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MECHANICAL INJURIES OF SUNFLOWER
STALKS, LEAVES AND HEADS AT
DIFFERENT PHASES OF DEVELOPMENT.
IN RELATION TO SEED YIELD AND SEED
OIL CONTENT

Our studies were aimed at establishing the influence of hail injuries at different phases of sunflower plant development on seed yield and seed oil percentage, with account being taken of the weather conditions during the recuperation period.

Experiments were carried out in 1966-1968 at the experimental field of the Agricultural Research Institute in Novi Sad. The studies involved the VNIIMK 8931 variety, the plot size being 10.9 sq m and the nutritive area 70 x 35 cm.

Hail was imitated with the help of special instruments tearing the leaves and giving surface and deep blows to stalks, heads and leaf petioles causing injuries to vascular-fibrous bundles.

The injury rate was determined for each plant. Injuries were rated as weak at 20-25% of damaged leaf surface at all phases of development. Medium injuries were rated at 50-55% of damaged surface of leaves. Additional injuries were as follows: at the phase of 3-4 pairs of leaves 3 deep blows, 50 surface blows, and 1 broken petiole, at the bud formation phase 5 deep blows, 80 surface blows, 2 broken petioles; at the phases of flowering and seed filling 10 deep blows, 120 surface blows, 3 broken petioles. Severe injury was rated at all phases at 80-85%, the additional injuries being at 6 deep blows, 120 surface blows and 4 broken petioles the phase of 3-4 pairs of leaves; 10 deep blows, 150 surface blows, and 5 broken petioles at the phase of budding; and 20 deep blows, 180 surface blows, and 6 broken petioles at the phases of flowering and seed filling.

Weak intensity of injuries at the beginning of vegetation (3-4 pairs of leaves) reduced the yield in a minimal degree. At this phase of development the reduction of yield was 0.5-4.9% for the years of studies (Table 1). At the budding stage yield reduction ranged from 5.0 to 5.7%, at the flowering stage from 21.4 to 24.8% and at the phase of seed filling it was 25.3-41.8% (plants were injured 20 days after head flowering). These figures demonstrate the increase of damage as plants grow older. The largest yield reduction was observed in damaged plants at the flowering and seed filling stages; this can be explained by a low recuperating ability of sunflower during the second half of vegetation. At the flowering stage the plants have a maximal height the leaves a maximal area. Following the hail injuries new leaves are not formed, but under favourable weather conditions callus formed on damaged stalks. At the seed filling stage callus did not appear on stalks.

Sunflower has the highest regenerating ability at the stage of 3-4 pairs of leaves and during budding. New leaves grow and callus is formed on all damaged stalks and leaf petioles. Depending on injury rate the subsequent stages of development are somewhat delayed. At severe injuries the delay of growth processes during this period is 5-8 days, at weak injuries it is 1-2 days.

At medium injuries at the phase of 3-4 pairs of leaves yield reduction was 15.9-24.3%, at the budding stage 25.2-41.8%, at the flowering stage 41.7-50.1%, and at the seed filling stage 43.2-55.8%. Just as at the weak rate of hail injury, sunflower damaged with imitated hail at the first half of vegetation period continues growth, new undamaged leaves completely fulfil their functions and the plants as a whole less suffer from injuries than at the subsequent phases of development.

Severe hail injuries at the stage of 3-4 pairs of leaves reduced the yield by 30.5-45.4%.

Table 1 (continued)

	1	2	3	4	5	6	7	8	9
<u>Start of flowering:</u>									
Weak damage		23.09	75.2	21.12	77.5	26.06	78.6	23.42	77.10
Medium damage		15.32	49.9	14.80	53.2	19.33	58.3	16.48	53.80
Severe damage		5.98	19.4	3.68	13.4	8.86	26.7	6.17	19.80
<u>Maturity:</u>									
Weak damage		17.89	58.2	17.10	62.5	24.77	74.7	19.92	65.13
Medium damage		13.58	44.2	14.06	51.4	18.83	56.8	15.49	50.80
Severe damage		8.05	26.2	9.23	33.7	14.62	44.0	10.60	34.67
Undamaged plants (Check)		30.70	100.0	27.34	100.0	33.16	100.0	30.40	100.0

At the budding stage reduction was 38.7-56.8%, at the flowering stage 73.3-86.6%, and at the seed filling stage 56.0-73.8%. For all years of experiments yield reduction was the largest when plants were severely injured at the flowering stage, while at weak and medium injuries, as mentioned above, the damage from hail injuries was increasing from the beginning of vegetation to its end. This can be explained by the fact that, given weak regeneration abilities of plants at the flowering stage seeds grow and are filled under very unfavourable conditions, with almost all leaves damaged or killed. Plants of the last variant showed normal development of seeds 20 days following flowering.

