

## DISEASES OF BRASSICA SPECIES IN SASKATCHEWAN, 1970-72. I. STAGHEAD AND ASTER YELLOWS<sup>1</sup>

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### Abstract

No infection by the fungus (*Albugo cruciferarum*) responsible for staghead was observed in commercial fields of *Brassica napus* in the period from 1970 to 1972, but a steady increase in incidence and severity of all phases of the disease occurred in fields of *B. campestris*. In Saskatchewan, estimated losses resulting from hypertrophies of the inflorescence in *B. campestris* in 1970, 1971, and 1972 were 0.747, 1.836, and 1.080 million bu worth 1.68, 4.13, and 2.43 million dollars, respectively. Losses due to aster yellows were negligible in each of the 3 years.

### Introduction

This paper reports the results of 3 years' surveys of *Brassica* crops for the staghead and stem blister phases of white rust caused by *Albugo cruciferarum* S. F. Gray, and for the aster yellows disease. In 1971, Berkenkamp (1) and Harper (F. R. Harper, personal communication) conducted surveys involving staghead in Alberta. Berkenkamp's survey was carried out in central and northern areas and Harper's in the south. Average yield loss figures reported were 1.21 and 3.6%, respectively. Also in 1971, Bernier (2) examined fields in southern and northwestern Manitoba and estimated yield reductions from severe staghead infections of 30 to 60%.

The acreage sown to rape and the total production in Saskatchewan in each of the years 1970-72 appear in Table 6 (3, 4, 5). In recent years, a very high percentage of the acreage has been in the crop districts 5, 8 and 9.

### Methods

Annually routes were mapped out through the principal areas of production and the approximate locations of fields to be sampled were marked along them at random. The surveys were conducted in August; the locations of fields entered are shown in Figures 1 and 2. Fields were sampled by pulling plants at equally spaced sampling sites following an "M" pattern within the

crop. Further detail is provided in Table 1. Samples were examined in the laboratory and each symptom given a severity rating between 0 and 3. Disease severity classes employed for the staghead phase of white rust and for aster yellows have been converted to those used for staghead by Harper and Pittman; severity classes 1, 2, and 3 represented, respectively, 1-25, 26-50, and over 50% of a plant's branches systemically infected (F. R. Harper, personal communication). Ratings for stem blisters caused by *Albugo* were related to percentage of stem area damaged (Table 2). A disease severity index (DSI) was calculated for each symptom rated at each sampling site according to the following formula:

$$DSI = \frac{a + 2b + 3c}{3d} \times 100$$

In the equation, a, b, and c represent the number of plants in severity classes 1, 2, and 3 respectively, and d the total of diseased plus healthy plants. Plants rated "trace" were considered healthy when calculating the rating for stem blisters.

Estimates of reductions in yield caused by systemic *Albugo* infections were based on the linear relationship between severity class and reduction in yield per terminal stem found by Harper and Pittman (F. R. Harper, personal communication) and were very similar to the DSI values. Only the latter, therefore, have been reported in the tables. The relationship between severity of *Albugo* stem blisters or aster yellows and loss in yield has not been determined.

### Results

*Albugo* infections were never observed on *Brassica napus* L. during the three disease surveys, nor were they noted in the two

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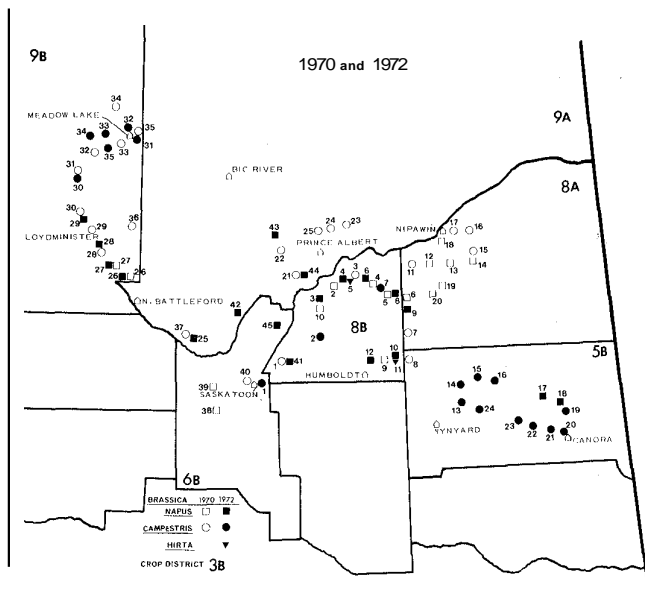


Figure 1. Commercial fields of *Brassica napus*, *B. campestris*, and *B. hirta* sampled during disease surveys conducted in Saskatchewan in 1970 and 1972.

