A RAPID METHOD OF BRUISE ANALYSIS AND ITS USEFULNESS *

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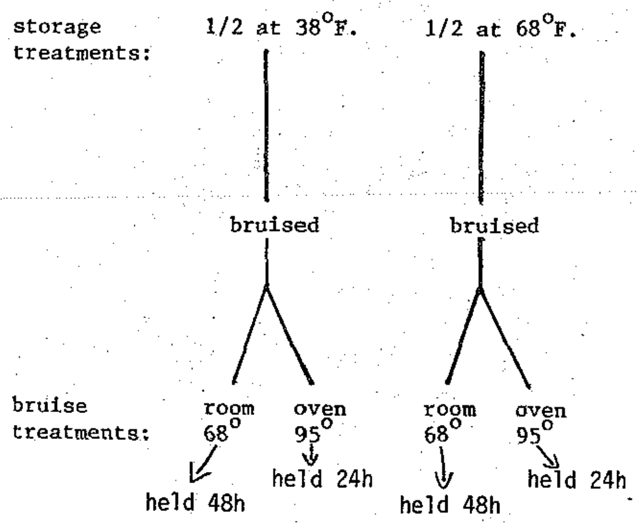
For as long as potatoes have been grown the formation of blackspot after tuber damage has not been prevented. This enzyme mediated reaction is still the cause for headaches to both growers and processors alike. Since we can't stop this reaction let's use what we know about blackspot to help improve harvest and therefore obtain a better final product. Because bruise formation requires enzymes the reaction can be sped up by increased temperature, however, too high a temperature will result in death of the tissue. The optimum temperature for blackspot formation is reported by Dwelle and Stallknecht, (1**), to be between 90 - 100°F. These same researchers estimated that the development of blackspot could be maximized in just 6 hours. Many people, however, are skeptical as to the validity of using this "rapid discoloration" method of analysis. This report presents three experiments that show a comparison of the rapid vs traditional (48-hour) bruise analysis method. The value of a more rapid analysis in bruise sampling is also discussed.

The procedure used on experiments to evaluate the influence of storage temperature on bruise susceptibility is shown in Figure 1.

Figure 1. Outline of treatments for study of traditional (48 hrs at room temperature (68°F)) vs rapid (24 hrs at 95°F) bruise detection method.



*Paper presented at the Annual Washington Potato Conference, Moses Lake, Wa., February 2-4, 1982.
** Number in parenthesis refers to literature cited listed on last page of this article.

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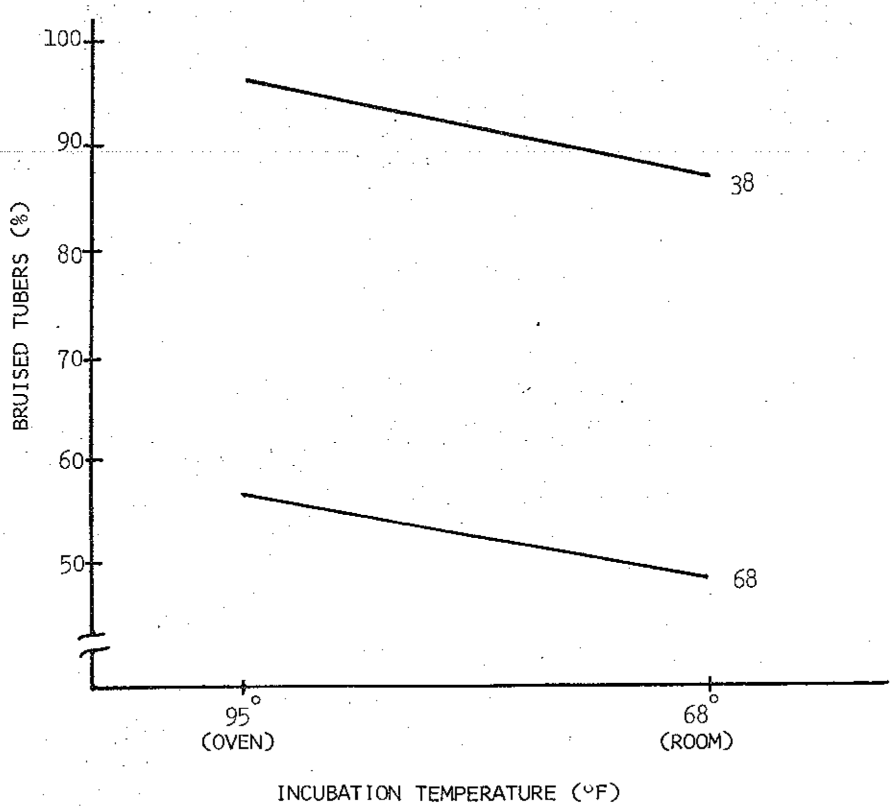
In addition the accuracy of bruise detected in samples held 48 hours at 68°F vs 24 hours at 95°F was determined. Tuber samples were divided and stored at either 38 or 68°F. All tubers were then subjected to an equal impact using a "bruise" machine similar to that of Kunkel and Gardner (2). After "bruising" the samples were then further separated as follows: Half of the tubers stored at 38° and 68° for 48 hours. The other half were held at 95°F for 24 hours. Following the holding period the tuber samples were evaluated for bruise. The results of this comparison can be seen in Figures 2 and 3.