Hail injuries reduce both seed yield and seed oil content (Table 2).

Oil yield per hectare is reduced correspondingly (Table 3).

Experiments have shown that at the same intensity of injuries yield reduction usually differs in the seasons of experiments, depending on weather conditions (temperature and air humidity) during the first 8 days after hailing. The most favourable season for sunflower was 1968 in Voevodiva, which has also been the most productive season in the country for the last 14 years. Temperature and moisture in the regeneration period assured rapid recuperation of damaged plants. Damage from hailing in that year, even at a severe rate of injuring, was 30.5, 38.7, 73.3 and 56.0% by phases of development. Under less favourable meteorological conditions in 1966 the yield reduced by 45.4, 56.3, 80.6 and 73.8% respectively, by phases of development during the regeneration period, and by 31.8, 45.0, 86.6 and 66.3% in 1967.

The following conclusions may be made on the basis of three-year studies.

Regeneration ability of sunflower plants depends on plant age and weather conditions during the regeneration period.

Table 2

Influence of Hail Injuries on Seed Oil Content,
1966-1968

Rate of damage	Oil content of absolutely dry seeds						Mean for 3 years	
	1966		1967		1968			
	%	devia- tion from check	%	devia- tion from check	%	devia- tion from check		
<u>3-4 pairs of leaves:</u>								
Weak damage	45.99	-0.04	44.51	-0.31	48.71	-0.62	46.40	-0.32
Mean damage	44.69	-1.34	44.46	-0.35	48.64	-0.69	45.93	-0.79
Severe damage	43.58	-2.46	43.11	-1.70	48.32	-1.01	45.00	-1.72
<u>Budding:</u>								
Weak damage	45.72	-0.31	44.70	-0.11	49.57	-0.24	46.66	-0.06
Mean damage	45.91	-1.40	44.17	-0.64	49.19	-0.14	46.42	-0.30
Severe damage	44.63	-1.40	42.87	-1.94	48.72	-0.61	45.41	-1.32

Table 2 (cont.)

	1	2	3	4	5	6	7	8	9
<u>Flowering:</u>									
Weak damage		44.80	-1.23	43.55	-1.26	48.73	-0.60	45.69	-1.03
Mean damage		44.85	-1.18	41.21	-3.60	47.16	-2.17	44.41	-2.32
Severe damage		42.50	-3.53	39.93	-4.88	46.23	-3.10	42.89	-3.84
<u>Maturity:</u>									
Weak damage		42.70	-3.33	41.94	-2.87	48.27	-1.06	34.30	-2.42
Mean damage		39.82	-6.21	40.29	-4.52	46.65	-2.68	42.25	-4.47
Severe damage		33.13	-12.9	33.35	-11.46	44.31	-5.02	36.93	-9.79
Intact plants - check		46.03	-0.00	44.81	0.00	49.33	0.00	46.72	0.00

Table 3

Hailing Effect on Oil Yield (1966-1968)

Rate of damage	Oil yield				Mean for 3 years	
	1966	1967	1968	1967	1968	%
	kg/ha	%	kg/ha	%	kg/ha	%
<u>3-4 pairs of leaves:</u>						
Weak damage	1212	98.6	1053	98.8	1336	93.9
Mean damage	904	73.6	873	81.9	1179	82.9
Severe damage	637	51.8	637	59.8	968	68.0
<u>Budding:</u>						
Weak damage	1153	93.8	1010	94.8	1347	94.7
Mean damage	715	58.2	723	67.8	1056	74.2
Severe damage	521	42.4	542	50.8	861	60.5
					1200	97.1
					985	79.4
					747	59.8
					1170	94.4
					831	66.7
					641	51.2

Table 3 (cont.)

	1	2	3	4	5	6	7	8	9
<u>Flowering:</u>									
Weak damage		900	73.2	800	75.1	1104	77.6	834	75.3
Mean damage		598	48.6	530	49.7	792	55.6	640	51.3
Severe damage		221	17.9	127	11.9	356	25.0	234	18.2
<u>Maturity:</u>									
Weak damage		665	54.1	623	58.4	1040	73.1	776	61.8
Mean damage		469	38.1	492	46.1	764	53.7	575	45.9
Severe damage		231	18.8	267	25.0	563	39.5	353	27.7
Intact, check plants		1228	100.0	1065	100.0	1422	100.0	1238	100.0

The regeneration ability is the largest at the phase of 3-4 pairs of leaves. At the budding stage this ability is lower, though callus is formed on all injured tissues. At the flowering stage regeneration ability is much lower, callus being seldom formed. At the seed filling stage plants are practically incapable of regenerating.

Seed yield and oil percentage reduction from hailing is closely related to the regenerating abilities of sunflower plants.