SOME EFFECTS OF STRAW MULCH ON YIELD OF
POTATOES

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INTRODUCTION

It is well known that the potato \((Solanum tuberosum)\) is a cool-
climate crop. From a survey of the literature Bushnell (3) concluded
that the optimum temperature for the growth of the potato
is near 64° F. In Ohio, mean July temperatures are much too high
for its best development, ranging from 71° to 76° F. Any cultural
practice which would keep the soil cool during midsummer would
therefore be expected to result in increased yields. Light-colored
straw as mulch has occasionally been tried by potato growers, but it
has not consistently given the anticipated benefits. Consequently
mulching is not a widespread practice.

LITERATURE REVIEW

Brief reports from experiment stations indicate that straw mulch
is more likely to produce increased yields of potatoes in the Central
and Southern States than in the Northern. In Oklahoma, Waugh (12)
and later Morris (9), reported increased yields from the use of straw
mulch. In Ohio, Lazenby (7, 8) and Alwood (2) obtained beneficial
results with later varieties in one year out of three. In Illinois, Pieper,
Burlison, and Flint (10) recently reported an average increase of 41.6
bushels per acre from an experiment extending through four seasons.
They stated that straw is used to some extent in Illinois in small-
scale potato production, and that it is especially beneficial in years of
deficient moisture. In Nebraska, Emerson (5) obtained small in-
creases with an early variety in two seasons and a decrease the
third season. Recently, Werner (14), repeating the work in Ne-
braska, obtained increased yields in four seasons out of five. Farther
north, Harwood (6) at Michigan and Whipple (15) at Montana found
that straw mulch was detrimental, retarding growth and reducing
yields.

Pieper, Burlison, and Flint (10) state that the culinary quality of
the crop is much improved by mulching. Werner (14) found from a
chemical analysis of the tubers of one crop that the starch content
was considerably increased by the use of a straw mulch.

EXPERIMENTS AT WOOSTER

The possibility that straw mulch might prove a practical cultural
practice in Ohio was brought to the attention of the writers in the
course of a study primarily concerned with the lodging of wheat
when sown after potatoes. In cultivated potato plots an excessive
nitrate content developed which was deemed the cause of the frequent

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1 Received for publication Apr. 30, 1931; issued November, 1931.
2 Reference is made by number (italic) to Literature Cited, p. 845.
lodging of the following crop of small grain (13). Straw was therefore applied as a mulch to some plots as a means of reducing the nitrate content.

On all plots, cut seed was planted with a machine planter to a depth of 2 to 3 inches; straw was applied immediately after planting, except where otherwise noted. Cultivated plots or those on which the application of straw was delayed were subjected to current farm practices with the aim of controlling weeds with minimum injury to the potatoes. Usually the plots were harrowed twice before the plants emerged; then a weeder of the Hallock type was used at intervals of a week or more until the plants branched. After a hard rain the weeder was ineffective, and a shallow cultivation was required to loosen the surface soil. After the plants branched, two or three shallow cultivations sufficed. The rows were not ridged or hilled, as level cultivation is the accepted practice in Ohio.

**YIELD**

On May 19, 1925, four plots, each one-fortieth acre, were planted to Russet Rural. Two of the plots were mulched immediately after planting at the rate of 10 tons of straw per acre. The layer was 8 to 10 inches deep when applied, and about 4 inches deep after settling. As shown in Table 1, the yields were approximately doubled by the mulch. The season, however, was peculiarly favorable for obtaining benefits from mulch. The mean temperatures for June and September, 1925, were far above normal, while the rainfall for the season was deficient, as shown in Table 2. Smith (11) has pointed out from correlations of weather and potato yields that when temperatures are above normal and rainfall is below normal there tends to be a reduction in the yield of potatoes in Ohio. Consequently, it might be anticipated that a straw mulch by correcting to some degree the unfavorable conditions would be particularly beneficial in such a season. The results were so striking as to suggest that the use of straw as a mulch might prove to be a practical procedure.

