THE EFFECT OF FERTILIZERS ON YIELD AND SEED QUALITY IN CMS SUNFLOWER LINES

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Abstract

Sunflower (*Helianthus annuus* L.) lines are less vigorous and have a shorter vegetative season than hybrids, and we wanted to determine optimal doses and ratio of nitrogen, phosphorus and potassium nutrients needed for high yields and good quality of sunflower seed lines. In the sunflower fields, from a stationary multiyear four-field trial on a chernozem soil, we studied two CMS sunflower lines: Ha-981 and BCSS-7 in ten characteristic fertilization treatments: control, N100, P100, K100, N100 P100, N100 K100, P100 K100, N50 P50 K50, N100 P100 K100, and N150 P150 K150. Next traits were analyzed: total number of seeds per plant, percentage of fertilization, 1000-seed mass, seed yield per hectare, energy of germination and germination. Year, lines and fertilizers significantly influenced all traits. The total number of seed per plant depends especially on nitrogen, although phosphorous and potassium stimulates its effect. Percentage fertilization is affected only by optimal nutrition with all three nutrients, 100NPK. On 1000-seed mass, nitrogen had the highest effect in the 100 kg/ha treatment, separately and in triple combination. The highest yield was achieved with the triple combination of nutrients; although differences between different amounts of them were not significant, the economic effect of the higher rate should be considered. Energy of germination and germination for both lines were significantly lower in the control and treatments 100P and 100PK, and additionally in treatment 100N on line BCSS-7. Due to the higher price of seed lines, minor increases of yield or especially quality are economically justifiable; therefore the recommended fertilization of the sunflower lines is 100NPK.

Introduction

The realization of the genetic potential for yield of a crop and yield quality depends on good mineral nutrition. For the formation of vegetative plant parts and seeds, sunflowers require high amounts of nutrients. Sunflower lines are less vigorous and have shorter vegetation than hybrids, and their nutrient needs are different. Because of this, we wanted to determine optimal doses and ratios of nitrogen, phosphorus and potassium nutrients needed for high yields and good quality of sunflower seed lines. Besides these biological reasons, due to the higher price of seed lines, the fertilization of sunflower lines is significantly more cost-effective, since even minor increases of yield or quality are economically justifiable.

The principal yield components are the number of seeds per unit area and 1000-seed mass. It was presumed that mineral nutrition significantly affects total number of seeds per plant, percentage fertilization, 1000-seed mass, and yield per hectare, as well as germination energy and germination.

Materials and Methods

For our investigation, we used a stationary multiyear four-field trial (wheat, sugar beet, maize and sunflower) on a chernozem soil established at the Experimental Field of the Institute of Field and Vegetable Crops in Novi Sad. Since 1966, the plots in all four crops were fertilized with the same amount and ratio of NPK nutrients without ploughing under harvest residues. In the sunflower field during 1998 and 1999, we studied the CMS sunflower lines Ha-981 and BCSS-7 in a two-factorial complete randomized block design with three replications. There were ten characteristic fertilization treatments: control, N100, P100, K100, N100 P100, N100 K100, P100 K100, N50 P50 K50, N100 P100 K100, and N150 P150 K150. The CMS lines were machine-sown with the restorer line RHA-SNRF in the second ten-day period of April on a fixed space of 70 x 25 cm. The size of the basic plot was 17 x 2.8 m.

At full maturity, six plants from each replication were used to count the number of filled, empty and total seeds per plant and to determine percentage fertilization. At the end of the growing season, we determined seed yield (kg/ha, 11% moisture) and 1000-seed mass as well as energy of germination and germination. Results were analyzed by ANOVA and presented graphically.

During both years of the experiment the weather conditions were favorable. Winter rainfall (X-III) in 1998 was similar to the multiyear average (MYA 246 mm), while in 1999 it was higher by 111 mm. Summer rainfall (IV-IX) amounts were higher in both years than the MYA (365 mm) by 101 and 156 mm, respectively, which caused a higher disease susceptibility. The average daily temperature in both years was slightly higher, but at seed fill in 1998 it was higher by 2.5-3C. Humidity at flowering was satisfactory at 67-73 % and 75-82% in 1998 and 1999, respectively.

