratio of superposed and unavailable plant spacing for 1%, oil content declined 0.017% in 1991 and for 0.027% in 1992, and averaged 0.022%. Correlative relation in all three cases was high (-0.84 to -0.87) with the probability of $P=2.5$ to 3.5%, but lower than in seed yield. The size of unavailable plant spacing had higher effect on oil content in 1991 than in 1992. On average for two years, significantly highest oil content was in the variant with low and the lowest in the variant with large unavailable plant spacing.

Due to the fact that oil yield is the calculated characteristics which is more affected by seed yield, in 1991 it was lower for 95.11 kg/ha than in 1992, which is above the values of LSD for P=1% (Figure 2c). The difference in oil yield between the variant 0 with an optimum spacing and the variant with 41.65% of superposed and unavailable plant spacing was 214.2 kg/ha. The increase of the ratio of superposed and unavailable plant spacing for 1%, oil yield in 1991 declined 4.03 kg/ha and in 1992 for 6.16 kg/ha, which is 5.10 kg/ha on average. In all three cases, correlation coefficient was high (-0.96 to -0.99) with the probability of p<1%. The size of free space had in 1991 lower effect on oil yield than in 1992. On average for two years, the significantly highest oil yield was on the variant with low, and the lowest on the variant with large free space. The difference was 107.8 kg/ha.

Figure 2.

Protein content in the two years did not differ significantly (17.79 and 17.78%). The difference in protein content between the variant 0 with optimum density and the variants with 41.65% of superposed and unavailable plant spacing was 0.59% (Figure 3a). The increase of the ratio of superposed and free space for 1%, protein content in 1991 declined 0.0037%, in 1992 for 0.0159%, which is 0.097% on average. Correlation coefficient in 1991 was very low (0.28 P=60.9%) and in 1992 it was higher (0.90 P=1.6%). The size of free plant spacing had no significant effect on protein content, not in the years nor on average for the two years.

The mass of 1000 seeds in 1991 was 9.76 g lower than in 1992, which is above the LSD value for P=1% (Figure 3b). The difference in 1000-seed mass between the variant 0 with optimum stand and the variants with 41.65% of superposed and unavailable space was 4.59 g. The increase of the ratio of superposed and unavailable plant spacing for 1%, reduced 1000-seed mass for 0.035 g in 1991 and 0.186 g in 1992, and averaged 0.110 g. In all three cases, correlation coefficient was very high (-0.94 to -0.99) with the probability of p<1%. The size of unavailable plant spacing in both years had similar effect on 1000-seed mass. The average results for two years showed that significantly highest 1000-seed mass was achieved in the variant with high and the lowest in the variant with small unavailable plant spacing. This difference was 1.81 g.

In 1991, hectolitre mass was 0.6 kg/hl higher than in 1992, which is above the values of LSD for P=1% (Figure 3c). Considering other characteristics, plant spacing had no regular and significant effect. With the increase of ratio of superposed and unavailable plant spacing for 1%, hectolitre mass increased in both years for 0.0034 kg/hl, which is 0.0013 kg/ha on average. Correlation coefficient in 1992 and on average was very low (-0.18 P=73%). In 1991 it was -0.65 and P=15.8%. The size of unavailable plant spacing in both years had similar effect. The average values for both years show that the significantly highest hectolitre mass was in the variant with low and the lowest in the variant with large free space. The difference was 0.2 kg/hl. No significant differences occurred between the variant with mean and large size.

Figure 3

Years, plant spacing and the size of unavailable plant spacing, according to F-test, affected all studied characteristics very significantly ($p<1\%$) except protein content and hectolitre mass.

With the increase of the ratio of plants with superposed, and free space, the yield of seed, oil and 1000-seed mass was reduced ($r>0$, $p<1\%$). Lower dependence was expressed for oil content ($r=-0.87$ $P=2.5\%$), while for protein content it was not significant ($r=-0.71$ $P=11\%$). Hectolitre mass increased but not significantly ($r=0.18$ $P=73.8\%$).

The increase of the size of unavailable plant spacing in the ratio of 1:4, significantly reduced seed yield, oil yield, oil content and hectolitre mass (LSD for $P=5\%$), while 1000-seed mass increased.

Although the differences occurring between the years are large for all characteristics, the same trend of the studied treatments occurred in both years.

REFERENCES

1. Crnobarac. J., Marinković B., Starčević Lj. and Popi J.(1992): Effect of number and arrangement of missing plants on seed yield in sunflower."Zbornik radova" a periodical of scientific research on field and vegetable crops, 24:409-415.

2. Crnobarac J. and Popi J.(1990): Uticaj gustine i međurednog razmaka na prinos zrna suncokreta. Zbornik radova XV savetovanja o unapređenju uljarstva jugoslavije, p. 64-73, Beograd.

