# SOME EFFECTS OF PLANTING DEPTH AND TIME AND HEIGHT OF HILLING ON KENNEBEC AND SEBAGO POTATOES[1]

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## ABSTRACT

Kennebec and Sebago potatoes were grown under level culture and various hilling treatments at two planting depths. These treatments were applied at planting time or after tuber-set, or both. There were no differences in total yield but lower marketable yields were obtained under level culture due to the increased amount of sunburn. Hilling after tuber-set caused the range of tuber-set to be displaced upwards so that the uppermost tubers were at a nearly constant depth below the soil surface, regardless of the height of hill applied. Hilling after tuber-set also tended to produce tubers of higher specific gravity than hilling only at planting.

## INTRODUCTION

The practice of planting potatoes in rows and ridging or hilling the plants at some stage after they have emerged is virtually universal where mechanized potato production is carried out. Until recently weeds have been controlled solely by the use of harrows or finger-weeders before the potatoes emerge, followed by cultivation between the rows after emergence. Further inter-row cultivation continued until a substantial ridge or hill was built over the seed-piece and developing tubers. The advent of chemical weed-control, however, has renewed interest in Ontario in planting "on-the-flat", i.e. without subsequent hilling, because of the increased yield obtained by Collin (3) with early cultivars. The current interest in increasing yields by the use of higher plant populations also suggested the need to examine (i) the need for hills and (ii) the best timing and size of hills with respect to their possible application to the above situations. In growing "on-the-flat" there is also the question of optimum planting depth and this was included in the investigation.

Moursi (11), Ivins and Montague (7), Burton (2), Hardenburg (5) and Cox (4) found that shallow planting hastened the emergence of plants compared with deep planting. However, Moore (10) found that deep planting hastened emergence, particularly in dry soil and when the planter hill was flattened. Werner (12) explained this by stating that the planting depth should be such that the seed-pieces are in soil which has adequate moisture for the establishment of the crop.

Moursi (11) and Moore (10) also found that planting depth had no effect on the final plant stand, but Hardenburg (5) and Collin (3) found that delayed emergence could result in an increase in seed-piece decay, or sprout decay such as that caused by *Rhizoctonia*, thereby giving

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poor stands. The above workers (5, 7, 10, 11) and Lorenz (9) found no differences in total yield due to seed-piece depth but several of them (5, 9, 11) and Bleasdale (1) and Zavitz (13) obtained lower marketable yields at a shallow (2 in.; 5.1 cm) depth because of the increased amount of sunburn.

Hilling is practiced in North America to protect the seed-piece from early-season frosts, to prevent sunburning of the tubers, to control weeds, to protect the tubers from late-blight spores and late-season frosts and to reduce the amount of soil to be moved at harvest. In Europe, where excessive rainfall is often a problem on the heavier soils, keeping the tubers in a relatively dry position is also important (8).

Moore (10) obtained reductions in both total and U.S. No. 1 yields and also in the number of tubers per plant as the height of the hill increased from level culture to 7 inches (17.8 cm). The decrease in tubers per plant was also observed by Ivins and Montague (7). Burton in sunburning and increase in tuber size, the marketable yield can be higher than in the level culture.

## Materials and Methods

Sebago and Kennebec potatoes were planted in 1968 and 1969 in a Fox sandy loam soil at the Horticultural Research Station, Preston, Ontario. A split-plot design of four replicates was used, with planting depths as main treatments and times and heights of hilling as sub-treatments. Each plot consisted of three 36-inch (91.4 cm) rows, 25 ft. (7.62 m) long. All rows within a plot received the same treatment but only the center row was harvested.

Foundation A-size seed cut into pieces 1½-2 oz. (42-56 gm) in weight, was planted at 10 inch (25 cm) spacing by a rotating-plate-feed type of planter which also banded the 10-10-10 fertilizer at the rate of 1100 lb/acre (1.2 T/ha) as called for by soil tests. Hydraulic controls provided the desired planting depth of 2 and 4 inches (5.1 and 10.2 cm) between the original soil level and the top of the seed piece.