Results and Discussion

Total Seed Number per Plant. This trait was significantly influenced by year, line and fertilization treatment. Line Ha-981 had a significantly higher number than BCSS-7 (Figure 1). On average for both lines, the highest number was in the treatment with 100NK, which was not significantly higher than treatments 100N, 150NPK, 100NP, 100NPK, 50NPK and 100PK and

significantly higher than all the other treatments. The lowest number was in the control treatment, which was not significantly lower than treatments 100K and 100P and was significantly lower than all the other treatments. Line BCSS-7 had the highest number in treatment 100NK and the lowest number in treatment 100P, but there were no significant differences between the treatments. Line Ha-981 had the highest number in treatment 100NPK, which was significantly higher than only treatment 100K and the control. The lowest number of seeds was in the control, which was not significantly lower than treatments 100K and 100P and significantly lower than all the other treatments. This trait depends on nutrients, especially on nitrogen, although phosphorous and potassium stimulates its effect (Steer et al., 1984).

Percentage Fertilization. This factor was significantly influenced by year, line and fertilizer. Line Ha-981 had a significantly higher percentage than BCSS-7 (Figure 2). On average for both lines, the highest percentage fertilization was in treatment 100NPK, which was significantly higher than in all the other treatments. The percentage in treatment 100N was the lowest, and was significantly lower than all other treatments, except 100P, 100PK, control and 150NPK. Line BCSS-7 had the significantly highest percentage in treatment 100NPK, while the lowest was in 100N, which was significantly lower than all the other treatments, except 100PK and 100P. Line Ha-981 had the highest percentage in treatment 100NPK, and was significantly higher than only the control and treatment 100P. The lowest percentage of fertilization was in treatment 100P, which was significantly lower than only variants 100NK and 100NPK. It can be concluded that percentage fertilization is affected only by optimal nutrition with all three nutrients, which is in accordance with the findings of Samui and Ghosh (1988).

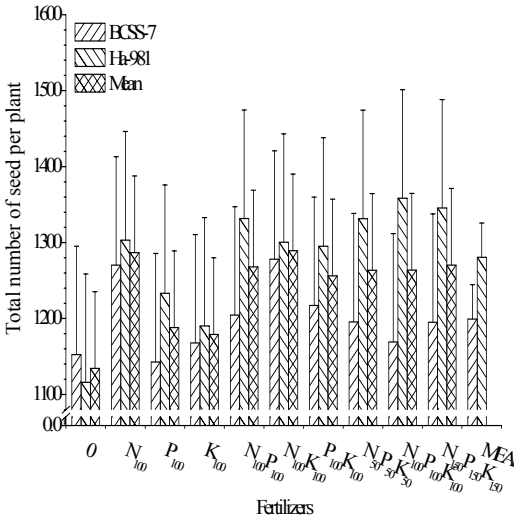

Figure 1. Total number of seeds per plant.

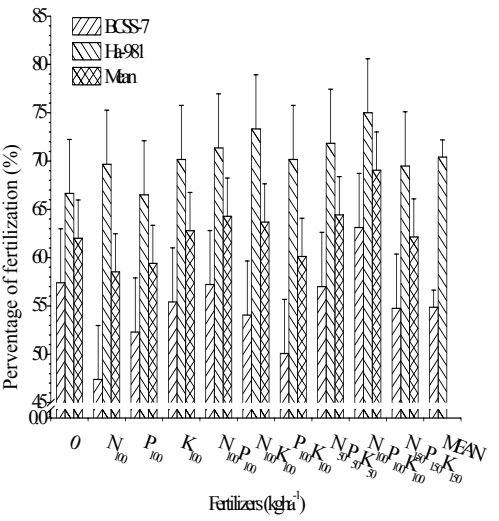

Figure 2. Percentage fertilization.

