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Abstract. An epiphytotic of blast occurred in the Iowa oat crop in 1957. The blasting was atypical in that the panicles were stratified with all of the spikelets in a section being blasted. Normally blasting occurs in the spikelets near the base of the panicle and the central axis. The environmental condition which appeared to be the most likely cause of the blasting was a cold, cloudy period between May 10 and 27. This was during early spikelet development and panicle elongation. Severity of atypical blasting was associated with earliness and lateness in the oat varieties. The highest percentage of panicles with atypical blast and the highest percentage of blast on these panicles occurred in varieties which headed on June 13 and 14. Seeds from heads with atypical blast were from 10 to 25 per cent heavier than those from normal heads. The yield losses caused by atypical blast ranged from 7 to 15 per cent depending upon the maturity of the varieties.

Blast is a condition which affects oats to a certain extent every year. Blasting, the failure of oat spikelets to develop fully, is expressed variously from small white appendages hardly recognizable as having been potential spikelets, to large, light green but empty glumes (Figure 1). Blasted spikelets typically occur at the base of the panicle and near the central axis. Spikelets in this region are the last to differentiate (Bonnett, 1937). Sheals (1950) found that 85 per cent of the blasted spikelets occurred in the lower third of the panicle, while only 14 and 1 per cent occurred in the middle and upper thirds, respectively. Oat blast as described above will be referred to in this paper as "normal blast."

Oat blast has been reported caused by any adverse environmental condition which occurred during the critical period of spikelet differentiation and panicle elongation; e.g., reduced water, cold and cloudy weather, leaf injury, insects, or any of several diseases (Derick and Forsyth, 1935; Huskins, 1931; Johnson and Brown, 1940; Rademacher, 1933, 1936; Sheals, 1950). However, blast seldom can be attributed precisely to a given factor.

An epiphytotic of oat blast occurred in central Iowa in 1957. Two distinct types of blast were clearly represented in this epiphytotic—normal blast, as described above, and an atypical type. This atypical blast differed from the normal in that all of the spikelets on the

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Figure 1. "Normal" blast of oats.

panicle, or in a section of the panicle, were blasted. The upper, middle, or lower portions of a given panicle would be blasted while the remainder of the panicle appeared healthy (Figure 2). The oat crop in 1957 apparently sustained an average amount of "normal" blast plus the "atypical" blast. The condition was striking in fields of lodged grain because the culms bearing atypically blasted panicles stood erect.

This paper reports the yield losses from the atypical blasting and suggests a cause for the phenomenon.

Etiology

Long term average daily maximum and minimum temperatures for Ames, Iowa, and daily maximum and minimum temperature readings for May, 1957, are presented in Figure 3 and Table 1.

Holt (1955) has shown that in spring oats grown at Ames the period of spikelet differentiation is about 30-40 days after planting,

Figure 2. "Atypical" blast of oats.

or about 30-40 days before heading. The oat yield nurseries were planted on April 10, 1957, and varieties with the greatest atypical blast headed on June 14 (Table 2.). Judging from the stage of spikelet development when growth was arrested and these two dates, the factor causing the blasting probably occurred approximately between May 10 and 25. This period was characterized by abnormally cold temperatures and generally cloudy weather. For instance on May 16, 36 days after planting, the maximum temperature did not reach the normal minimum, and minimum readings were below normal for the next several days. Furthermore, the minimum temperature May 27 was 42° F. with clear skies which would have allowed considerable radiation to occur. The temperature of the oat plants could well have been as low as 35° F. under such conditions. These observations suggest that low temperature may have caused the atypical oat blast which occurred in 1957.

Rademacher (1933) and Derick and Forsyth (1935) have shown cool, cloudy weather to be a cause of blast. Cloudiness may also

have contributed to the atypical oat blast in 1957. Mean insolation for the 5-day period beginning May 16 was only 293 gram calories per square centimeter per day (Table 1) whereas the 27th, a clear day, had a reading of 951.

Oat blast has been shown to be associated with water supply by several investigators (Derick and Forsyth, 1935; Elliott, 1922; Johnson and Brown, 1940; Rademacher, 1936). Derick and Forsyth (1935) and Johnson and Brown (1940) increased blast by withholding water during critical periods. However, moisture was

