The Effect of Simulated Hail Damage on *Flax*

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Crops in the Red River Valley of Minnesota are subject to several hazards between planting and harvest. Some of these hazards can be partially avoided while others, like hail, can not. Although crop insurance can help reduce the financial losses due to hail, farmers and insurance companies sometimes disagree on the amount of hail damage. Growers and insurance companies, therefore, are interested in obtaining information that can be used to arrive at better adjustments resulting from hail damage.

The objectives of this research were to study the effect of simulated hail damage on yield and quality of flax seed. The research was conducted from 1965 to 1967 in cooperation with the Hail Insurance Adjustment and Research Association.

METHODS AND PROCEDURES

Three simulated hail injuries were studied, including (1) stand reduction at the 1- and 2-inch stage of growth, (2) bud removal at five different rates, and (3) stems broken by pinching at four stages of growth. The plots were sown on Bearden silt loam soil that had been fallowed the previous year. A randomized block design was used with three replications. Each plot consisted of four 20-foot rows, 6 inches apart. The two middle rows were harvested for yield determinations.

The average seeding date for the 3-year period was May 21, and the average emergence date was June 1. The average maturity date was August 30 with the exception of the bud removal plots, which matured about 1 week later.

B5128 flax was sown at a rate of 1 bushel per acre and gave an average stand of 180 plants per 10 feet of row.

The plots were sprayed with T.C.A. and 2,4-D amine and were relatively weed-free.

The stand reduction treatments consisted of reducing stands 0, 25, 50, and 75 percent at the 1- and 2-inch stages of growth by pulling out the extra plants. The average dates of these treatments were June 11 and June 16, respectively.

In the second study, the flax was damaged by removing 0, 25, 50, 75, and 100 percent of the buds from each plant when the crop was in the full bud stage of growth. The 3-year average date for these treatments was July 10.

The damage in the last study consisted of breaking the stems by pinching them between two blocks of wood at a random height of 5 to 9 inches above the ground. These treatments were applied at the following stages of growth and on the average dates:

Stage of growth	3-year average date of stem breakage
11 inch	July 7
First boll	July 18
Green boll	July 25
Mature	July 26*

*1967

RESULTS AND DISCUSSION

Because of good growing conditions in 1965 and 1966 the flax yields were high, but in 1967 the summer drought caused severe moisture stress and low yields. This condition may have influenced results from the stand reduction studies in 1967 because the reduced stands had more available moisture per plant than the check plots.

Mean temperatures for the 3-year period were similar to the 65-year averages as given in table. 1. The greatest variance occurred in September 1965 when the mean temperature was approximately 11° lower than in September 1966 and 1967.

Precipitation for the 5-month period, as shown in table 1, varied greatly from a total of 7.33 inches in 1967 to 16.74 inches in 1965. Precipitation during the 5-month period in 1965 was 2.78 inches above, and in 1967 was 6.63 inches below, the average. June precipitation was above average for all 3 years, and varied from 0.88 to 1.13 inches higher than that of the 65-year average. July 1967 was the driest month on record in the weather station at the Northwest Experiment Station, Crookston.

Stand Reduction—In this discussion the "0" or "check"

Table 1. Mean temperature and precipitation at Crookston, Minnesota, for th

	Mean monthly temperature (F)		
Month	1965	1966	1967
May	54.5	51.0	51.1
June	64.1	65.7	63.0
July	68.3	72.4	68.2
August	67.0	66.6	67.0
September	48.9	59.7	62.1
Total precipitation			

plots are used as a standard. Tables 2 and 3 give the yield of flax for each of the 3 years, the 3-year average yields, and percent of stand reduction at the 1- and 2-inch stages of growth, respectively. The effect of stand reduction on flax yields in percent of check for the 3-year average for both stand reductions is shown in figure 1. In general, the average yield reduction at the 1-inch stage was less than that at the 2-inch. The data in both tables show that the yields decreased as the degree of stand reduction increased.

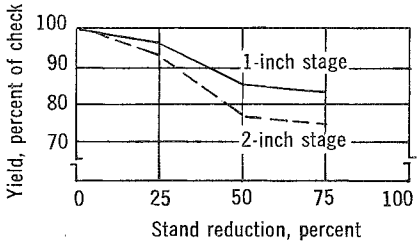


Figure 1. The effect of stand reduction on the yield of flax in percent of check. Average 1965-67.

Table 2 shows that the greatest yield reductions occurred in 1965 and the smallest in 1967. The 25 percent stand reduction did not differ significantly from 0 reduction for the individual years, but the 50 and 75 percent reductions did. The 3-year average results followed somewhat the same pattern as that of the individual years.