1000-Seed Mass. This trait was significantly influenced by year, line and fertilizer. Line BCSS-7 had significantly higher mass than Ha-981 (Figure 3). On average for both lines, the highest 1000-seed mass was in treatment 100NPK, and was significantly higher than 100K, 100P and control, but not significantly higher than all the other treatments. The lowest mass was in the

control, and it was not significantly lower than 100P, 100K and 150NPK, but was significantly lower than all the other treatments. Line BCSS-7 had the highest seed mass in treatment 100NPK, which was not significantly higher than all the other treatments except 100P, and 100K. The lowest mass was in treatment 100P, which was not significantly lower than treatments 100K and 100N, 50NPK, control, 150NPK and 100PK, but was significantly lower than all the other treatments. Line Ha-981 achieved the highest mass in treatment 100N, which was significantly higher than only the control and 100P, and was not significantly higher than all the other treatments. The significantly lowest mass was in the control treatment. On both lines the highest effect was nitrogen in the amount of 100 kg/ha, separately and in combination, which is in accordance with Vrebalov (1983).

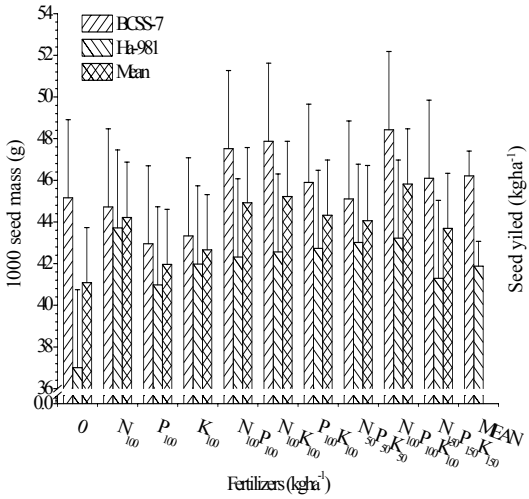

Figure 3. 1000-seed mass.

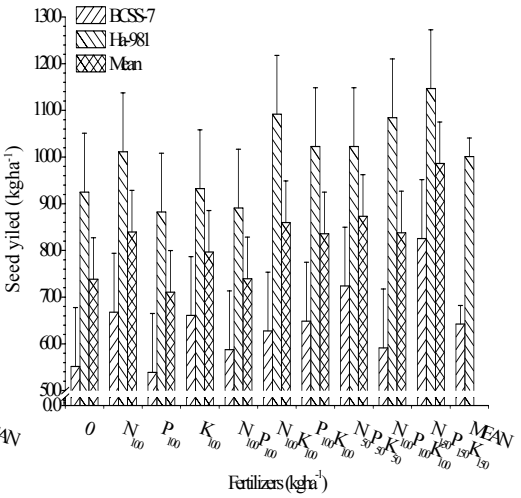

Figure 4. Seed yield per hectare.

Seed Yield per Hectare. Yield was significantly influenced by year, line and fertilizer. Line Ha-981 had a significantly higher yield than BCSS-7 (Figure 4). On the average for both lines, the highest yield significantly was in treatment 150NPK. The lowest yield was in treatment 100P, and it was not significantly lower than the control, 100NP, or 100K, but was significantly lower than all the other treatments. Line BCSS-7 had the highest yield significantly in treatment 150NPK, except for 50NPK. The yield in treatment 100P was the lowest, which was not significantly lower than the control and treatments 100NP, 100NPK, 100NK, 100PK and 100K, but was significantly lower than all the other treatments. Line Ha-981 achieved the highest yield in treatment 150N, which was not significantly higher than the treatments 100NK, 100NPK, 100PK and 50NPK, but was significantly higher than all the other treatments. The lowest yield was in treatment 100P and it was not significantly lower than 100NP, control and 100K, but was significantly lower than all the other treatments. It can be concluded that yield was mainly influenced by nitrogen, since in all cases when it was lower yield significantly decreased (Crnobarac et al., 1999). The highest yield was achieved in a triple combination of nutrients (Gal et al., 1998) and although differences between their amounts were not significant, the economic effect of the higher rate should be

considered.