The initial hilling treatments were applied within a week of planting, when the low hill left by the planter was altered by hand rakes. The final treatments were carried out at the blossom stage before the foliage closed in the area between the rows, using tractor-mounted disc hillers, with hand rakes to complete hill formation. The treatments were: low hill* only, at planting (L); medium hill only, at planting (M); low hill at planting, built high later (L-H); medium hill at planting, built higher later (M-H); no hill (O); no hill, built low later (O-L); no hill, built medium later (O-M) and no hill, built high later (O-H).

Weeds were controlled by using a pre-emergence herbicide (Patoran) in 1968 and a post-emergence herbicide (Propanil) in 1969. Normal disease- and insect-control sprays were applied throughout the season.

Plant emergence was considered as the number of days from planting until 67% of the plants had emerged. After the crop was established plant stands were checked to ensure that there were no "blind" or diseased

*The low, medium and high hills were 3, 5 and 7 inches (7.6, 12.7 and 17.8 cm) respectively above the adjacent furrow bottom and 2.5, 4 and 5 inches (6.4, 10.2 and 12.7 cm) above the original soil surface.

seed-pieces. Sample plants in the border rows of each treatment were checked to ascertain the time of tuber-set so that the final hilling would be carried out where appropriate.

The range of tuber -set, i.e. the distance from the top of a hill to the top of the uppermost tuber and the bottom of the lowest was measured at harvest. Five adjacent hills, in two replications, with no missing hills on either side of any hill, were measured. In 1969 only the 4 inch planting depth was checked. It was intended to monitor the temperature of the soil in the tuber zones with a multi-point recorder, but continuous malfunctioning of the instrument in both years made this impossible.

## RESULTS

### *Plant emergence*

The number of days to plant emergence is given in Table 1. In both varieties, potatoes at the 2 inch (5.1 cm) depth required fewer days than those at the 4 inch (10.2 cm) depth in 1968, but this difference did not occur in 1969.

The height of hill, however, had an effect in both years. In 1968 at the 2 inch (5.1 cm) depth the plants of both varieties emerged soonest under the "O" hill, followed by the "L" and then the "M". At the 4 inch (10.2 cm) depth Sebago followed the same pattern, but with Kennebec the "O" treatment was first and the "L" and "M" were the same. In 1969, with both varieties, the "O" treatment was again first with "L" and "M" the same.

### *Total yield*

Table 2 shows that planting depth had no effect on total yield of Kennebec or Sebago in either year. In 1968 the "M" treatment gave a higher yield of Kennebec than did the "O" and "O-L", but no differences were found in 1969. With Sebago, no differences due to hilling treatments were observed among total yields in either year.

TABLE 1.—*Time (in days) from date of planting to date of plant emergence of Kennebec and Sebago; 1968 and 1969.*

| | 1963 | | | 1969 | | |
|---|---|---|---|---|---|---|
| | Depth | | | Depth | | |
| Hilling treatment | 2″ | 4″ | Mean | 2″ | 4″ | Mean |
| *Kennebec* | | | | | | |
| No-hill | 26 | 27 | 27b[1] | 21 | 22 | 21b |
| Low-hill | 27 | 29 | 28ab | 24 | 25 | 24a |
| Medium-hill | 28 | 29 | 29a | 23 | 23 | 23a |
| Mean | 27a | 28b | | 23a | 23a | |
| *Sebago* | | | | | | |
| No-hill | 27 | 29 | 28c | 26 | 27 | 26a |
| Low-hill | 29 | 30 | 29b | 27 | 28 | 28a |
| Medium-hill | 30 | 31 | 31a | 28 | 29 | 28a |
| Mean | 29a | 30b | | 27a | 28a | |

[1]Figures within cultivars, years, columns and rows followed by the same letter(s) are not significantly different; Duncan's New Multiple Range Test.

