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**TITLE: THE 2011 IPM PROGRAM OF THE MUCK CROPS RESEARCH STATION**

The 2011 Integrated Pest Management (IPM) program for vegetable crops in the Holland Marsh, Ontario, was successfully provided by the University of Guelph, Muck Crops Research Station (MCRS) in cooperation with the Holland Marsh Growers' Association. The program's objectives are to scout growers' fields, provide growers with disease and insect forecasting information, identify and diagnose diseases, insect pests and weeds, provide growers with timely, accurate and convenient access to insect and disease pest information, and to update and improve the IPM program. One example of this is to implement rotorod spore traps to trap spores of various vegetable crop pathogens.

### 1. SCOUTING

In 2011, 70 commercial vegetable fields, totaling 808 acres (carrot 361, onion 329, celery 98, and lettuce 20), were scouted for 30 growers. Compared to the 2010 growing season, fields scouted increased by 76 acres and one more grower participated in the IPM program in 2011. The information gathered from the scouted fields was used to manage the insect and disease problems of all the cultivated fields in the Holland/Bradford Marsh.

Two scouts were hired for the 2011 season. Scout training was conducted at the MCRS with a two day in-class and in-field training session at the beginning of May. Training, re-training and pest updating continued throughout the growing season through in-class and in-field sessions once per week.

The scouting schedule consisted of visiting fields twice per week, either on Mondays and Thursdays or Tuesdays and Fridays. Besides training, Wednesdays were set aside to prepare sticky traps and to scout fields that were skipped due to pesticide application re-entry periods or inclement weather. Beginning in September, field scouting was continued on a weekly basis. During the first six weeks of the scouting season, the IPM supervisor went out once per week with each scout for training and scouting assessment. During the rest of the growing season, the IPM supervisor went out with each scout once every other week.

### 2. DIAGNOSTICS, EXTENSION & DISSEMINATION OF INFORMATION

Any grower, whether on the IPM program or not, could bring in samples (plant and/or soil) for diagnosis. Field visits could also be requested. Two MCRS personnel were available for diagnosis and extension including the IPM program advisor (Mary Ruth McDonald) and the IPM program coordinator/supervisor (Michael Tesfaendrias). The MCRS manager (Shawn Janse) was also available for consultations and recommendations. On-site tools available for diagnosis were visual inspection and laboratory inspection using a microscope and culturing. Diagnoses were made by comparison to known symptoms, published descriptions of pathogens, insect pests and weeds and personal experience. Following assessment, the extension advice given was based on OMAFRA recommendations for pesticides and other control methods.

From January 8 to November 30, 2011, the MCRS diagnostic laboratory received 273 samples. Of these, 88% were for disease diagnosis (239 in total). These samples were associated with the following crops: onion (38.5%), carrot (27.6%), celery (4.6%), lettuce (2.5%), and other crops (26.8%). A total of 26 samples of insects or insect damage were assessed and there were also 8 weed identifications. Other samples were diagnosed in field during scouting and not brought in for analysis, thus the numbers mentioned above do not include these samples.

For extension services, data collected from growers' fields and the MCRS research plots were compiled twice per week, analyzed and summarized. The results (IPM report) were updated twice per week and circulated to participating growers, academia, industry, OMAFRA experts, posted at the MCRS web site ([www.uoguelph.ca/muckcrop](http://www.uoguelph.ca/muckcrop)), and a copy was sent to the Bradford Co-op for display on the notice board. The IPM report also contained additional important data related to pest monitoring and

modeling, forecasting and control, relevant weather data, OMAFRA and government notices, and meetings. During the 2011 growing season, more than 100 phone inquiries and email requests for information concerning plant problems and recommendations were addressed.