3. Krall J.M., Esechie H.A.,Raney R.J., Clark S.,TenEyck G., Lundquist M., Humburg N.E., Axthelm L.S., Dayton A.D. and Vanderlip R.L.(1977): Influence of within raw variability in plant spacing on corn grain yield. Agronomy J. 69:797-799.

4. Remussi C., Samuell H. and Vidal Aponte G.A.(1974): Effect of sowing uniformity on sunflower yield, Proceeding of 6th Internacional Sunflower Conference, p.439-497. Bucharest.

5. Robinson R.G., Ford J.H., Lueschen W.E.,Rabas D.L., Warnes D.D. and Wiersma J.V.(1982): Responce of sunflower to uniformity of plant spacing. Agronomy J. 74:363-365.

6. Soman P., Jayachandran R. and Bidinger F.R.(1987): Uneven variation in plant-to-plant spacng in pearl millet. Agronomy J. 79:891-895.

7. Wade L.J., Norris C.P. and Walsh P.A.(1988): Effects of suboptimal plant density and non-uniformity in plant spacing on grain yield of raingrown sunflower. Australian Journal od Experimental Agriculture, 28:617-622.

8. Wade L.J.(1990): Estimating loss in grain yield due to suboptimal plant density and non-uniformity in plant spacing. Australian Journal od Experimental Agriculture, 30:251-255.