TABLE 2.—*Total yield of Kennebec and Sebago in cwt./acre and tons/hectare, 1968 and 1969.*

| Hilling treatment | 1968 Depth 2 in. | 1968 Depth 4 in. | 1968 Mean | 1969 Depth 2 in. | 1969 Depth 4 in. | 1969 Mean |
|---|---|---|---|---|---|---|
| Kennebec | T/ha[2] | T/ha | T/ha | T/ha | T/ha | T/ha |
| O[1] | 47.1 | 46.3 | 46.7b[3] | 30.5 | 26.8 | 28.6a |
| O - L | 42.9 | 50.5 | 46.7b | 26.9 | 31.5 | 29.2a |
| O - M | 47.7 | 49.5 | 48.2ab | 35.2 | 29.4 | 32.3a |
| O - H | 52.0 | 55.6 | 53.8ab | 30.5 | 34.6 | 32.6a |
| L | 54.9 | 52.9 | 53.9ab | 26.3 | 28.8 | 27.5a |
| L - H | 50.5 | 55.1 | 52.8ab | 31.7 | 30.2 | 30.9a |
| M | 54.2 | 60.3 | 57.3a | 29.5 | 29.5 | 29.5a |
| M - H | 46.9 | 50.3 | 48.6ab | 29.7 | 27.5 | 28.6a |
| Mean | 49.5a | 52.6a | | 30.0a | 29.8a | |
| *Sebago* | | | | | | |
| O | 41.1 | 42.2 | 41.7a | 20.0 | 20.0 | 20.0a |
| O - L | 44.3 | 45.4 | 44.9a | 23.4 | 27.9 | 25.6a |
| O - M | 44.6 | 41.5 | 43.1a | 27.4 | 21.2 | 24.3a |
| O - H | 42.3 | 47.1 | 44.7a | 23.2 | 22.6 | 22.9a |
| L | 48.8 | 46.0 | 47.4a | 19.4 | 23.1 | 21.2a |
| L - H | 40.5 | 44.0 | 42.3a | 24.5 | 24.5 | 24.9a |
| M | 39.7 | 46.2 | 42.6a | 29.2 | 24.8 | 27.0a |
| M - H | 46.6 | 45.5 | 46.1a | 23.1 | 23.9 | 23.5a |
| Mean | 43.5a | 44.7a | | 23.8a | 23.6a | |

[1]For explanation of code see page 302.
[2]Multiply T/ha by 8.92 to obtain cwt per acre.
[3]Differences shown by Duncan's New Multiple Range Test.

*Number of tubers per plant*

Neither planting depths nor hilling treatments affected the number of tubers per plant.

*Yield of Ont. No. 1 tubers*

Planting depth had no effect on the yield of Kennebec or Sebago Ont. No. 1 (2"-3½"; 5-9) cm) in either year. (Table 3) Hilling treatments did not affect either variety in 1969 or Sebago in 1968, but in the latter year the "M" treament in Kennebec increased the yield over the "O" and "O-L" while the "O-H", "L-H" and "L" outyielded the "O."

*Percentage of sunburned tubers*

There was no effect of planting depth on the percentage of total yield of Kennebec which was sunburned in either year, nor of Sebago in 1969 (Table 4). However, the percentage was increased at the 2 inch (5.1 cm) depth with Sebago in 1968. The "O" hilling treatment increased the percentage of sunburned tubers over all other treatments for both varieties in both years except that in 1969 there was no difference between the "O" and "L" treatments in Kennebec.