Figure 2. Effect and temperature on bruise level and detecting of bruise of Russet Burbank potato tubers.

STORAGE TEMPERATURE	INCUBATION TEMPERATURE 68°F	INCUBATION TEMPERATURE 95°F
38°F	85.9% ± 1.8	96.7% ± 1.0
68°F	50.0% ± 1.6	55.9% ± 3.2

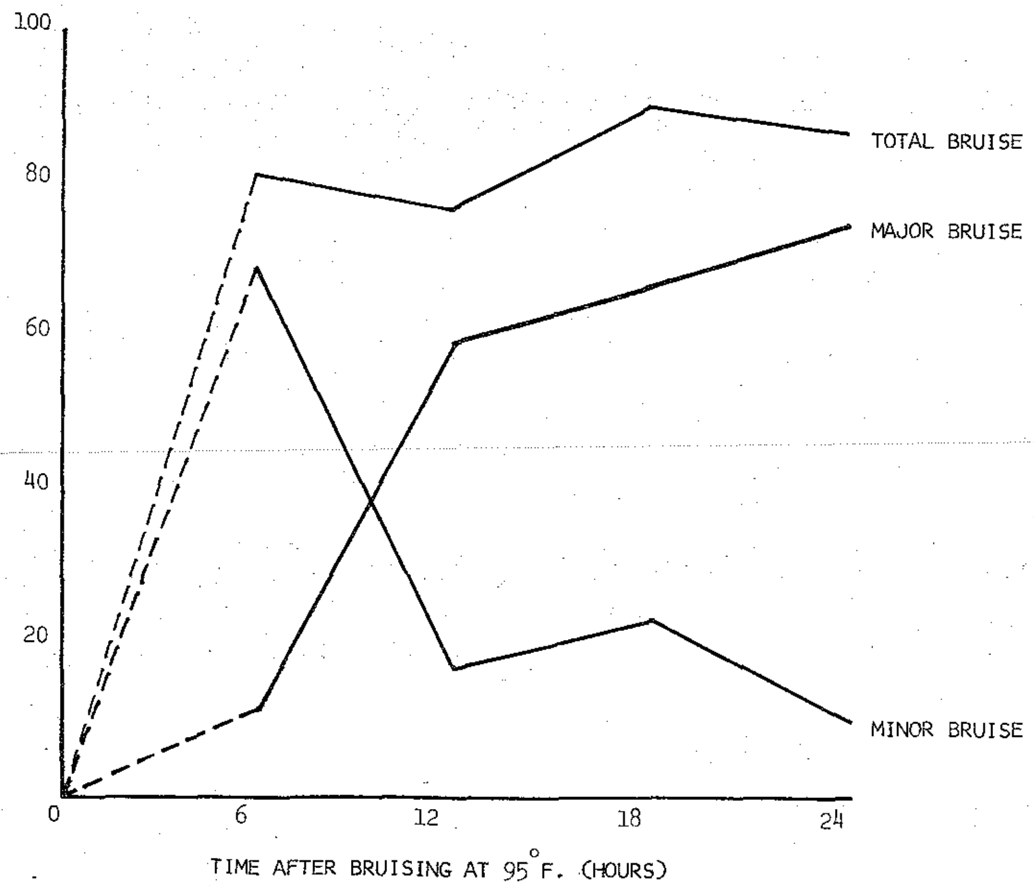
Figure 3. Influence of storage (38° and 68°) and incubation (68° and 95°) temperatures on Russet Burbank tuber damage.