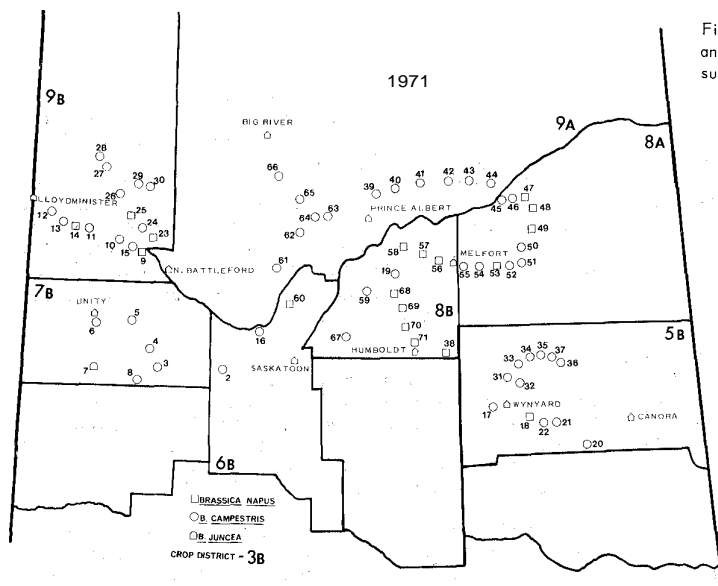


Figure 2. Commercial fields of *Brassica napus*, *B. campestris*, and *B. juncea* sampled in Saskatchewan during the 1971 disease survey.

Table 1. Details of Brassica disease surveys conducted in Saskatchewan from 1970-1972

| Year | Number of sampling sites per field | Minimum number of plants pulled per sampling site | Species and number of fields entered |                      |                 |                  |       |
|------|------------------------------------|---|--------------------------------------|----------------------|-----------------|------------------|-------|
|      |                                    |   | <i>B. napus</i>                      | <i>B. campestris</i> | <i>B. hirta</i> | <i>B. juncea</i> | Total |
| 1970 | 5                                  | 25  | 16                                   | 24                   | 0               | 0                | 40    |
| 1971 | 10                                 | 10  | 18                                   | 51                   | 0               | 1                | 70    |
| 1972 | 10                                 | 10  | 19                                   | 19                   | 2               | 0                | 40    |

fields of *B. hirta* Moench sampled in 1972. In the only field of *B. juncea* (L.) Coss examined. (field 7, 1971), 1% of the plants had stagheads and 3% had stem blisters. Percent infection levels and severity indices for all fields of *B. campestris* L. are recorded in Tables 3-5. Other data are included to indicate the degree of uniformity of distribution of the particular disease symptom within fields. By reference to Figures 1 and 2 and the tables, an indication of the geographical distribution of infection may be obtained.

Table 6 contains the data used in calculations of yield reductions in bushels and monetary losses due to staghead. In

Table 2. Disease severity classes used in rating stem blisters caused by *Albuqo*

| Disease class | Percentage of stem area damaged |
|---------------|---------------------------------|
| 0             | 0                               |
| TR            | < 1%                            |
| 1             | 1 to 10%                        |
| 2             | 10 to 30%                       |
| 3             | >30%                            |

Table 3. Prevalence and severity of stagheads and stem blisters on *Brassica campestris* in Saskatchewan, 1970