**Table 1.—Effect of using straw mulch on the yield of Russet Rural potato at Wooster, Ohio, 1925**

<table>
<thead>
<tr>
<th>Plot No.</th>
<th>Treatment</th>
<th>Yield per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Straw mulch</td>
<td>277 Bushels</td>
</tr>
<tr>
<td>1</td>
<td>Straw mulch</td>
<td>274</td>
</tr>
<tr>
<td>2</td>
<td>Cultivated</td>
<td>131</td>
</tr>
<tr>
<td>3</td>
<td>Straw mulch</td>
<td>141</td>
</tr>
<tr>
<td>4</td>
<td>Cultivated</td>
<td>151</td>
</tr>
</tbody>
</table>

The experiment was repeated the two following seasons, with a modification to include a test of various quantities of straw.
Effects of Straw Mulch on Yield of Potatoes

Table 2.—Mean temperature and rainfall and departures from normal for the summer months at Wooster, Ohio, 1925–1927

[From records of C. A. Patton, Ohio Experiment Station]

<table>
<thead>
<tr>
<th>Month</th>
<th>1925</th>
<th>1926</th>
<th>1927</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Departure</td>
<td>Mean</td>
</tr>
<tr>
<td>June</td>
<td>72.0</td>
<td>+4.3</td>
<td>64.4</td>
</tr>
<tr>
<td>July</td>
<td>70.4</td>
<td>−1.0</td>
<td>71.4</td>
</tr>
<tr>
<td>August</td>
<td>70.4</td>
<td>+7.0</td>
<td>73.1</td>
</tr>
<tr>
<td>September</td>
<td>67.8</td>
<td>+3.9</td>
<td>65.2</td>
</tr>
</tbody>
</table>

RAINFALL, INCHES

<table>
<thead>
<tr>
<th>Month</th>
<th>1925</th>
<th>Departure</th>
<th>1926</th>
<th>Departure</th>
<th>1927</th>
<th>Departure</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>2.24</td>
<td>−1.76</td>
<td>3.58</td>
<td>−0.41</td>
<td>3.36</td>
<td>−0.62</td>
</tr>
<tr>
<td>July</td>
<td>4.09</td>
<td>−0.01</td>
<td>2.49</td>
<td>−1.57</td>
<td>4.28</td>
<td>+2.22</td>
</tr>
<tr>
<td>August</td>
<td>1.88</td>
<td>−1.67</td>
<td>2.75</td>
<td>−0.80</td>
<td>2.88</td>
<td>−0.62</td>
</tr>
<tr>
<td>September</td>
<td>4.98</td>
<td>+5.81</td>
<td>8.51</td>
<td>+5.11</td>
<td>2.89</td>
<td>−0.69</td>
</tr>
</tbody>
</table>

In 1926, Russet Rurals were planted May 19, and the straw applied June 1. The yields, as shown in Table 3, were not as large from the mulched as from the cultivated plots. The detrimental effects of the mulch may have been due to abnormally heavy rainfall in September and October, which was injurious to potatoes on soils of the type used in the experiment (Wooster silt loam) and was probably more injurious under the straw where evaporation and run-off were impeded.

Table 3.—Effect of using straw mulch on the yield of Russet Rural potato at Wooster, Ohio, 1926

<table>
<thead>
<tr>
<th>Plot No.</th>
<th>Treatment</th>
<th>Straw used per acre</th>
<th>Yield per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Straw mulch</td>
<td>4 Tons, 163 Bushels</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Cultivated</td>
<td>6 Tons, 200 Bushels</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Straw mulch</td>
<td>8 Tons, 201 Bushels</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Cultivated</td>
<td>10 Tons, 221 Bushels</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Straw mulch</td>
<td>12 Tons, 208 Bushels</td>
<td></td>
</tr>
</tbody>
</table>

In 1927, plots were planted on June 6 and mulched on June 14. The results, as reported in Table 4, were less consistent than were those of the preceding seasons, due largely to soil variation, but the highest yield was from the plot with the heaviest straw mulch. It was noted in both seasons that annual weeds readily penetrated the straw when less than 8 tons per acre were used.

Table 4.—Effect of using straw mulch on the yield of Russet Rural potato at Wooster, Ohio, 1927

<table>
<thead>
<tr>
<th>Plot No.</th>
<th>Treatment</th>
<th>Straw used per acre</th>
<th>Yield per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cultivated</td>
<td>4 Tons, 132 Bushels</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Straw mulch</td>
<td>6 Tons, 164 Bushels</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Cultivated</td>
<td>8 Tons, 181 Bushels</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Straw mulch</td>
<td>10 Tons, 209 Bushels</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Cultivated</td>
<td>12 Tons, 153 Bushels</td>
<td></td>
</tr>
</tbody>
</table>

Average increases in yield for the three seasons due to the application of 8 or 10 tons of straw per acre were calculated by comparing the yield of individual plots with that of adjacent cultivated plots.
The average increase of 50 bushels per acre, as shown in Table 5, might by itself be a basis for recommending the use of straw mulch as a farm practice, but the variation from season to season was too great to permit predictions as to the probable value of the practice over a longer period.