As expected tubers bruised at 38° had a higher (35-40%) incidence of bruise thus were more susceptible to bruise than those bruised at 68°F. This demonstrates the value of higher tuber temperature when handling potatoes both in the field and out of storage. By increasing the storage temperature for a short period prior to removal potatoes can be conditioned and thus bruising between storage and processing can be avoided. These results also indicate that the rapid method of bruise analysis (holding tubers at 95°F) detected more bruise than the traditional method. This was accomplished with half the sample turn around time. Further, this experiment also demonstrates that rapid bruise analysis accuracy is not affected by tuber temperature prior to bruising. This is an important consideration since we now know that tubers harvested at a variety of field-temperatures can be evaluated by rapid bruise analysis with the same accuracy throughout the harvest period.

Having demonstrated that a 24-hour holding time at 95°F was as accurate as the traditional 48-hour holding time at 68°F, an important question arose. How short of a holding period at 95°F can be used and still retain accuracy and reliability? An experiment was set up to answer this question. Figure 4 shows a comparison of tuber damage after holding times of from 0 to 24 hours after bruise occurs.

Figure 4. Effect of different holding time on detection of tuber damage.



All sample tubers were dug by hand and were assumed to be bruise free. For this reason the dotted line in figure 4 from 0 to 6 hours represents an extrapolation from the assumed 100% bruise free (zero bruise) to the value determined after the 6-hour holding period. The total bruise line in figure 4 indicates that after just 6 hours holding time 80% of the tubers already exhibit signs of bruise. Over the next 18 hours total bruise increased only slightly. However, it is important to look at two distinct components of bruise in this study, termed major and minor bruise. These two bruise types are distinguished by intensity of discoloration and size of the bruised area. The bruise detected after a 6-hour holding period is largely, (approaching 70%) minor bruise with a small proportion (approximately 10%) major bruise. When tubers are held an additional 6 hours for a total of 12, the proportion of major bruise is greatly increased with a corresponding reduction in minor bruise with total bruise remaining relatively the same. A further increase in holding period results in only a slight increase in major bruise level and no increase in total bruise. These results indicate the reliability of a rapid bruise analysis method in determining bruise severity using a 12-hour or longer holding time at 90-100°F. However, if a rough estimate of total bruise is required or desired a 6-hour holding period is sufficient.

These two experiments were small and carefully controlled. The last experiment, involved commercially machine harvested potatoes. Samples were taken from ten-wheel trucks after being field loaded. Six replications were run and the variability between bruise analysis methods was substantial between paired samples. However, the sample means are similar indicating statistically that the two methods of analysis obtained the same results (Table 1).

Table 1. Effect of Holding.

FIELD BRUISED SAMPLES AT 90°-95°F FOR 12 HOURS - VS - HOLDING 48 HOURS, AT TEMPERATURE.

REPS	(48 HRS) TREATMENTS	(12 HRS)
1	77	80
2	67	67
3	87	67
4	80	70
5	77	80
6	70	77
$\bar{x}$ mean	76.3	73.5

Thus far it has been shown that analyzing bruise using a rapid method is as reliable as the traditional method. However, in commercial harvesting there is substantial time between taking samples and obtaining the results. The time saved depends on the length of holding time chosen. With examples the value of this rapid turn around time can be demonstrated. In these samples the actual values are not important but the tremendous difference in dollars returned to the producer that a simple change in method of analysis can make is what is important.