Table 2. The effect of stand reduction at the 1-inch stage of growth on the yield of flax in bushels per acre for 1965-67, 3-year averages, and percent of yield reduction

Percent stand reduction	Year 1965	1966	1967	3-yr. avg.	Percent yield reduction
0	28.0a[1]	20.1a	15.9a	21.3a	—
25	26.0a	19.7a	15.6a	20.4a	4.2
50	20.0b	19.4a	14.4b	18.2b	14.6
75	22.7b	16.8b	14.0b	17.8b	16.4
L.S.D. 5%	4.2	2.5	1.1	1.5	

[1] Any two averages followed by the same letter do not differ at the 5% level of significance according to Duncan's new Multiple Range Test.

growing season 1965-67, with 65-year average

	Mean monthly precipitation, inches			
65-year avg.	1965	1966	1967	65-year avg.
54.6	4.06	1.31	0.78	2.62
63.8	4.24	4.49	4.25	3.36
69.7	2.27	3.17	0.31	2.98
67.5	1.40	3.72	0.70	2.89
57.2	4.77	0.67	1.29	2.11
	16.74	13.36	7.33	13.96

Stand reduction at the 2-inch stage of growth, as given in table 3, followed a pattern similar to that at the 1-inch stage. The largest yield reduction occurred in 1965 and the smallest in 1967. The 25 percent stand reduction did not differ significantly from 0 reduction but the 50 and 75 percent reductions did. The 3-year average yield reductions were greater than those of the stand reduction at the 1-inch stage

Table 3. The effect of stand reduction at the 2-inch stage of growth on the yield of flax in bushels per acre for 1965-67, 3-year averages, and percent of yield reduction

Percent stand reduction	Year 1965	1966	1967	3-yr. avg.	Percent yield reduction
0	23.3a[1]	22.8a	16.6a	20.9a	—
25	22.3a	21.5a	15.5ab	19.8a	5.3
50	17.3b	17.0b	14.5b	16.3b	22.0
75	16.0b	16.1b	15.3ab	15.8b	24.4
L.S.D. 5%	4.5	4.2	1.9	1.9	

[1] See footnote, table 2.

Bud Removal—The effect of bud removal on the yield of flax for each of the 3 years, the 3-year average yields, and the average percent of reduction are given in table 4. In general, the removal of buds did not reduce the flax yield as much as stand reduction did. There were significant differences in the yield reductions of flax in both 1966 and 1967, but not in 1965. In 1966 and 1967, the O, 25, 50, and 75 percent treatments did not differ significantly.

Table 4. The effect of bud removal on the yield of flax in bushels per acre for 1965-67, 3-year averages, and percent of yield reduction

Percent bud removal	Year 1965	1966	1967	3-yr. avg.	Percent yield reduction
0	28.4	17.7a[1]	15.6a	20.6a	—
25	28.3	15.3a	14.4a	19.3a	6.3
50	29.5	15.2a	14.4a	19.7a	4.4
75	27.9	16.1a	14.0a	19.3a	6.3
100	26.8	8.9b	11.9b	15.8b	22.8
L.S.D. 5%	4.9	4.3	2.0	2.0	

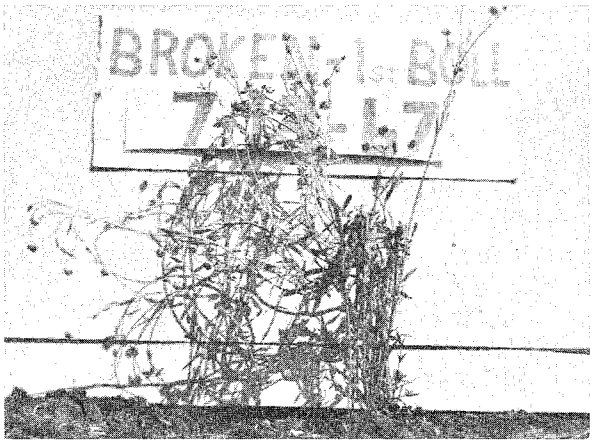
[1] See footnote, table 2.

The 3-year average yields showed smaller variations than those of the individual years. The 25 and 75 percent treatments produced identical yields. When 100 percent of the buds were removed, the yield reduction was 4.8 bushels.

The flax plants showed a rapid recovery from the bud removal damage, and by harvest time the 25, 50,

Stems broken at a height of 5 to 9 inches above ground at first boll stage (photo 1), 11-inch stage (photo 2), and late boll stage (photo 3).