| Field no. | Stagheads         |           |                                | Stem blisters                                  |                   |           |   |
|-----------|-------------------|-----------|--------------------------------|--|-------------------|-----------|---|
|           | % plants infected | Mean DSI* | % sites having infected plants | Range in severity indices among sampling sites | % plants infected | Mean DSI* | Range in severity indices among sites** |
| 1         | 2                 | 1         | 40                             | 0-3  | 75                | 17        | 10-20                                   |
| 3         | 11                | 4         | 100                            | 1-7  | 89                | 13        | 8-14                                    |
| 7         | 18                | 6         | 100                            | 6-8  | 22                | 1         | 0-2                                     |
| 8         | 24                | 10        | 100                            | 5-19   | 75                | 7         | 5-9                                     |
| 11        | 4                 | 2         | 60                             | 0-4  | 69                | 5         | 3-6                                     |
| 15        | 24                | 11        | 100                            | 8-14   | 53                | 2         | 0-5                                     |
| 16        | 11                | 6         | 100                            | 2-9  | 32                | 0         | 0-1                                     |
| 17        | 2                 | 0         | 40                             | 0-1  | 32                | 1         | 0-4                                     |
| 21        | 6                 | 2         | 100                            | 1-4  | 68                | 5         | 0-10                                    |
| 22        | 2                 | 1         | 50                             | 0-1  | 52                | 3         | 0-8                                     |
| 23        | 2                 | 0         | 40                             | 0-1  | 61                | 4         | 1-9                                     |
| 24        | 3                 | 1         | 33                             | 0-7  | 45                | 4         | 1-6                                     |
| 25        | 6                 | 2         | 60                             | 0-5  | 31                | 1         | 0-6                                     |
| 28        | 13                | 6         | 100                            | 3-9  | 32                | 1         | 0-3                                     |
| 29        | 8                 | 3         | 80                             | 0-6  | 38                | 2         | 0-5                                     |
| 30        | 4                 | 1         | 80                             | 0-2  | 61                | 12        | 9-16                                    |
| 31        | 6                 | 2         | 100                            | 1-5  | 49                | 3         | 1-5                                     |
| 32        | 14                | 6         | 100                            | 1-13   | 55                | 2         | 0-5                                     |
| 33        | 16                | 6         | 100                            | 3-12   | 39                | 1         | 0-3                                     |
| 34        | 11                | 5         | 100                            | 2-7  | 61                | 5         | 2-9                                     |
| 35        | 7                 | 3         | 80                             | 0-6  | 69                | 9         | 4-16                                    |
| 36        | 9                 | 3         | 80                             | 0-7  | 54                | 1         | 0-2                                     |
| 37        | 3                 | 1         | 40                             | 0-5  | 71                | 2         | 1-4                                     |
| 40        | 1                 | 0         | 20                             | 0-2  | 75                | 5         | 2-8                                     |
| Average   | 9                 | 3         | 75                             | 1-7  | 55                | 4         | 2-7                                     |

\* DSI values for stagheads and stem blisters are not comparable. Only those for stagheads are known to approximate reductions in yield.

\*\* All sampling sites had plants with stem blisters.

Table 4. Prevalence and severity of stagheads and stem blisters on *Brassica campestris* in Saskatchewan, 1971