TABLE 3.—*Yield of Kennebec and Sebago Ont. No. 1 in cwt./acre and tons/hectare, 1968 and 1969.*

| Hilling treatment | 1968 Depth 2 in. | 1968 Depth 4 in. | 1968 Mean | 1969 Depth 2 in. | 1969 Depth 4 in. | 1969 Mean |
|---|---|---|---|---|---|---|
| *Kennebec* | T/ha | T/ha | T/ha | T/ha | T/ha | T/ha |
| O[1] | 37.7[2] | 40.8 | 39.3c[3] | 25.9 | 23.9 | 24.9a |
| O - L | 38.3 | 46.6 | 42.5bc | 25.2 | 28.9 | 27.1a |
| O - M | 45.2 | 46.9 | 46.1abc | 32.5 | 26.3 | 29.4a |
| O - H | 48.5 | 53.6 | 50.9ab | 28.3 | 32.5 | 30.4a |
| L | 49.5 | 48.2 | 48.8ab | 23.2 | 25.7 | 24.4a |
| L - H | 46.0 | 52.5 | 49.2ab | 29.5 | 27.9 | 28.7a |
| M | 49.2 | 56.5 | 52.9a | 27.5 | 27.2 | 27.4a |
| M - H | 44.0 | 46.6 | 45.3abc | 27.2 | 25.9 | 26.5a |
| Mean | 44.8a | 49.0a | | 27.4a | 27.3a | |
| *Sebago* | | | | | | |
| O | 33.7 | 36.6 | 35.2a | 17.7 | 18.2 | 17.9a |
| O - L | 38.8 | 42.0 | 40.4a | 21.4 | 26.1 | 23.8a |
| O - M | 40.8 | 38.8 | 39.8a | 26.0 | 18.9 | 22.5a |
| O - H | 38.2 | 43.2 | 40.7a | 21.4 | 20.5 | 20.9a |
| L | 43.9 | 43.1 | 43.5a | 17.7 | 21.4 | 19.5a |
| L - H | 36.8 | 41.5 | 39.2a | 22.6 | 24.1 | 23.4a |
| M | 35.2 | 42.3 | 38.7a | 27.7 | 23.4 | 25.5a |
| M - H | 42.6 | 42.6 | 42.6a | 21.4 | 22.3 | 21.9a |
| Mean | 38.7a | 41.3a | | 21.9a | 21.9a | |

[1]For explanation of code see page 302.

[2]Multiply T/ha by 8.92 to obtain cwt per acre.

[3]Differences shown by Duncan's New Multiple Range Test.

*Percentage of tubers infected by late blight and blackleg*

These parameters were not affected by any treatment in either variety in either year. There was a small amount of blackleg and late blight in all treatments in both varieties in 1968 but none at all in 1969.

*Percentage marketable yield*

Planting depth had no effect on the percentage of marketable tubers of Kennebec in either year nor of Sebago in 1969; however, the percentage was lower for Sebago at the 2 inch (5.1 cm) than at the 4 inch (10.2 cm) depth (Table 5) in 1968.

Hilling treatments affected percent marketable yield of Kennebec in both years. In 1968 the "O" treatment was lower than all others, but in 1969 it decreased the percent marketable yield below that of the "O-H" treatment only. At the 2 inch (5.1 cm) planting depth the percent marketable yield of Sebago was lower for the "O" treatment than for all others except the "O-L." At the 4 inch (10.2 cm) depth the "O" treatment decreased the yield below that of the "L," "L-H" and "M-H" treatments. Hilling treatments did not influence the percent marketable yield of Sebago in 1969.

TABLE 4.—*Percentage of total yield of Kennebec and Sebago which was sunburned; 1968 and 1969.*