1.



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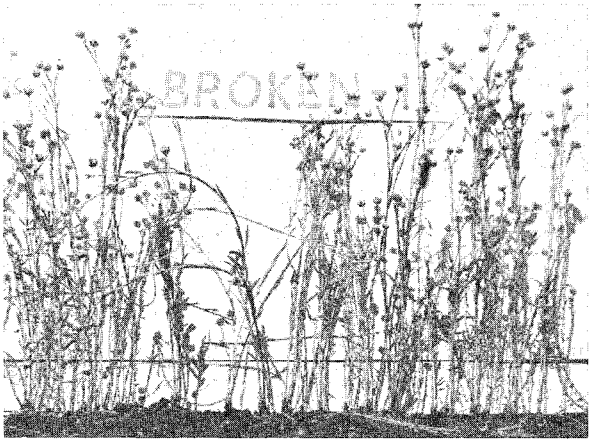

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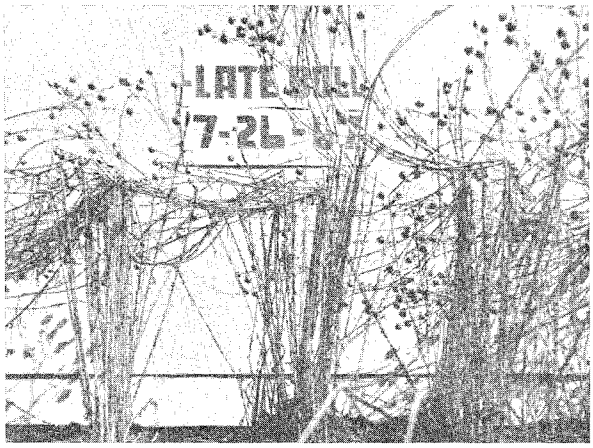

and 75 percent plots were only 1 to 2 days later in maturity than the check. The 100 percent bud removal plots ripened 5 to 7 days later.

The effect of bud removal on the yield of flax in percent of check for the 1965-67 average is shown in figure 2.

Stems Broken by Pinching—The effect of simulated hail damage by breaking stems on the yield of flax for each of the 3 years, the 3-year averages, and the percent of reduction are given in table 5. This type of simulated hail inflicted the greatest injury to the flax plants and produced the largest yield reduction. The damages applied at all stages of growth produced significant yield reductions when compared to the check plots. The greatest reductions occurred at the first and green boll stages. The 1967 yield reductions were not as severe as those in 1965 and 1966.

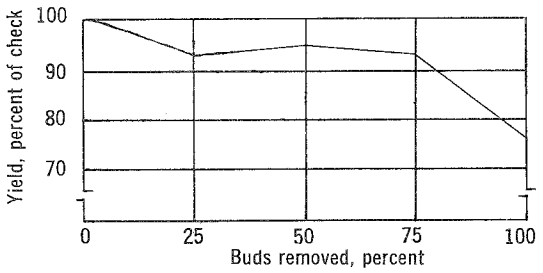

Figure 2. The effect of bud removal on the yield of flax in percent of check. Average 1965-67.

Table 5. The effect of breaking stems by pinching on the yield of flax in bushels per acre for 1965-67, 3-year averages, and percent of yield reduction

Stage of growth	Year			3-yr. avg.	Percent yield reduction
	1965	1966	1967		
Check	25.9a[1]	20.4a	15.1a	20.5a	—
11-inch	20.3b	10.7b	12.2b	14.4b	29.8
First boll	7.3c	3.5c	7.1c	6.0c	70.7
Green boll	9.0c	6.5c	7.2c	7.6c	62.9
Mature	—	—	8.4c	8.4c*	55.6*
L.S.D. 5%	5.0	3.4	1.4	2.1	

* 1967

[1] See footnote, table 2.

The effect of breaking stems on the yield of flax in percent of check is shown in figure 3.

Quality Studies—The effect of simulated hail damage on the seed weight, oil percent, and iodine number of flax for 1967 is given in table 6. When the stand was reduced at both the 1- and 2-inch stages of growth, there was a tendency for the seed weight to increase as the stand reduction increased, but the differences were not significant at the 1-inch stage. The effect on the oil percent was similar for both stages of growth.