Energy of Seed Germination. Germination energy was significantly influenced by year, line and fertilizer. Line Ha-981 had a significantly higher energy than BCSS-7 (Figure 5). On average for both lines, the highest energy was in treatment 150NPK, which was not significantly higher than the treatments 100K, 50NPK, 100NK, 100NP and 100NPK, but was significantly higher than all the other treatments. The lowest energy was in the control treatment and it was not significantly lower than 100P, 100PK and 100N, but was significantly lower than all the other treatments. Line BCSS-7 had the highest energy of germination in treatment 100NK, which was not significantly higher than the treatments 100NP, 100K, 150NK and 50NPK, but significantly higher than all the other treatments. The energy in the control treatment was the lowest, which was not significantly lower than treatments 100PK, 100P, 100N and 100NPK, but was significantly lower than all the other treatments. Line Ha-981 achieved the highest energy of germination in treatment 150NPK, which was not significantly higher than the treatments 100NPK, 50NPK, 100N, 100K and 100PK, but was significantly higher than all the other treatments. The lowest energy was in treatment 100NK, which was only significantly lower than treatments 100NPK and 150NPK.

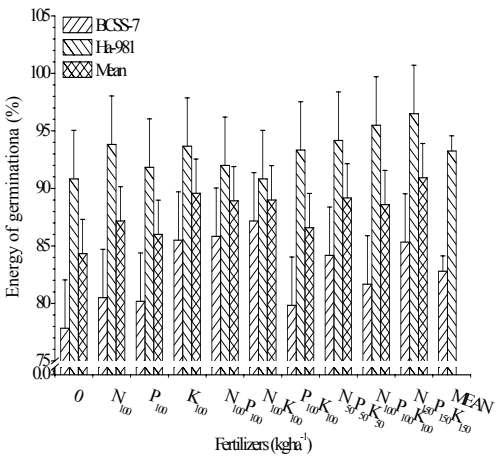

Figure 5. Seed energy of germination.

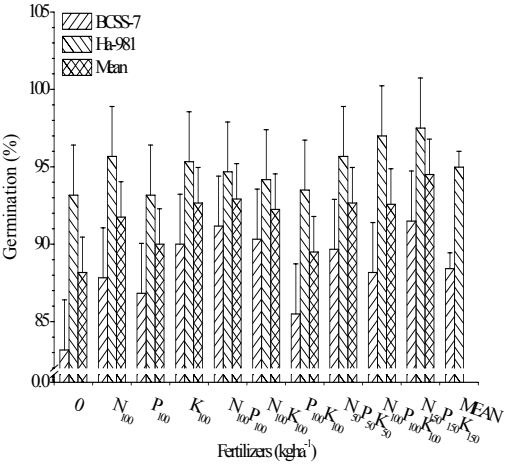

Figure 6. Seed germination.

Seed Germination. Germination was significantly influenced by year, line and fertilizer. Line Ha-981 had a significantly higher germination than BCSS-7 (Figure 6). On average for both lines, the highest germination was in treatment 150NPK, which was not significantly higher than the treatments 100NP, 50NPK, 100K, 100NPK and 100NK, but was significantly higher than all the other treatments. The lowest germination was in the control treatment and it was not significantly lower than 100PK and 100P, but was significantly lower than all the other treatments. Line BCSS-7 had the highest seed germination in treatment 150NPK, which was not significantly higher than the treatments 100NP, 100NK, 100K and 50NPK, but was significantly higher than all the other treatments. The germination in the control treatment was the lowest, which was not significantly lower than treatment 100PK, but was significantly lower than all the

other treatments. Line Ha-981 achieved the highest seed germination in treatment 150NPK, which was not significantly higher than the treatments 100NPK, 50NPK, 100N, 100K and 100NP, but was significantly higher than all the other treatments. The lowest germination was in treatment 100P, which was only significantly lower than treatments 100NPK and 150NPK.

Conclusions

According to two years' results obtained on chernozem soil, we can make the following conclusions for fertilizing sunflower lines. Year, line and fertilizer significantly influenced all traits. The total number of seed per plant depends especially on nitrogen, although phosphorous and potassium stimulate its effect. Percentage fertilization is affected only by optimal nutrition with all three nutrients 100NPK. On 1000-seed mass the highest effect had nitrogen in the amount of 100kg/ha, separately and in a triple combination. The highest yield was achieved in a triple combination of nutrients, and although differences between different amounts of nutrients were not significant, the economic effect of the higher rate should be considered. Energy of germination and germination for both lines were significantly lower on the control and treatments 100P and 100PK, and additionally, treatment 100N on line BCSS-7.

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