| Field no. | Stagheads         |          |                                |                                       | Stem blisters     |          |  |
|-----------|-------------------|----------|--------------------------------|---------------------------------------|-------------------|----------|--|
|           | % plants infected | Mean DSI | % sites having infected plants | Range in severity indices among sites | % plants infected | Mean DSI | Range in severity indices among sites* |
| 2         | 5                 | 2        | 20                             | 10                                    | 50                | 10       | 13                                     |
| 3         | 0                 | 0        | 0                              | 0                                     | 53                | 4        | 7                                      |
| 4         | 2                 | 1        | 20                             | 7                                     | 91                | 18       | 10-27                                  |
| 5         | 14                | 8        | 70                             | 20                                    | 71                | 6        | 13                                     |
| 6         | 3                 | 1        | 20                             | 7                                     | 81                | 12       | 3-17                                   |
| 8         | 9                 | 4        | 50                             | 10                                    | 51                | 3        | 7                                      |
| 10        | 36                | 20       | 100                            | 10-33                                 | 66                | 7        | 12                                     |
| 11        | 10                | 6        | 60                             | 17                                    | 88                | 21       | 10-30                                  |
| 12        | 10                | 5        | 60                             | 20                                    | 91                | 41       | 27-50                                  |
| 13        | 4                 | 2        | 40                             | 7                                     | 91                | 42       | 23-53                                  |
| 15        | 46                | 23       | 100                            | 50                                    | 56                | 7        | 3-13                                   |
| 16        | 12                | 5        | 70                             | 17                                    | 78                | 14       | 3-27                                   |
| 17        | 2                 | 1        | 20                             | 6                                     | 50                | 8        | 20                                     |
| 19        | 6                 | 3        | 20                             | 17                                    | 74                | 10       | 27                                     |
| 20        | 3                 | 2        | 20                             | 13                                    | 58                | 7        | 10                                     |
| 21        | 18                | 10       | 80                             | 27                                    | 72                | 8        | 17                                     |
| 22        | 1                 | 0        | 10                             | 3                                     | 48                | 5        | 13                                     |
| 24        | 10                | 5        | 70                             | 13                                    | 94                | 26       | 20-33                                  |
| 26        | 4                 | 2        | 40                             | 7                                     | 66                | 10       | 20                                     |
| 27        | 6                 | 2        | 40                             | 10                                    | 90                | 27       | 10-37                                  |
| 28        | 4                 | 2        | 20                             | 13                                    | 73                | 27       | 13-37                                  |
| 29        | 3                 | 1        | 30                             | 3                                     | 87                | 20       | 7-30                                   |
| 30        | 32                | 18       | 100                            | 3-42                                  | 53                | 5        | 9                                      |
| 31        | 6                 | 3        | 30                             | 15                                    | 80                | 23       | 7-33                                   |
| 32        | 0                 | 0        | 0                              | 0                                     | 83                | 16       | 3-30                                   |
| 33        | 7                 | 3        | 50                             | 13                                    | 81                | 26       | 20-33                                  |
| 34        | 12                | 5        | 80                             | 17                                    | 69                | 14       | 33                                     |
| 35        | 13                | 8        | 70                             | 20                                    | 72                | 9        | 3-13                                   |
| 36        | 4                 | 2        | 30                             | 10                                    | 82                | 17       | 3-30                                   |
| 37        | 11                | 7        | 56                             | 20                                    | 63                | 5        | 13                                     |
| 39        | 8                 | 4        | 50                             | 13                                    | 86                | 16       | 10-23                                  |
| 40        | 17                | 10       | 90                             | 20                                    | 38                | 6        | 17                                     |
| 41        | 14                | 7        | 80                             | 20                                    | 91                | 33       | 27-53                                  |
| 42        | 20                | 12       | 80                             | 27                                    | 56                | 15       | 7-27                                   |
| 43        | 33                | 13       | 88                             | 30                                    | 95                | 21       | 10-33                                  |
| 44        | 15                | 8        | 75                             | 13                                    | 88                | 18       | 7-23                                   |
| 45        | 5                 | 4        | 40                             | 17                                    | 40                | 6        | 3-13                                   |
| 46        | 12                | 6        | 90                             | 13                                    | 38                | 4        | 10                                     |
| 50        | 9                 | 6        | 60                             | 17                                    | 23                | 4        | 10                                     |
| 51        | 15                | 10       | 70                             | 37                                    | 27                | 5        | 10                                     |
| 52        | 7                 | 5        | 50                             | 17                                    | 76                | 17       | 7-27                                   |
| 54        | 18                | 9        | 80                             | 20                                    | 35                | 6        | 17                                     |

Table 4 (ctd.)

| Field no. | Stagheads         |          |                                |                                       | Stem blisters     |          |  |
|-----------|-------------------|----------|--------------------------------|---------------------------------------|-------------------|----------|--|
|           | % plants infected | Mean DSI | % sites Having infected plants | Range in severity indices among sites | % plants infected | Mean DSI | Range in severity indices among sites* |
| 55        | 7                 | 3        | 40                             | 13                                    | 88                | 18       | 10-20                                  |
| 59        | 0                 | 0        | 0                              | 0                                     | 86                | 20       | 13-23                                  |
| 61        | 9                 | 4        | 63                             | 10                                    | 78                | 28       | 20-33                                  |
| 62        | 2                 | 2        | 20                             | 10                                    | 13                | 3        | 10                                     |
| 63        | 0                 | 0        | 0                              | 0                                     | 80                | 18       | 37                                     |
| 64        | 7                 | 4        | 70                             | 7                                     | 39                | 7        | 13                                     |
| 65        | 6                 | 4        | 50                             | 17                                    | 76                | 20       | 10-28                                  |
| 66        | 8                 | 4        | 50                             | 10                                    | 88                | 15       | 3-20                                   |
| 67        | 9                 | 3        | 50                             | 13                                    | 94                | 23       | 17-30                                  |
| Average   | 10                | 6        | 50                             | 1-15                                  | 69                | 15       | 6-23                                   |

\*

Considering all fields, 99% of the sampling sites had plants with stem blisters.