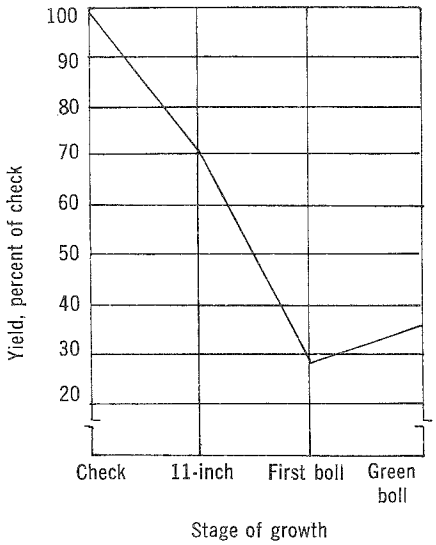

Figure 3. The effect of breaking stems on the yield of flax in percent of check. Average 1965-67.

Table 6. The effect of stand reduction at the 1- and 2-inch stages of growth on seed weight, oil percent, and iodine number of flax in 1967

Percent stand reduction	Seed wt.* g/1000	Oil percent	Iodine value
1-inch stage			
0	5.21	41.7b[1]	192
25	5.24	41.8b	192
50	5.25	41.9ab	192
75	5.28	42.1a	191
L.S.D. 5%	.1	.3	.5
2-inch stage			
0	5.20ab[1]	41.6c	192
25	5.24ab	41.9b	192
50	5.09b	41.8bc	192
75	5.26a	42.2a	192
L.S.D. 5%	.2	.3	.9

* Weight of 1000 kernels in grams.

[1] See footnote, table 2.

Table 7. The effect of bud removal on seed weight, oil percent, and iodine value of flax in 1967

Percent bud removal	Seed wt. g/1000	Oil percent	Iodine value
0	5.35c[1]	41.9ab	192b
25	5.43bc	41.8b	193a
50	5.46abc	42.1a	193a
75	5.56ab	42.0a	193a
100	5.60a	41.6b	193a
L.S.D. 5%	.2	.3	.7

[1] See footnote, table 2.

The iodine value is an index of the drying quality of the oil; the higher the index the better the oil. There were no significant differences in the iodine value at the 1- and 2-inch stages of growth between the various treatments.

The effect of bud removal on seed weight, oil percent, and iodine value for 1967 is given in table 7. This type of simulated damage had the smallest effect on the flax seed when compared to stand reduction and breaking stems. Seed weight increased as the degree of damage increased. The removal of the buds had very little effect on the oil percent and iodine value.

Table 8 shows the effect of breaking stems by pinching on the seed weight, oil percent, and iodine value. When the damage was applied at the 11-inch and first boll stages of growth, there were no significant changes in the seed weight from the check, but at the green and mature stages the reduction in seed weight was significant.

Table 8. The effect of breaking stems by pinching on the weight of seed, oil percent, and iodine value of flax in 1967

Stages of growth	Seed wt. g/1000	Oil percent	Iodine value
Check	5.22a[1]	41.6a	192a
11-inch	5.41a	41.4a	192a
First boll	5.22a	38.9b	178b
Green boll	4.14b	37.1c	169c
Mature	4.22b	37.5c	170c
L.S.D. 5%	.4	.5	3.3

[1] See footnote, table 2.

The oil percent and iodine value were not affected when the stems were broken at the 11-inch stage, compared to the check, but significant reductions occurred from damage at all the other stages of growth. This lower oil quality may have resulted from less favorable temperatures at the time of seed development, compared to the same stage of growth for the check, and not as a direct result of plant damage.

SUMMARY

The effect of simulated hail damage on flaxseed yields and quality is reported to guide growers and hail adjusters in assessing hail losses.

As the degree of stand reduction increased from 0 to 75 percent, the yields of flax decreased with each treatment at both the 1- and 2-inch stages of growth. The yield reduction was greater at the 2-inch stage of growth.

Bud removal had the least effect on the yield of flax compared to stand reduction and breaking stems. Removing 100 percent of the buds caused the greatest yield reduction and delayed the maturity about 1 week.

Breaking stems inflicted the greatest injury to the flax plant and the greatest yield reduction. Breakage at stages ranging from 11 inches to maturity produced significant yield reductions when compared to the check plot.

As the degree of stand reduction increased from 0 to 75 percent, weight per seed and oil percent increased in value. There was no significant change in iodine value. The removal of buds had very little effect on oil content and iodine value. Breaking the stems at the green boll and mature stages of growth produced the largest reductions in weight per seed, oil content, and iodine value.

These trials were conducted on nearly weed-free land, but under field conditions competition from weeds could influence the results.

ACKNOWLEDGMENT

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