| Hilling treatment | 1968 Depth 2" | 1968 Depth 4" | 1968 Mean | 1969 Depth 2" | 1969 Depth 4" | 1969 Mean |
|---|---|---|---|---|---|---|
| *Kennebec* | | | | | | |
| O[1] | 16.2 | 9.4 | 12.8a[2] | 11.6 | 5.6 | 8.6a |
| O - L | 6.0 | 4.8 | 5.4b | 2.5 | 4.0 | 3.3b |
| O - M | 2.9 | 2.2 | 2.5b | 3.3 | 3.8 | 3.5b |
| L | 7.2 | 6.1 | 6.7b | 5.2 | 5.4 | 5.3b |
| L - H | 3.2 | 2.1 | 2.7b | 1.5 | 3.7 | 2.6b |
| M | 6.3 | 3.7 | 5.0b | 2.0 | 3.6 | 2.8b |
| M - H | 3.0 | 4.2 | 3.6b | 3.1 | 1.1 | 2.1b |
| Mean | 6.0a | 4.3a | | 3.9a | 3.5a | |
| *Sebago* | | | | | | |
| O | 9.8 | 7.3 | 8.5a | 3.3 | 2.8 | 3.1a |
| O - L | 3.4 | 1.6 | 2.5b | 0.6 | 0.8 | 0.7b |
| O - M | 2.3 | 1.0 | 1.6b | 0.4 | 0.1 | 0.3b |
| O - H | 0.8 | 1.4 | 1.1b | 0.2 | 0.3 | 0.3b |
| L | 3.8 | 1.8 | 2.8b | 0.8 | 1.1 | 0.9b |
| L - H | 0.9 | 0.6 | 0.7b | 1.3 | 0.2 | 0.7b |
| M | 3.2 | 1.8 | 2.5b | 0.6 | 1.3 | 0.9b |
| M - H | 1.8 | 1.2 | 1.5b | 0.2 | 0.1 | 0.1b |
| Mean | 3.3a | 2.1b | | 0.9a | 0.8a | |

[1]For explanation of code see page 302.
[2]Difference shown by Duncan's New Multiple Range Test.

*Specific gravity*

Specific gravity was not affected by planting depth in either year (Table 6). However, hilling treatments influenced the specific gravity of Kennebec in 1968 and 1969. In Kennebec the "O-L" and "O-H" gave higher specific gravity than the "L" and "M" treatments. With Sebago, in 1968 the "O-H" gave higher readings than the "L," "M" and "O-L" treatments while the "O" treatment had higher specific gravity than the "L" and "M." In 1969, the "O-L" and "O-H" were higher than the "M" treatment.

*Cut tubers at harvest*

The number of tubers cut by the digger share during harvest was not affected by planting depth in either variety. Hilling treatments had no effect on the number of Sebago tubers cut but the "O" and "L" treatments increased the number of Kennebec cut tubers over all other treatments.

*Range of tuber-set*

Fig. 1 shows the relationships among planting depth, hilling treatment and tuber-set range in Kennebec and Sebago. The top of the tuber-set range appears to be at a relatively constant depth below the soil surface regardless of planting depth or hilling treatment. The results show a trend that, as the height of the hill increases, the range of tuber-set

TABLE 5.—*Percentage of total yield of Kennebec and Sebago which was marketable; 1968 and 1969.*

| Hilling treatment | 1968 | | | 1969 | | |
|---|---|---|---|---|---|---|
| | Depth | | | Depth | | |
| | 2″ | 4″ | Mean | 2″ | 4″ | Mean |
| *Kennebec* | | | | | | |
| O[1] | 81.1 | 88.0 | 84.5b[2] | 83.6 | 89.3 | 86.5b |
| O - L | 89.3 | 92.6 | 90.9a | 92.0 | 91.5 | 91.7ab |
| O - M | 95.2 | 95.1 | 95.1a | 92.0 | 88.9 | 90.5ab |
| O - H | 93.3 | 96.0 | 94.7a | 93.3 | 93.6 | 93.5a |
| L | 90.5 | 91.1 | 90.8a | 88.5 | 89.4 | 88.9ab |
| L - H | 91.5 | 95.4 | 93.5a | 93.1 | 92.1 | 92.6ab |
| M | 90.9 | 93.8 | 92.3a | 93.3 | 92.5 | 92.9ab |
| M - H | 93.6 | 92.7 | 93.1a | 92.0 | 93.4 | 92.7ab |
| Mean | 90.7a | 93.1a | | 91.0a | 91.3a | |
| *Sebago* | | | | | | |
| O | 82.4b | 86.6b | 84.5b | 87.1 | 90.8 | 88.9a |
| O - L | 87.1ab | 92.6ab | 89.9ab | 91.6 | 93.7 | 92.7a |
| O - M | 90.8a | 93.0ab | 91.9a | 94.1 | 87.0 | 90.5a |
| O - H | 89.5a | 91.9ab | 90.7ab | 88.4 | 89.7 | 89.1a |
| L | 90.1a | 93.4a | 91.7a | 91.0 | 92.8 | 91.9a |
| L - H | 90.9a | 94.3a | 92.6a | 91.4 | 95.3 | 93.3a |
| M | 88.7a | 92.0ab | 90.3ab | 94.9 | 94.3 | 94.6a |
| M - H | 91.1a | 93.4a | 92.3a | 92.6 | 91.6 | 92.1a |
| Mean | 88.8a | 92.1b | | 91.3a | 91.9a | |