Table 5. Prevalence and severity of stagheads and stem blisters on *Brassica campestris* in Saskatchewan, 1972

| Field no. | Stagheads         |          |                                |                                       | Stem blisters     |          |  |
|-----------|-------------------|----------|--------------------------------|---------------------------------------|-------------------|----------|--|
|           | % plants infected | Mean DSI | % sites having infected plants | Range in severity indices among sites | % plants infected | Mean DSI | Range in severity indices among sites* |
| 1         | 4                 | 4        | 40                             | 0-18                                  |                   |          |  |
| 2         | 30                | 17       | 90                             | 0-43                                  | 96                | 30       | 20-40                                  |
| 7         | 28                | 13       | 100                            | 6-30                                  | 89                | 23       | 13-39                                  |
| 13        | 12                | 9        | 60                             | 0-22                                  | 88                | 29       | 19-37                                  |
| 14        | 13                | 7        | 90                             | 0-14                                  | 84                | 20       | 10-31                                  |
| 15        | 17                | 13       | 80                             | 0-31                                  | 93                | 28       | 10-39                                  |
| 16        | 15                | 9        | 80                             | 0-26                                  | 81                | 23       | 13-35                                  |
| 19        | 26                | 8        | 90                             | 0-17                                  | 97                | 24       | 18-31                                  |
| 20        | 15                | 9        | 90                             | 0-18                                  | 81                | 20       | 7-29                                   |
| 21        | 16                | 10       | 90                             | 0-19                                  | 96                | 24       | 14-40                                  |
| 22        | 6                 | 3        | 60                             | 0-9                                   | 96                | 31       | 24-40                                  |
| 23        | 29                | 11       | 100                            | 3-19                                  | 91                | 25       | 14-37                                  |
| 24        | 19                | 12       | 100                            | 7-24                                  | 93                | 37       | 31-45                                  |
| 30        | 17                | 8        | 100                            | 3-11                                  | 84                | 37       | 24-52                                  |
| 31        | 7                 | 4        | 60                             | 0-14                                  | 96                | 24       | 7-39                                   |
| 32        | 24                | 13       | 100                            | 4-21                                  | 98                | 33       | 27-42                                  |
| 33        | 3                 | 1        | 50                             | 0-4                                   | 100               | 38       | 27-53                                  |
| 34        | 19                | 9        | 100                            | 2-19                                  | 100               | 34       | 26-45                                  |
| 35        | 30                | 15       | 100                            | 3-24                                  | 98                | 34       | 21-47                                  |
| Average   | 17                | 9        | 83                             | 2-20                                  | 92                | 29       | 18-40                                  |

\*

All sampling sites had plants with stem blisters.

Table 6. Rapeseed acreage, production in bushels, and reduction in yield caused by the staghead phase of white rust in Saskatchewan, 1970-1972

| Year | Acreage<br>(millions) | Total production<br>(millions of bu) | % of acreage in varieties of |   | Avg loss in yield due to staghead |                  | Avg loss in<br>millions of dollars *** |
|------|-----------------------|--------------------------------------|------------------------------|---|-----------------------------------|------------------|--|
|      |                       |                                      | <i>Brassica campestris</i>   | Total production of<br><i>B. campestris</i> varieties<br>(millions of bu) | (%) **                            | (millions of bu) |  |
| 1970 | 2.20                  | 39.5                                 | 63.0                         | 24.9  | 3.0                               | 0.747            | 1.68                                   |
| 1971 | 2.74                  | 51.0                                 | 60.0                         | 30.6  | 6.0                               | 1.836            | 4.13                                   |
| 1972 | 1.50                  | 25.5                                 | 47.0                         | 12.0  | 9.0                               | 1.080            | 2.43                                   |

\*\* Sources of information regarding acreage and production were literature citations 3, 4, and 5.

\*\*\* The disease severity index (DSI) equals loss in yield

Calculated using a price per bushel of \$2.25.

Table 7. Incidence of aster yellows on Brassica species in Saskatchewan, 1970-1972

| Species               | % of fields in which symptoms recorded |      |      | % of plants per field diseased (avg) |      |      |
|-----------------------|--|------|------|--------------------------------------|------|------|
|                       | 1970                                   | 1971 | 1972 | 1970                                 | 1971 | 1972 |
| <i>Brassica napus</i> | 37.5                                   | 22.2 | 35.0 | 0.3                                  | 0.2  | 0.2  |
| <i>B. campestris</i>  | 62.5                                   | 13.7 | 0.0  | 1.0                                  | 0.2  | 0.0  |
| All fields            | 52.5                                   | 15.7 | 17.5 | 0.8                                  | 0.2  | 0.1  |

Saskatchewan, losses in *B. campestris* were approximately 31, 6%, and 9%, respectively, for 1970, 1971 and 1972. In millions of bushels, this would amount to 0.75, 1.84 and 1.08 and, at \$2.25 per bushel, 1.65, 4.13, and 2.43 million dollars lost in 1970, 1971, and 1972. Considering the total Saskatchewan production of rape (including *B. napus*), losses from staghead averaged 1.9%, 3.6%, and 4.2% in the 3 years.