### 3. PEST PREDICTIVE MODELS

A number of predictive models were used to forecast different insect pests and plant diseases. Insect pest emergence was predicted with degree day models and confirmed with sticky traps and plant assessments. Disease forecasts were provided based on various forecasting models: BREMCAST for downy mildew (*Bremia lactucae*) of lettuce, BOTCAST for botrytis leaf blight (*Botrytis squamosa*) of onion and DOWNCAST for downy mildew (*Peronospora destructor*) of onion. All of the predictive models required environmental data such as air temperature, relative humidity, rainfall and leaf wetness. The environmental data was collected using various sensors attached to a permanent CR3000 data logger located at the side of the field at the MCRS. An additional CR21X data logger was placed in a MCRS onion research plot to collect environmental data within the crop canopy. Sclerotinia rot of carrots was predicted by trapping *Sclerotinia sclerotiorum* spores using Burkard spore trap and using a semi-selective growth medium. This enabled the grower to know the occurrence of *Sclerotinia* and the start of incidences of sclerotinia rot of carrot.

#### 3.1. WEATHER/ENVIRONMENTAL DATA

Compared to the averaged previous 10 years, the air temperatures in 2011 were average for May (14.1°C), June (18.4°C), August (20.2°C) and September (16.6°C), and above average for July (22.8°C) and October (10.1°C). The long term previous 10 year average temperatures were: May 13.3°C, June 18.5°C, July 20.4°C, August 19.6°C, September 15.7°C and October 8.9°C. Monthly rainfall was below the previous long term 10 year average for June (67 mm) and July (56 mm), average for September (67 mm), and above average for May (92 mm), August (113 mm) and October (83 mm). The long term previous 10 year rainfall averages were: May 76 mm, June 74 mm, July 82 mm, August 59 mm, September 72 mm and October 62 mm.

#### 3.2. DAMAGING WEATHER EVENTS

Weather conditions in the 2011 growing season were conducive for the development of most pathogens including bacteria, *Pythium* spp., *Sclerotinia* spp. and *Rhizoctonia* spp. Excessive soil moisture, associated with the above average rain fall recorded in August, created ideal conditions for soil borne pathogens, particularly *Pythium* spp. on carrot. High incidence of heat canker was observed on carrots due to a heat wave and shortage of rain in July.

### 4. CROP PEST SUMMARIES

For scouting purposes, the Holland Marsh was divided into the following five areas: West (all fields west of highway 400), Centre (fields north of Woodchoppers Lane, south of Strawberry Lane, east of highway 400 and west of Keele Street), North (all fields on North Canal Road, east of highway 400), East (all fields not on North Canal Road but east of Keele Street), South (all fields south of Woodchoppers Lane). At the end of the scouting program, carrot samples were collected from each scouted field and assessed for damage from insects (Table 1), diseases or physiological disorders. Similarly, onions were assessed in mid-season and at the end of the scouting program for onion maggot damage and incidence of smut (Figs 4 and 5).

#### 4.1. CARROT

##### 4.1.1. Insects

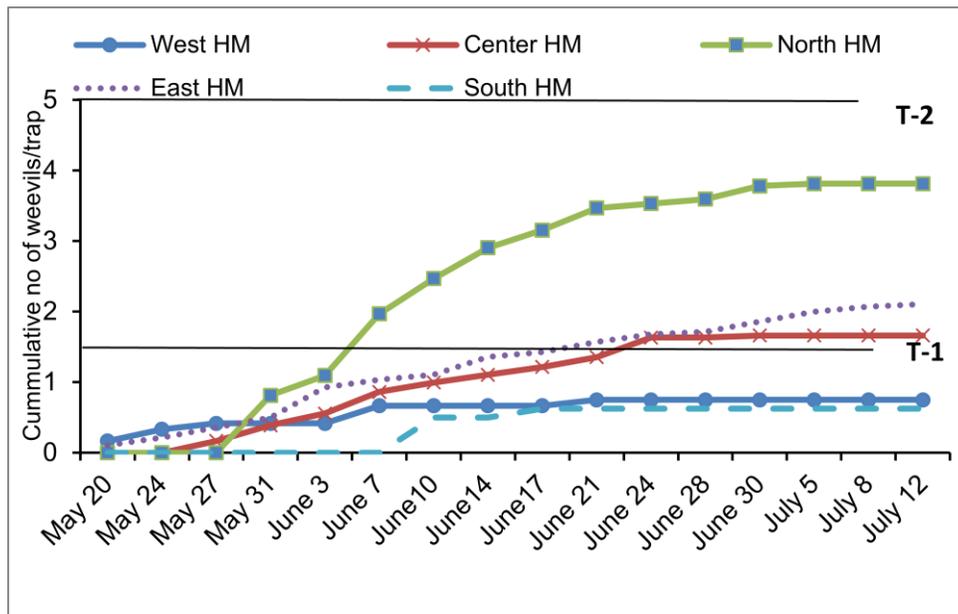
In 2011, carrot fields were scouted for carrot weevil (*Listronotus oregonensis*), carrot rust fly (*Psila rosae*) and aster leafhopper (*Macrosteles quadrilineatus*). Degree day models were used to predict the occurrence of different life stages of all three insects.