First look at the value of harvesting bruise free potatoes with a standard bruise incentive contract in addition to the basic contract.

Table 2. Assumed Contract Incentives for Russet Potatoes (3) *

OUT-OF-FIELD CONTRACT INCENTIVE: $.50/T GAIN OR LOSS FOR EACH 1% ABOVE OR BELOW 50% BRUISE FREE BASE TO UPPER AND LOWER LIMITS OF 75% AND 27% BRUISE FREE.

*See reference 3 for additional discussion on the influence of bruise incentive on crop value and a detailed description of a method of bruise evaluation.

Table 3. Effect of Bruise Free Incentive on Cash Return of a 25 T/Acre Potato Crop (3) *

OUT-OF-FIELD CONTRACT PRICE: $54.00/T

50% BRUISE FREE: 25T/ACRE X $54./T = $1350 /ACRE

27% BRUISE FREE: 25T/ACRE X $54./T - (50-27) x
$.50/T 25T/ACRE = $1350./ACRE - $287.50/ACRE
= $1106.50/ACRE

75% BRUISE FREE 25T/ACRE X $54./T + (75-50) x
$.50/T 25T/ACRE = $1350./ACRE + $312.50/ACRE
= $1662.50/ACRE

As you can see the potential for making a profit or taking a loss may hinge on harvester performance. The difference in value between harvesting 27% or 75% bruise free potatoes is $556/A ($1106/A vs 1662/A). The importance of implementing a rapid bruise analysis can now be demonstrated. Given the above information let us assume that the percent bruise free can be increased from some base level, say 50%, to 70% bruise free with changes in harvester chain speeds, tractor gears, truck belt speeds, and piler adjustments. Also assume that the changes in equipment needed to bring about a higher percent bruise free are done following careful bruise analysis by either the traditional 48-hour method or a rapid method, using 24 hours in this example. If to increase the bruise free 20%, from 50 to 70%, we make five sets of equipment changes, using the traditional method we could expect to take about two weeks. Using the 24-hour rapid method of analysis we could reach this same bruise free level in one week. What does this mean in return to the grower? If a harvester harvests 90A/week, going from 50-70% bruise free will net $250/A or $22,500 per digger of additional capital. A substantial gain in crop value for a minimal amount of expense. Consider also that holding time could be reduced further, increasing profits even more, simply by reaching the higher bruise free levels sooner.

Table 4. Return Due to Rapid Bruise Detection From a Given Harvester at 25T/Acre

GIVEN INFORMATION

BASE PRICE: $54./TON AT 50% BRUISE FREE
TOTAL RETURN/ACRE AT 50% BRUISE FREE: $1350.00
TOTAL RETURN/ACRE AT 70% BRUISE FREE: $1600./ACRE
GAIN DUE TO BRUISE INCENTIVE: $250./ACRE

TOTAL GAIN DUE TO RAPID BRUISE DETECTION:

90 A/WEEK X 1 DIGGER X $250. A = $22,500.00

In summary, using the knowledge we have about how blackspot occurs we can utilize a rapid bruise analysis method. This method has been proven to be reliable in both laboratory and field run experiments. Further, initial tuber temperature has no influence on the analysis accuracy. Finally, a rapid method of analysis can influence the value of a potato crop with a minimal amount of additional effort or expense. This method can help the Washington potato industry produce a higher quality product.

*See reference 3 for additional discussion on the influence of bruise incentive on crop value and a detailed description of a method of bruise evaluation.

Literature Cited

1. Dwell, R. B. and G. F. Stallknecht, 1976. Rates of internal blackspot bruise development in potato tubers under conditions of elevated temperatures and gas pressures. Am. Pot. J. 53:235-245.

2. Kunkel, R. and W. H. Gardner, 1959. Blackspot of Russet Burbank potatoes. Proc. Am. Soc. Hort. Sci. 73:436-444.

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