The data for aster yellows are in Tables 7 and 8. From the figures for percentages of plants infected (Table 7), it is apparent that reductions in yield due to this disease were much less than 1% in each of the 3 years.

## Discussion

Immunity to staghead continues to be maintained in commercial varieties of *Brassica napus* in spite of their continued cultivation in certain areas of high disease intensity. On *B. campestris* a steady rise in severity of hypertrophies of the inflorescence has been evident over the 3 years. Disease indices for the stem blister stage have shown a more spectacular increase. White rust is now so uniformly established

that at least one of its symptoms can be readily observed at every sampling site in every *B. campestris* field. The severity of the problem is emphasized by the extent of monetary loss which has resulted from just one phase of the disease.

## Acknowledgments

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Table 8. Levels of aster yellows infection in individual fields of *Brassica napus* and *B. campestris*, 1970-1972

| 1970                       |                      |                                   | 1971      |                      |                                   | 1972      |                      |                                   |
|----------------------------|----------------------|-----------------------------------|-----------|----------------------|-----------------------------------|-----------|----------------------|-----------------------------------|
| Field no.                  | % of plants infected | % of sites having infected plants | Field no. | % of plants infected | % of sites having infected plants | Field no. | % of plants infected | % of sites having infected plants |
| <i>Brassica napus</i>      |                      |                                   |           |                      |                                   |           |                      |                                   |
| 2                          | 1.3                  | 20                                | 23        | 1.0                  | 10                                | 3         | <1.0                 | 10                                |
| 4                          | 1.3                  | 17                                | 60        | 1.0                  | 10                                | 4         | <1.0                 | 10*                               |
| 5                          | 0.6                  | 17                                | 70        | 1.0                  | 10                                | 8         | <1.0                 | <10                               |
| 10                         | 0.7                  | 20                                | 71        | 1.0                  | 10                                | 9         | <1.0                 | <10                               |
| 27                         | 0.7                  | 20                                |           |                      |                                   | 12        | <1.0                 | <10                               |
| 39                         | 0.9                  | 20                                |           |                      |                                   | 43        | <1.0                 | <10                               |
|                            |                      |                                   |           |                      |                                   | 44        | <1.0                 | <10                               |
| <i>Brassica campestris</i> |                      |                                   |           |                      |                                   |           |                      |                                   |
| 1                          | 3.5                  | 80                                | 2         | 1.0                  | 10                                |           |                      |                                   |
| 7                          | 0.9                  | 25                                | 15        | 2.0                  | 20                                |           |                      |                                   |
| 8                          | 0.8                  | 20                                | 17        | 1.0                  | 10                                |           |                      |                                   |
| 11                         | 3.8                  | 20                                | 33        | 1.0                  | 10                                |           |                      |                                   |
| 21                         | 0.6                  | 17                                | 46        | 1.0                  | 10                                |           |                      |                                   |
| 22                         | 0.7                  | 17                                | 51        | 1.0                  | 10                                |           |                      |                                   |
| 23                         | 0.8                  | 20                                | 64        | 1.0                  | 10                                |           |                      |                                   |
| 24                         | 0.7                  | 17                                |           |                      |                                   |           |                      |                                   |
| 25                         | 2.3                  | 40                                |           |                      |                                   |           |                      |                                   |
| 28                         | 1.5                  | 40                                |           |                      |                                   |           |                      |                                   |
| 29                         | 0.8                  | 20                                |           |                      |                                   |           |                      |                                   |
| 30                         | 3.7                  | 80                                |           |                      |                                   |           |                      |                                   |
| 32                         | 0.8                  | 20                                |           |                      |                                   |           |                      |                                   |
| 35                         | 0.7                  | 20                                |           |                      |                                   |           |                      |                                   |
| 40                         | 2.7                  | 60                                |           |                      |                                   |           |                      |                                   |

\* Occasional infected plant observed in field.