Fig. 1. Plan and arragments of exprimental variant

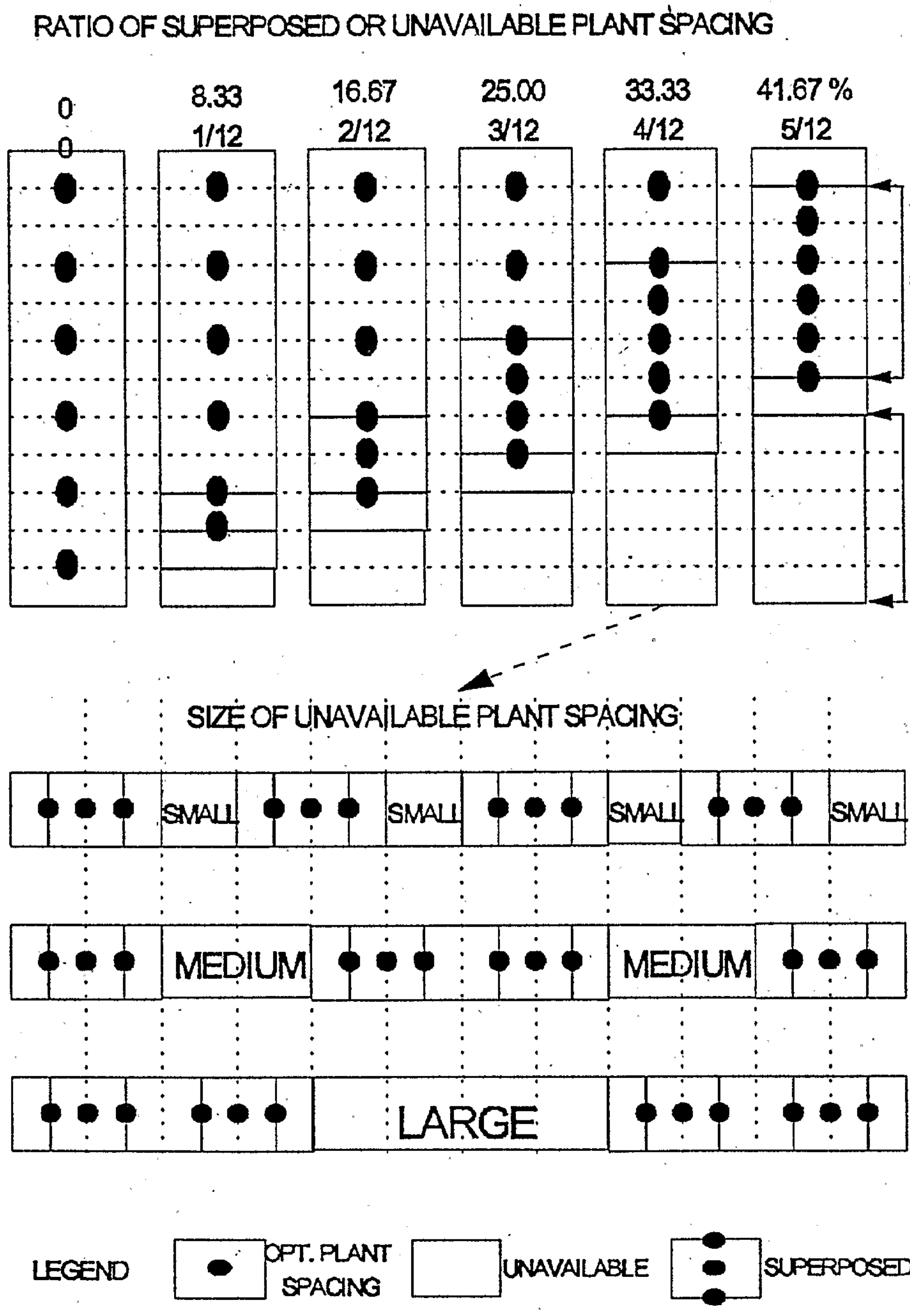

Fig. 2. Effect of superposed and unavailable plant spacing on seed yield, oil content and oil yield of sunflower

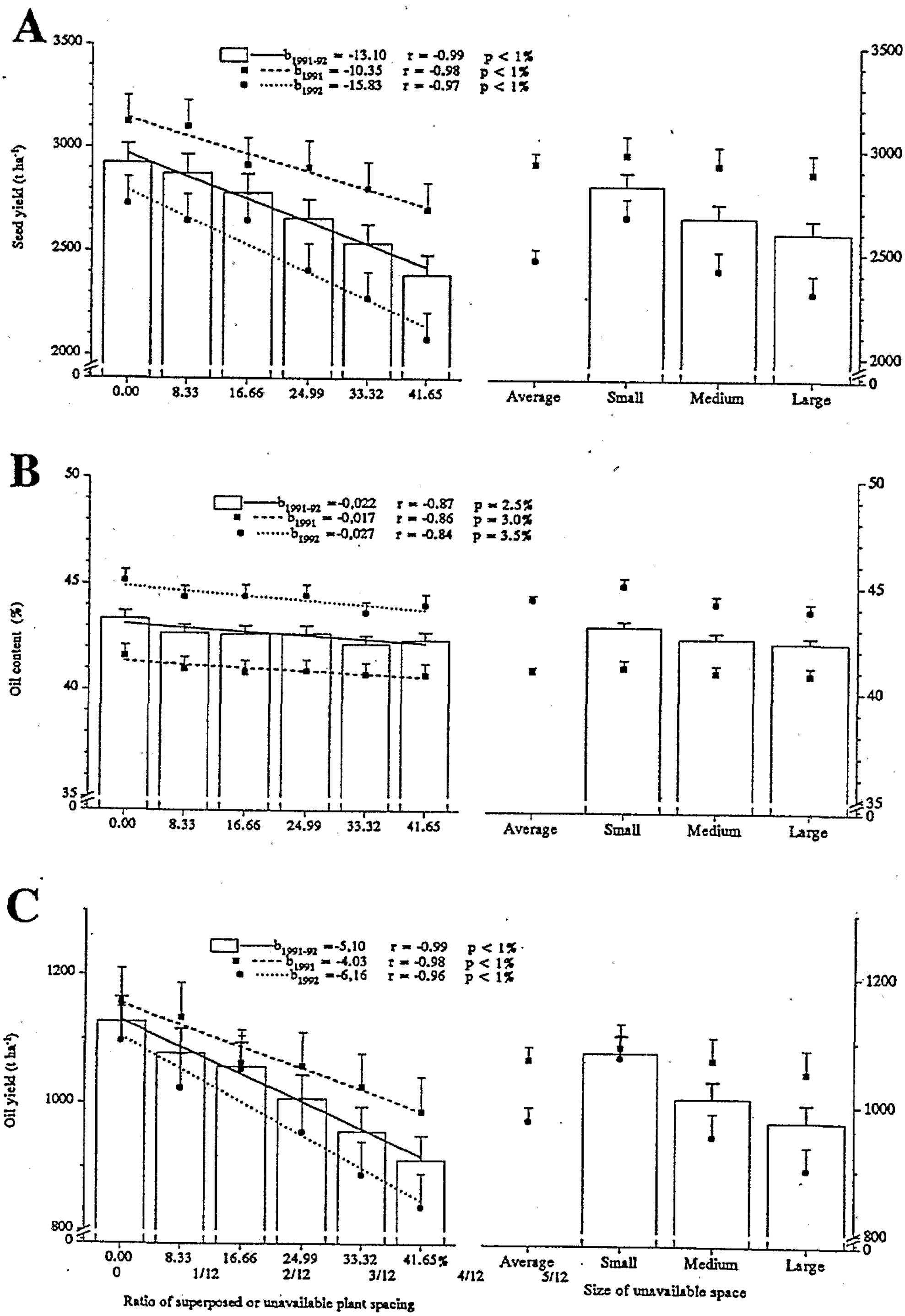

Fig. 3. Effect of superposed and unavailable plant spacing on protein content, 1000 seeds mass and hectoliter mass