Table 1

Weather Data[1] for Ames, Iowa, May, 1957

Date May	Air Temperature[2] °F. Max.	Min.	Wind direction and cloud cover[2]	Wind movement, miles/day[2]	Insolation gm. cal./cm²/ day	Evaporation, inches[2]
1	80	49	SE Clear	31	631	.24
2	75	55	E P. C.[3]	72	494	.27
3	67	46	NE P. C.	126	685	.34
4	61	32	NE C	77	767	.25
5	68	37	NW C	31	—	.19
6	75	38	SW C	45	—	.28
7	79	46	SW P. C.	170	690	.43
8	52	57	SW P. C.	235	679	.45
9	75	56	NE P. C.	92	380	.22
10	56	46	NE C	129	86	.10
11	59	45	SE C	49	245	.04
12	65	51	SE C	64	228	.04
13	63	55	NE C	84	73	.04
14	67	54	SW P. C.	140	393	.14
15	63	47	NE C	66	166	.08
16	48	41	SE C	126	155	.04
17	66	47	W P. C.	112	499	.08
18	57	45	NW P. C.	33	299	.07
19	56	46	NE P. C.	65	284	.05
20	57	46	SE C	117	228	.13
21	76	52	SW P. C.	194	853	.37
22	69	48	NW P. C.	81	888	.23
23	68	44	NW P. C.	31	850	.19
24	75	45	SE P. C.	88	895	.34
25	74	60	SW P. C.	140	396	.12
26	63	53	NW P. C.	99	392	.14
27	70	42	NW Clear	48	952	.17
28	78	46	SE P. C.	83	813	.27
29	82	55	SW P. C.	81	666	.22
30	76	61	SE P. C.	55	515	.25
31	78	57	NW P. C.	20	620	.10

[1]Kindly furnished by Dr. Robert Shaw, Professor of Agricultural Climatology, Iowa State University.
[2]For 24-hour period ending at 7 p.m.
[3]P. C.=partly cloudy; C=cloudy.

not limiting for oats at Ames in 1957. On May 2 there were 5 inches of available moisture in the top 5 feet of soil, and on May 31 this had been increased to 8 inches, indicating a more than adequate moisture supply. The May rainfall data are given in Table 1. Drought certainly did not contribute to the atypical blast that occurred in the oat crop in central Iowa in 1957. Of the components of the environment considered, low temperature and cloudiness seem most likely to have been the factors responsible.

Yield Losses From Atypical Blast

Data on losses were obtained from two replications of each of three oat yield nurseries (Uniform Red Oat test, Uniform North Central Oat test, and Iowa Elite Oat test) which included a total of 114 entries. A random sample of 50 panicles in the west row of each plot was classed as having either normal or atypical blast. Five panicles with normal blast were removed and the number of healthy and

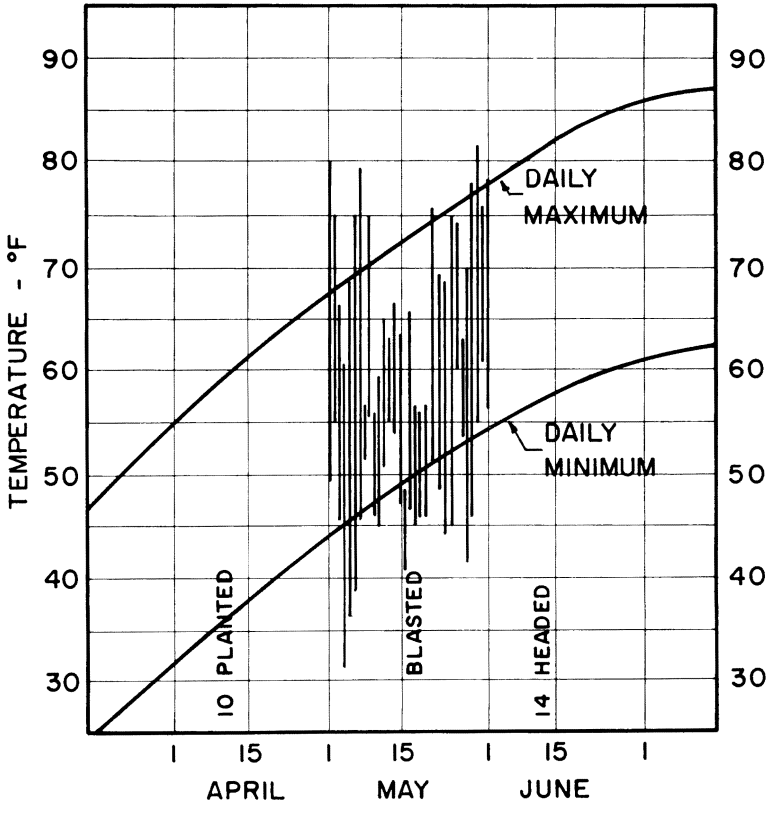

Figure 3. Daily maximum and minimum temperatures for long term periods (diagonal lines) and for May, 1957 (vertical lines), for Ames, Iowa.

blasted spikelets were counted on each. The same was done for 5 panicles with atypical blast. Next, 5 each of normally and atypically blasted panicles were tagged to be harvested when mature. From these the weight per 100 seeds was determined. The data were used to calculate (a) the percentage blasted panicles per variety; (b) the percentage blast on panicles with normal and atypical amounts of blast; (c) the compensatory effect on the weight of seed from panicles with atypical blast; and (d) the effect of the atypical blast on yield.