[1]For explanation of code see page 302.

[2]Differences shown by Duncan's New Multiple Range Test.

increases and forms further above the seed-piece. They also show that tuber-set occurred above the seed-piece with all the hilling treatments, regardless of planting-depth, except the "O" at both planting depths and the "L" treatment at 2 inches (5.1 cm).

## DISCUSSION

It is reported (5, 11) that, as the planting depth for potatoes increases, so does the time from planing to emergence. The 1968 results in both cultivars support these findings but the 1969 results do not. Isleib and Thompson (6) stated 48-50 F (9-10 C) is the minimum temperature for normal germination. The average air temperature for the two weeks following planting in 1968 was only 48 F (9 C), so that a lower temperature would prevail in the soil at the 4 inch (10.2 cm) depth. The average temperature for the same period in 1969 was 56 F (13 C). Rainfall in both years was normal and adequate, so the lower temperature would account for the delayed emergence at the 4 inch (10.2 cm) depth.

Plant emergence was also much faster under level culture than with a low or medium hill in both years, regardless of depth of planting, which indicates that the amount of hill over the seed-piece is more important than the planting depth.

TABLE 6.—*Specific gravity of Kennebec and Sebago tubers; 1968 and 1969.*

| Hilling treatment | 1968 Depth 2″ | 1968 Depth 4″ | 1968 Mean | 1969 Depth 2″ | 1969 Depth 4″ | 1969 Mean |
|---|---|---|---|---|---|---|
| *Kennebec* | | | | | | |
| O[1] ..... | 1.079 | 1.077 | 1.078ba[2] | 1.082 | 1.080 | 1.081a |
| O - L .. | 1.081 | 1.080 | 1.080a | 1.087 | 1.083 | 1.085a |
| O - M .. | 1.081 | 1.078 | 1.078ab | 1.085 | 1.085 | 1.085a |
| O - H .. | 1.078 | 1.082 | 1.080a | 1.087 | 1.082 | 1.084a |
| L ..... | 1.077 | 1.077 | 1.077b | 1.083 | 1.083 | 1.083a |
| L - H .. | 1.078 | 1.080 | 1.079ab | 1.085 | 1.084 | 1.084a |
| M ..... | 1.078 | 1.076 | 1.077b | 1.081 | 1.082 | 1.081a |
| M - H .. | 1.077 | 1.081 | 1.079ab | 1.083 | 1.084 | 1.083a |
| Mean .... | 1.079a | 1.079a | | 1.084a | 1.083a | |
| Mean: final hill at planting | | | 1.077b | | | 1.082a |
| Mean: final hill after tuber-set | | | 1.079a | | | 1.084a |
| *Sebago* | | | | | | |
| O ..... | 1.075 | 1.075 | 1.075ab | 1.083 | 1.087 | 1.085ab |
| O - L .. | 1.073 | 1.073 | 1.073bc | 1.087 | 1.086 | 1.087a |
| O M .. | 1.075 | 1.073 | 1.074abc | 1.084 | 1.086 | 1.085ab |
| O - H .. | 1.077 | 1.075 | 1.076a | 1.088 | 1.088 | 1.088a |
| L ..... | 1.072 | 1.072 | 1.072c | 1.086 | 1.084 | 1.085ab |
| L - H .. | 1.075 | 1.073 | 1.074abc | 1.085 | 1.086 | 1.086ab |
| M ..... | 1.071 | 1.074 | 1.072c | 1.081 | 1.084 | 1.082b |
| M - H .. | 1.075 | 1.073 | 1.074abc | 1.086 | 1.085 | 1.086ab |
| Mean .... | 1.074a | 1.073a | | 1.085a | 1.086a | |
| Mean: final hill at planting | | | 1.073a | | | 1.084b |
| Mean: final hill after tuber-set | | | 1.074a | | | 1.086a |