### Table 5.—Average increase or decrease in yield of Russet Rural potato when straw mulch was applied at the rate of 8 and 10 tons per acre, Wooster, Ohio

[Data summarized from preceding tables]

<table>
<thead>
<tr>
<th>Season</th>
<th>Average yield of cultivated (unmulched) plots</th>
<th>Average yield of mulched plots</th>
<th>Increase or decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>1925</td>
<td>136 Bushels</td>
<td>221 Bushels</td>
<td>85.5 Bushels</td>
</tr>
<tr>
<td>1926</td>
<td>221 Bushels</td>
<td>273.5 Bushels</td>
<td>52.5 Bushels</td>
</tr>
<tr>
<td>1927</td>
<td>167 Bushels</td>
<td>193 Bushels</td>
<td>-74 Bushels</td>
</tr>
<tr>
<td>Average</td>
<td>174.66 Bushels</td>
<td>224.33 Bushels</td>
<td>49.7 Bushels</td>
</tr>
</tbody>
</table>

**QUALITY**

In occasional seasons the weather is so unfavorable in midsummer at Wooster that growth of tubers nearly ceases, they lose their capac-

![Figure 1](image-url)

**Figure 1.**—A, Tubers with secondary apical knobs, from cultivated plot, 1926; B, normal tubers from mulched plot. Photographed in March, at which time the "dumb-bell" tubers were noticeably wilted at the stem end.
inappropriately called "dumb-bells." The effectiveness of straw mulch in preventing this abnormality was conspicuous in 1926. Typical tubers from the unmulched and mulched plots are shown in Figure 1. The photograph was taken in March, 1927, at which time the stem end of the dumb-bells was shriveling, while the tubers from the strawed plot remained firm.

The following season no abnormal shapes appeared, but the potatoes from the cultivated plots wilted and sprouted earlier in storage.

**SOIL TEMPERATURES**

The temperature of the unmulched and mulched plots was determined in 1925 by a Friez double soil thermograph, the bulbs of which were buried in the soil to a depth of 1 inch. The thermograph was placed in position June 22 and continuous records were obtained until harvest, September 29. The average mean temperature for the whole period was 68.8° F. for the cultivated and 63.3° F. for the mulched plots. The difference during the heat of the day was much more marked, as shown in typical record sheets, Figure 2. The extreme difference in soil temperature occurred in August, when it amounted to 29 degrees. Differences of 25 degrees in the middle of the day were quite common.
Moisture determinations were made on composite soil samples at intervals of about 10 days during 1925. As shown in Figure 3, the straw mulch was effective in maintaining a higher water content in the soil.

Nitrate determinations, made at the same time as the moisture determinations, disclosed a somewhat reduced nitrate content of the soil under the straw. (Fig. 4.)

EXPERIMENTS WITH EARLY POTATOES IN SOUTHERN OHIO

From the results obtained at Wooster it appeared that the use of straw mulch might be more consistently beneficial on soils which drained more rapidly and which were farther south where summer temperatures are higher. Experiments were therefore started at the Hamilton County experiment farm, near Cincinnati. In this district the mean summer temperature is more than 5 degrees higher than at Wooster, ordinarily precluding successful production of late varieties of potatoes. Early maturing varieties are therefore grown. But even when these are planted as early as possible they encounter the hot weather of July before maturity. That the potato is particularly sensitive to high temperature during the period of tuber growth has been emphasized by Bushnell (4). It therefore seemed reasonable to expect that a straw mulch would prove beneficial to the early crop in southern Ohio.

In actual farm experience, however, the expected benefits have not always been obtained. An explanation of this may be found in Emerson's (5) work at Nebraska. Emerson concluded from one season's data that it was advisable to delay application of the straw until the soil was warm because a mulch applied at the time of planting retarded early growth.