Table 2

Percentages of Blasted Panicles and Spikelets and Yield Loss Due to Atypical Blasting in Oat Varieties Grown at Ames, Iowa in 1957

Date of heading*	No. of varieties	Percentage of panicles with atypical blast	Percentage blasted spikelets per panicle		Ratio of seed weights (A/N)	Percentage yield loss
			Normal	Atypical		
8-9	2	0	–	–	–	–
10-11	21	14	10	62	1.17	7.2
12	20	17	12	63	1.20	9.3
13	21	22	12	68	1.25	11.5
14	22	24	16	72	1.16	14.6
15-16	20	19	15	69	1.18	11.2
17-21	8	19	18	62	1.09	8.7

*Date in June when 50 per cent of heads were completely emerged.

The yield losses from atypical blasting in oats and other supplementary data according to heading dates are given in Table 2. The groupings of heading dates were selected to give approximately 20 varieties per group. This number was obtained except in the earliest and latest groups. The average percentage of panicles with atypical blast was zero for the earliest group. It increased steadily from 14 per cent for varieties heading on June 10 and 11 up to 24 per cent for those heading on June 14. The percentage dropped to 19 for varieties heading on June 15 and later.

The mean percentage blasted spikelets on the normal panicles increased from 10 per cent for the varieties heading on June 10 and 11 to 18 percent for the latest group, whereas on panicles with atypical blast the percentage of blasted spikelets was highest for varieties heading on June 14.

To determine whether the atypical blasting was associated with panicle size, correlation coefficients between percentage blast and number of spikelets per panicle were calculated (Table 3). All but one were negative, but none was significant. Derick and Forsyth (1935) found no correlation between percentage blast and total spikelet number, but Derick and Hamilton (1939) reported a significant negative correlation between the number of spikelets and percentage blast in the variety, Eagle.

Table 3

Correlation Coefficients Between Percentage of Blasting and Number of Spikelets Per Panicle

Date of heading	No spikelets per panicle	Correlation coefficient
10-11	23	0.11
12	24	–0.27
13	27	–0.36
14	31	–0.29
15-16	31	–0.13

The ratio of weights of 100 seeds from atypically blasted panicles over the weight of 100 seeds from normal panicles ranged from 1.09 to 1.25 (Table 2), indicating that where fewer seeds were produced they were heavier. This is in contrast to the results of Derick and Hamilton (1939), who found no increase in the weight of seeds on blasted heads. They concluded that whatever caused blast also adversely affected the remaining, fertile spikelets.

The following formula was used to calculate the percentage of yield loss from atypical blasting of oats in 1957:

$$\text{Percentage yield loss} = \text{percentage of heads with atypical blast} - \left\{\left[\left(\frac{100}{100 \text{ percentage blast per normal head}}\right)\left(\text{percentage normal spikelets on heads with abnormal blast}\right)\left(\text{Ratio of seed weights A/N}\right)\right]\left(\text{percentage of head with atypical blast}\right)\right\}$$

The first two terms inside the brackets supply the correction factor for the normal amount of blasting on the panicles with atypical blast, and the ratio of seed weights corrects for the larger seed size on atypically blasted panicles. The calculated yield losses ranged from 7.2 per cent for varieties heading on June 10 and 11 to 14.6 per cent for those heading on June 14.

Most of the Iowa oat acreage in 1957 was planted to varieties that headed between June 10 and 14. The mean percentage loss in yield from atypical blast for these dates was approximately 10 per cent. Since atypical blast occurred in only about one-third of the state, the loss in oat production for Iowa from this cause was estimated at 3.0 to 3.5 per cent.

Literature Cited

Bonnett, O. T. 1937. The development of the oat panicle. Jour. Agr. Res. 54: 927-931.

Derick, R. A. and J. L. Forsyth. 1935. A study of the causes of blast in oats. Sci. Agr. 15: 814-824.

Derick, R. A. and D. G. Hamilton. 1939. Further studies on oat blast. Sci. Agr. 20: 157-165.

Elliott, Charlotte. 1922. Sterility of oats. U.S.D.A. Tech. Paper, Bul. 1058: 1-8.

Holt, I. V. 1955. Cytohistological responses of varieties of Avena to 2,4-D. Iowa State Col. Jour. Sci. 29: 581-629.

Huskins, C. L. 1931. Blindness or blast of oats. Sci. Agr. 12: 191-199.

Johnson, T. and A. M. Brown. 1940. Studies on oat blast. Sci. Agr. 20: 532-550.

Rademacher, B. 1933. Weitere Untersuchungen uber die Ursachen der Flissigkeit beim Hafer und deren Abhangigkeit von der Herkunft des Saatgutes. Arb. a-d Biol. Reichsanstalt Fur Land—und Forstwirtschaft 20: 587-602.

Rademacher, B. 1936. Flissigkeit, Blassenfuss Schoden and Fritfliegenbefall an Hafarispen. Franke Pfanze 13: 129.

Sheals, J. G. 1950. Observations on blindness in oats. Ann. Appl. Biol. 37: 397-406.

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