[1]For explanation of code see page 302.
[2]Differences shown by Duncan's New Multiple Range Test.

Lorenz (9) obtained lower marketable yields at the 2 inch (5.1 cm) planting-depth because of the greater amount of sunburn. Similar results were obtained in 1968 with Sebago but not with Kennebec, nor wih either in 1969. The shading effect of the heavier Kennebec vines could be responsible for this behaviour in 1968; in 1969 the latter part of the growing season was hot and dry, but supplementary irrigation kept the vines of both cultivars dense, producing good shade.

This shade, however, was not sufficient to prevent sunburning in the level culture, even though the topmost tubers were the same distance below the surface as in other treatments (Fig. 1). This was partly due to the fact that in this soil, cracks above the expanding tubers remained open in the level culture, but where hills had been applied the cracks tended to close again because the edges collapsed inwards, and partly because there was a greater concentration of tubers just below the soil surface in level culture than in the hilled rows, regardless of the time of hilling.

The specific gravity of the tubers was not affected by planting depth but was affected by hilling in both years. At first it was thought that there might be less tubers per plant where the hill had been raised after

**Figure 1. Range of tuber-set of Kennebec and Sebago potatoes at two depths of planting under several hilling treatments, 1968 and 1969.**

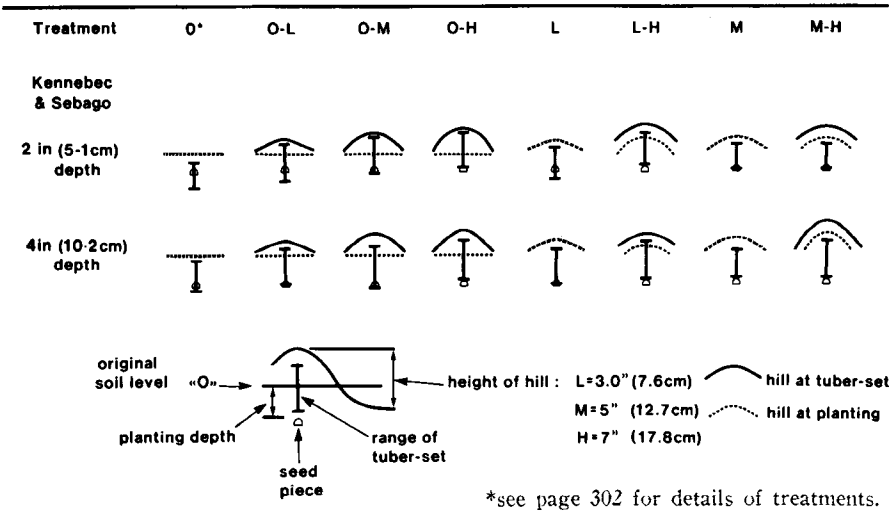


FIG. 1.—Range of tuber-set of Kennebec and Sebago potatoes at two depths of planting under several hilling treatments, 1968 and 1969.

tuber-set but the data do not support this, especially when tubers affected by sunburn, blight and rhizoctonia are included. A clear pattern does emerge, however, when the specific gravity in those treatments in which the final hill was applied after tuber-set, regardless of whether or not a hill was applied at planting, is compared with those where the planting hill has the final hill (Table 6). The differences are not statistically significant in Sebago in 1968 or Kennebec in 1969, but the trends are very clear.