To obtain further information on this point, the straw mulch was applied in the Hamilton County experiments on three different dates: (1) Immediately after planting in late March; (2) when the plants were up in late April; and (3) after the soil had reached a temperature of about 65° F. in late May or early June.

*Soil moisture and nitrates were determined by V. H. Morris.
The applications were made in triplicate, the plots being 0.027 acre each. A 4–10–6 fertilizer at the rate of 1,000 pounds per acre was used throughout. The straw was applied at the rate of 10 tons per acre. In 1928, the Early Ohio variety was used; in 1929, the Irish Cobbler. To facilitate digging it was found advisable to remove most of the straw before harvesting. Any detrimental effects which might have ensued from plowing under large amounts of straw were thus avoided.

The yields for both seasons are summarized in Table 6. The odds of significance for the increases over cultivated plots were calculated from unpublished tables of M. T. Myers derived from those of Student (1).

**Table 6.—Effect of using straw mulch applied at three different dates, on the yield of early potatoes, Hamilton County, Ohio, 1928 and 1929**

<table>
<thead>
<tr>
<th>Variety, date planted, yield, and increase or decrease compared with yields from unmulched plots</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Early Ohio, Mar. 28, 1928</strong></td>
</tr>
<tr>
<td>Yield</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Mulched when planted, about Apr. 1</td>
</tr>
<tr>
<td>Mulched early in May</td>
</tr>
<tr>
<td>Mulched early in June</td>
</tr>
</tbody>
</table>

* Average yield of three cultivated, unmulched plots, 135 bushels per acre.

* Average yield of three cultivated, unmulched plots, 275 bushels per acre.

The first mulch, applied immediately after planting, retarded early growth in both seasons and the plants showed typical symptoms of nitrogen deficiency. In 1928 this early mulch reduced the yield below that of the cultivated plots.

The second mulch, applied after the plants were up, gave the highest yields in both seasons. In appearance the plants on these plots were the best, and they remained green for more than a week after the cultivated plants had died prematurely from midsummer heat.
When the last mulch was applied some of the leaves were covered and some were unavoidably broken, which may in part account for the fact that the yield from this mulch was lower than from the preceding one. But it is also probable that the earlier application was beneficial during the period in May when the late-mulched plots were still being cultivated.

The mulches were conspicuously beneficial in 1929 when the weather was peculiarly favorable for potatoes. Even though the mean temperature was below normal and the rainfall was abundant, resulting in high yields on cultivated plots, the mulch increased yields, a result quite different from that obtained at Wooster in a comparable season.

**DISCUSSION**

Although the value of straw mulch as a means of reducing temperature has been the primary consideration in this work, no direct evidence has been secured to show that the reduction in temperature was more important than the conservation of soil moisture. The suggestion that temperature is the more important factor in Ohio is based upon the correlations of weather and potato yields compiled by Smith (11) and the observations enumerated by Bushnell (4). In a 3-year series of tests conducted by Werner at Lincoln, Nebr. (14), in which he made a comparative study of the effect of irrigation and straw mulch on yield of potatoes, he found that under the conditions of his experiments benefits were due both to conservation of moisture and to reduction of temperature. Irrigation increased the yields of potatoes for three successive seasons, and so also did straw mulch. With both irrigation and straw mulch, however, the yields were further increased. Presumably Werner added an abundance of water to the cultivated plots, so that the additional increase from the straw may be attributed to its effect on the temperature.

Practical benefits from straw mulch then would be expected in regions where the temperature is above the optimum for the growth of the potato and when moisture is deficient. An important practical conclusion from the experiments in southern Ohio is that detrimental effects may accrue if the mulch is applied too early, and that to obtain the best results with early varieties the application should be delayed until after the plants are up.

**SUMMARY**

When straw mulch was applied to the Russet Rural potato, a main crop variety, at Wooster, Ohio, the yield was twice as great as that from cultivated plots in one season, but there was no marked effect on yield in the two following seasons.

In southwestern Ohio, straw mulch applied to early potatoes after the plants were up increased the yield 31 and 91 bushels per acre, respectively, in two seasons. A similar mulch applied at the time of planting retarded early growth and hence was not so beneficial.

When the straw was applied at the rate of less than 8 tons per acre, annual weeds readily penetrated it.

The straw mulch reduced the soil temperature below that of cultivated plots, conserved the moisture content, and depressed the nitrates.
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