EFFECTS OF SOWING UNIFORMITY ON SUNFLOWER YIELD

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As a consequence of the numerous questions asked by agricultural machine manufactures about the incidence of sowing uniformity on sunflower *(Helianthus annuus)* yield, and due to the scarce bibliography on this subject, is was decided to carry out this investigation.

Sunflower (Guayacán INTA cultivar) was sown in rows at 0.70 m apart but with different distances among plants on the basis that six seeds would be sown every 1.20 m, so that the number of plants per unit area at the sowing moment was the same (70.000 plants/hectare) in all the treatments (table 1).

Table 1

Distribution of plants in each treatment

No. 1 — 20—20—20—20—20—20 cm	between	each seed
No. 2 — 10—30—10—30—10—30 cm	„	„ „
No. 3 — 10—20—30—10—20—30 cm	„	„ „
No. 4 — 10—10—40—10—10—40 cm	„	„ „
No. 5 — 5— 5— 5— 5—50—50 cm	„	„ „

Distances among plants were selected in that way, taking into account that No. 1 treatment would be taken as check, because it is the most uniform one ; No. 2 and 3 were considered as „scarcely uniform" possibly to occur commonly in sunflower sowings and No. 4 as well as No. 5 were considered as „ununiform treatments".

The results obtained during two years were similar, and showed that sunflower uniform sowing allows to obtain the best yields, as it probably happens in every agricultural species.

MATERIAL AND METHODS

Experiments were carried out during 1971/72 and 1972/73 years at the Experimental field for industrial crops (Agronomy Faculty-Buenos Aires University, 34° 35'S latitude ; 52° 29'W longitude ; 25 a.s l).

Guayacán INTA sunflower cultivar was used and each treatment was planted in a randomized complete block design with four replications. Each plot was formed by four rows, 6 m length and 0.70 m apart. Only the two central rows were harvested at ripening time. Before sowing a pre-sowing herbicide (trifluraline, 2 liters/hectare) was applied. Sowing dates were November 12, 1972 and November 13, 1973.

When sunflower flowering ended each investigated plant was covered by a polyethylene net bag for protection against bird damage. Harvesting was carried out on 11 February, 1972 and 2 February 1973.

It can be appreciated that there are some plants that growing closely together (separated less than 0.20 m from their neighbours) can be considered „injured" for being too near in comparison with those placed at more than 0.20 m apart from the following one. Plants considered „injured" and „noninjured" were harvested separately to analyse them, considering: number of plants harvested and differential head diameters and yields.

During the second year experiment, the number of plants and the head diameter determination could not be taken.

Variance analysis was performed, as statistic interpretation using Tuckey test, to compare yields.

RESULTS

According to the investigation plan, analyses of results were concentrated on plant losses between sowing and harvesting, head diameters and yields during the first year experiment, and only on yields during the second one.

Yields. Table 2 shows different treatments (yield/hectare) in 1971/72 and 1972/73 experiments.

Table 2

Yield (kg/ha) according to treatment and year

	1971/72	1972/73	Average	Calification
No.1	2347	2455	2401	Uniform
No.2	1942	2295	2118	Scarcely uniform
No.3	1987	2227	2107	Scarcely uniform
No.4	1775	1637	1706	Ununiform
No.5	1862	1785	1823	

Statistical analyses demonstrated significative differences among treatments both in 1971/72 and 1972/73 trials in this way: treatment No. 1 was significantly superior to No. 4 in both years, at the 5% level. When treatment No. 1 was compared with the yield averages of treatments No. 4 and No. 5, significative differences at 5% level were found in 1971/1972 experiment and at the 10% level in 1972/73.

Plant losses. Table No. 3 indicates the percentage of plant losses resulted from differences between plants left after spacing and plants counted at harvesting. Mean values of „injured" and „noninjured" are indicated in a separate way.

Table 3

Percentage of plant losses

Treatment	„noninjured" plants	„injured" plants
No. 1	16.3	—
No. 2	17.3	—
No. 3	14.1	15.6
No. 4	18.0	25.0
No. 5	14.2	46.6

Comparing the values from the table No. 3 with the distribution of plants it can be observed that :

a — When plants were sufficiently spaced, mean losses, due to the lack of normal development or ulterior death, attack of diseases, etc., can be considered 15.0%.

b — When plants were spaced 0.05 and 0.10 m from their neighbours, plant losses were 46.6% and 25.0% respectively. By increasing the distances over 0.05 and 0.10 m the density effect finally disappears.

Head diameter. Table No. 4 shows mean head diameter values ; here „plant losses" values were also separated for „injured" and „noninjured" plants.

Table 4

Head diameter (cm)

Treatment	„noninjured" plants	„injured" plants
No.1	13.1	—
No.2	11.8	—
No.3	14.3	6.1
No.4	12.7	5.6
No.5	14.4	7.3

Minimum values were obtained in treatments in which the plants were closer („injured") and the highest in treatments with larger growing space between plants.