It might be suggested that adding to the hill after tuber-set is conducive to lower soil temperatures in the tuber-zone, but the data in Fig. 1 show that this is not a valid assumption as the range of tuber-set remains the same; new tubers must be formed above the originals and the lowest of the originals must be resorbed. Kouwenhouven (8) found a temperature range of less than 1 C (1.8 F) between depths of 2.5 and 7.4 inches (10-18.7 cm) in his hills, which tends to rule out temperature as a factor. He also states that large hills have a better moisture supply than small hills from the soil beneath the hill, but this is unlikely to be a factor here as (i) it is our experience that the effect of moisture on specific gravity is very variable and (ii) after they had settled, the hills were the same size as the corresponding hills at planting-time. This problem is being investigated further as it is very pertinent to the use of pre- and post-emergence herbicides.

Late blight (*Phytophthora infestans*) is not a serious problem in Ontario, but the fact that here was no difference in the amount of infection among the treatments does not necessarily mean that there would be no differences in other areas.

## Conclusions

Growing late or main-crop potatoes in level culture is not practical in Ontario. Plants however, emerge sooner under this system than where the planter-hill is left in place. Hilling either before or after plant emergence gives higher marketable yields because of the lesser amount of sunburn on the tubers.

Placing a hill around the plant after tuber-set, regardless of previous hilling treatment, results in the range of tuber-set being displaced upwards until the top of the uppermost tuber is approximately one inch (2.5 cm) below the soil surface. Hilling at this time produces tubers of higher specific gravity than putting on the final hill at planting time, although the reasons for this are not yet clear.

Deep planting, followed by immediate levelling of the planter-hill to promote rapid emergence, with a final hill applied just after tuber-set would seem to be the best practice for Ontario. Techniques will have to be developed for the optimum application of pre- and post-emergence herbicides under these conditions.

## Literature Cited

1. Bleasdale, J. K. A. 1963. Competition studies. Potatoes. Rep. Nat'l Veg. Res. Stn. for 1962. 37-38.
2. Burton, W. G. 1966. *In* "The Potato." H. Veenman and Zonen N. V. Wageningen, Holland. 2nd Edn. 138-139.
3. Collin, G. 1968. Experience with flat-bed planting of potatoes. Rep. Hort. Exp. Stn. Simcoe, Ontario.
4. Cox, A. E. 1967. *In* "The Potato." W. H. and L. Collinbridge Ltd., London. 52-55.
5. Hardenburg, E. V. 1949. *In* "Potato Production." Comstock Publishing Co. Inc. Ithaca, N. Y.
6. Isleib, D. R. and N. R. Thompson. 1959. The influence of temperature on the rate of root and sprout growth of potatoes. Amer. Potato J. 36: 173-178.
7. Ivins, J. D. and V. J. Montague. 1958. Note on the influence of depth of soil covering the parent tuber on the development and yield of the potato plant. Emp. J. Exp. Ag. 26: 34-36.
8. Kouwenhoven, J. K. 1970. Yield, grading and distribution of potatoes in ridges in relation to planting depth and ridge size. Potato Res. 13: 59-77.
9. Lorenz, O. A. 1945. Effect of planting depth on yield and tuber-set of potatoes. Amer. Potato J. 22: 343-349.
10. Moore, G. C. 1937. Soil and plant response to certain methods of potato cultivation. Cornell Ag. Exp. Bull. 662: 1-48.
11. Moursi, M. A. 1953. The effect of depth of planting on germination, level of tuber formation and yield of the potato crop. Amer. Potato J. 30: 242-247.
12. Werner, H. O. 1947. Commercial potato production in Nebraska. Neb. Bull. 382: 1-173.
13. Zavitz, C. A. 1916. Potatoes. Ont. Dept. Agr. Bull. 239.