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EFFECT OF THE LOSS OF PLANTS OR HEADS AT DIFFERENT PHENOLOGICAL STAGES ON SUNFLOWER YIELD

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SUMMARY

We have investigated the response of sunflower yield to decapitation or loss of plants to simulate hail damage. A short-to-medium maturity hybrid was grown at 5.7 and 4.7 plants m^{-2}. Treatments included the factorial combination of two types of damage (decapitation, uprooting of plants), four intensities (0, 25, 50, and 75% plants treated) and six phenological stages (V7, R1, R3, R5, R6, or R9). Yield response depended on timing of damage for plant but not for head loss. Decapitation at V7 or R1 killed plants or reduced their growth whereas it increased plant growth at R3. Yield losses caused by decapitation were larger than those associated with reduction in plant stand.

INTRODUCTION

Hailstorms cause a range of damage, including reduction in plant stand and decapitation. Quantification of crop response to this sort of damage is of interest to both farmers and insurance companies. Assessment of yield loss caused by hailstorms involves a high degree of subjectivity. To simulate hail damage, we investigated sunflower yield response to decapitation or loss of plants in a field experiment.

MATERIALS AND METHODS

The trial was run at Balcarce, (37° S, 58° W,altitude 130 m). A short-to-medium maturity hybrid, Dekasol 3900, was sown on 15 Nov. 1996 at 5.7 and 4.7 plants m^{-2}. Treatments included the factorial combination of two types of damage (decapitation, uprooting of plants), four intensities (0, 25, 50, and 75% plants treated) and six phenological stages (V7, R1, R3, R5, R6, or R9, Schneiter and Miller, 1981). The experimental unit were three 6 m long rows; interow space was 0.7 m . A split-split plot design was used, with four replications. Plant density was assigned to the main plot, which was succesively split to account for intensity and timing of damage. Leaf area (Pereyra et al.,1982) and plant height were measured at R5. Grain yield, number and weight were registered at 11% grain humidity.

RESULTS AND DISCUSSION

Regression of yield vs % plants treated were highly significant at all phenological stages (Tables 1 and 2). The slopes for plants m^{-2} did not differ significantly ($P > 0.60$), so that data for both densities were pooled (Table 3).

Greater leaf area was registered when plant losses occurred before than R5 (data not shown). For plant loss near flowering (R5) or later, leaf area was close to maximum and compensation of undamaged plants was less. Yield loss, therefore, tended to represent the percentage of lost plants (Table 3).

Smaller leaf area and shorter plants were observed for decapitation at V7 and R1. Later treatments had less effect on leaf area and plant height (R2, R3, or R5). Decapitation at early stages (V7 or R1) probably upset development of leaf primordia. Decapitation at later stages, however, allowed for leaf primordia expansion and, as a result of lack of capitula, vegetative growth was enhanced and senescence delayed. Yield loss caused by decapitation was proportional to intensity of damage until R3 stage. Afterwards, yield decrease was more than proportional to lost heads (Table 3).

Table 1. Linear regression between yield loss (kg/ ha) and plant removal (%).

	V7	R1	R3	R5	R6
57.000 plants per hectare					
[1]R^2	0.55	0.67	0.70	0.86	0.92
[2]CV%	16.	21	13	24	12
[3]Pr > F	0.0220	0.0070	0.0003	0.0046	0.0001
47.000 plants per hectare					
R^2	0.80	0.85	0.91	0.92	0.93
CV%	14	16	13	13	22
Pr > F	0.0012	0.0004	0.0001	0.0001	0.0053

[1] **R^2:** Coefficient of determination.
[2] **CV%:** Coefficient of variation. It expresses the variation of yield, in percentage, with respect to the average.
[3] **Pr > F:** It expresses the significance of the regression model. It is the probability of finding a value of F greater than the calculated F. It is compared with the level of significance $\alpha = 0.05$. If Pr >F is < $\alpha = 0.05$ so there are evidences to assert that regression between plant loss and yield loss is significant (slope different from 0).

Table 2. Linear regression between yield loss (kg/ ha) and apical buds (flower buttons or heads) removal (%).

	V7	R1	R3	R5	R6
57.000 plants per hectare					
[1]R^2	0.94	0.90	0.94	0.94	0.95
[2]CV%	11	13	12	12	13
[3]Pr > F	0.0001	0.0001	0.0001	0.0001	0.0001
47.000 plants per hectare					
R^2	0.84	0.88	0.96	0.94	0.96
CV%	14	17	10	11	9
Pr > F	0.0005	0.0002	0.0001	0.0001	0.0001

[1] **R^2:** Coefficient of determination. It expresses the degree of adjustment of the regression model. It represents the proportion of the variation of yield (kg/ha) that is explained by head losses.
[2] **CV%:** Coefficient of variation. It expresses the variation of yield, in percentage, with respect to the average.
[3] **Pr > F:** It expresses the significance of the regression model. It is the probability of finding a value of F greater than the F calculated.

Table 3. Estimates of yield loss (%) caused by plant removal or decapitation at different phenological stages.

STAGE	PLANT REMOVAL			DECAPITATION		
	25%	**50%**	**75%**	**25%**	**50%**	**75%**
V7	2	12	45	20	47	70
R1	5	15	51	24	48	72
R3	9	17	58	27	50	74
R5	12	30	64	30	52	76
R6	18	36	68	30	55	81
R9	25	50	75	25	50	75

Yield losses caused by decapitation were larger than those associated with reduction in plant stand. This was due to (i) compensation in the case of stand reduction, and (ii) increased competition by barren plants in the case of decapitation.

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