It is important to remark that the highest mean diameter (14.4 cm) was obtained in plants spaced at 0.50 m (treatment No. 5) and the following (14.3 cm) almost equal value, in those at 0.20 m (treatment No. 3). On the third place is treatment No. 1 („uniform" sowing) with 13.1 cm. as mean head diameter.

DISCUSSION AND CONCLUSIONS

Yield. Statistical interpretation determined that treatment No. 1 („uniform") have 5% level significative differences with respect to No. 4 (ununiform").

Sheffée multiple comparison proof gave significative differences between treatment No. 1 and treatments No. 4 and 5 at the 5% level during 1971/72 and at the 10% level during 1972/73.

Observing fig. No. 1 and tables No. 1 and 4 some interesting considerations can be made.

In fig. No. 1 plants have been outlined supposing that each circle of 0.20 m represents the area occupied by the plant (roots and foliage). Then it can be observed areas, theoretically „superposed" and „unavailable" leaving within the circles the „available" surface for each plant.

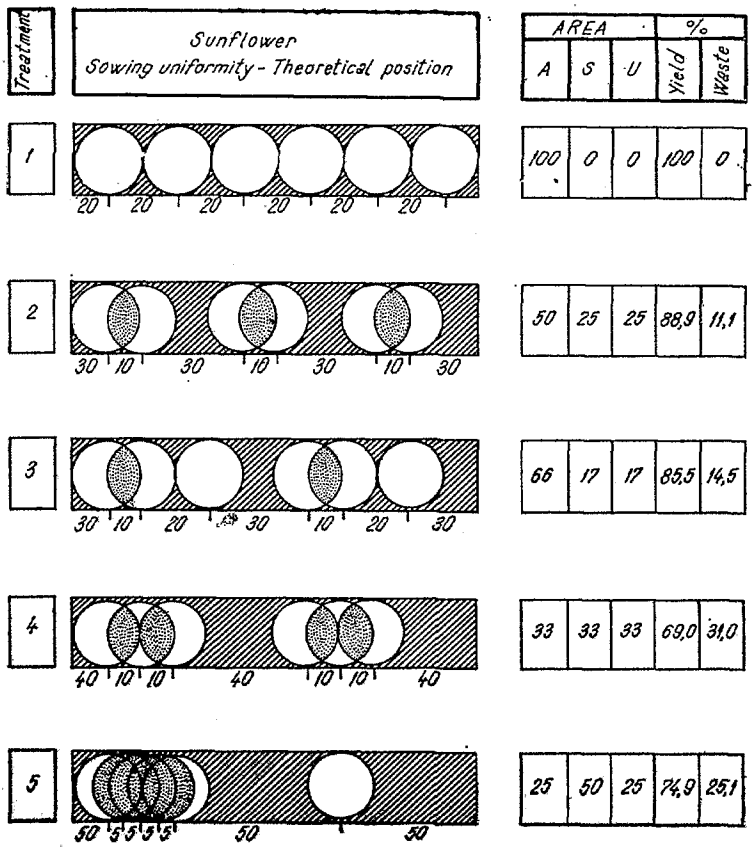

Fig. 1 — Theoretical position, available, superposed and unavailable areas, yields and waste.

The values obtained (table No. 5) show that when the „superposed" and/or „unavailable" areas increase, yields decrease considerably. Treatment No. 1, which was considered „uniform", had 100% available area without „superposed" or „unavailable" area and consequently the yield was highest in the two years (table 5 shows 1971/72 and 1972/73 average yields).

Table 5

Surface, yield and mean waste percentage, 1971/72 and 1972/73

Treatment	Surface %			Yield		Waste		Calification
	available	unavailable	superposed	kg/ha	%	kg/ha	%	
No. 1	100	0	0	2401	100	0	0	Uniform
No. 2	50	25	25	2118	88.3	280	11.7	Scarcely
No. 3	66	17	17	2107	87.8	291	12.2	uniform
No. 4	33	33	33	1706	71.1	692	28.9	Ununiform
No. 5	25	50	25	1823	76.0	575	24.0	

Treatments No. 2 and 3 considered as „scarcely uniform", had the „available" area decreased and the „superposed" and „unavailable" areas increased proportionally, then smaller yields were obtained, almost equal in relation to the check („uniform").

On the other hand, treatment No. 4 and 5, named „ununiform", having little „available" area and an extended „unavailable" and „superposed" areas, have considerably decreased yields.

Plant losses and head diameter. The increase of plant losses during growing period and the decrease of head diameter are a direct consequence of the spacing among plants such as it was observed by other authors (Luciano and Davreux, 1961).

Sunflower plants suffer of proximity („injured" plants) when seeds are sown less than 0.20 m apart within the row, taking into account the results obtained in this experiment.

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