**Table 1.** Percent damage on carrots at harvest caused by insects and rodents in scouted fields around the Holland Marsh (HM), 2011.

Location	% Damaged Carrots		
	Weevil damage	Rust fly damage	Rodent damage
South HM	0.0	0.0	1.5
West HM	0.8	0.7	0.0
North HM	5.1	2.8	0.1
Center HM	5.4	3.3	0.0
East HM	3.1	3.9	0.6

### CARROT WEEVIL

Carrot weevils are pests of carrots and celery. Carrot weevil adults were first found in wooden traps on 20 May in carrot fields (Fig. 1). The threshold of 1.5 or greater weevils/trap was reached 8-10 days after carrot weevil activity started around the Marsh. The highest average cumulative number of weevils caught anywhere in the Holland Marsh/trap was 10.5, higher than in 2010 where the highest average cumulative of weevils/trap was 4.8. There was a significant correlation ( $r = 0.49$ ;  $P = 0.004$ ) between the cumulative carrot weevil count and the damage inflicted by the pest on carrots.

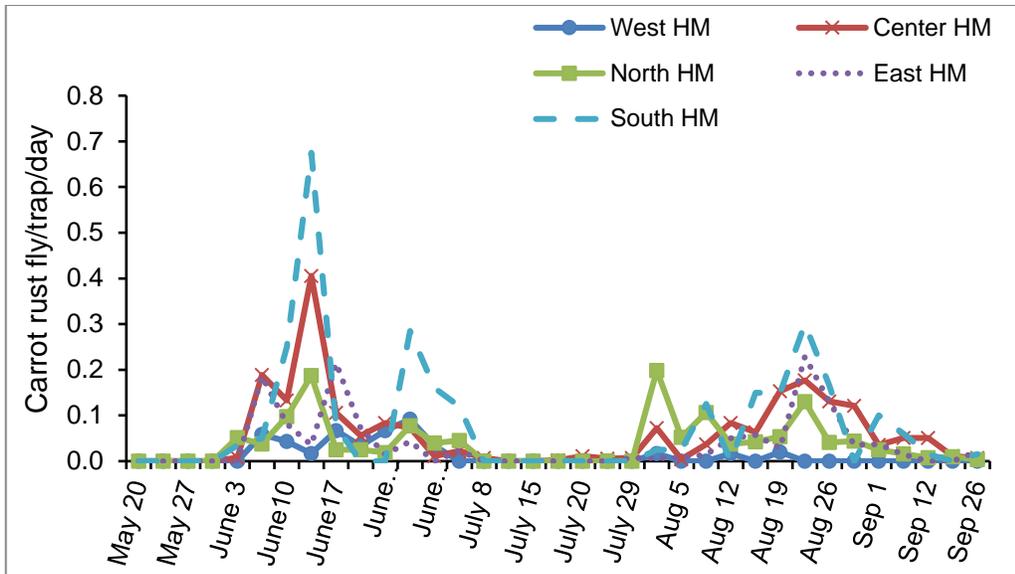


**Fig. 1.** Cumulative number of carrot weevils/wooden trap averaged over different areas of the Holland Marsh, 2011; (T-1, threshold 1=1.5-5 weevils/trap; T-2, threshold 2 = >5weevils/trap).

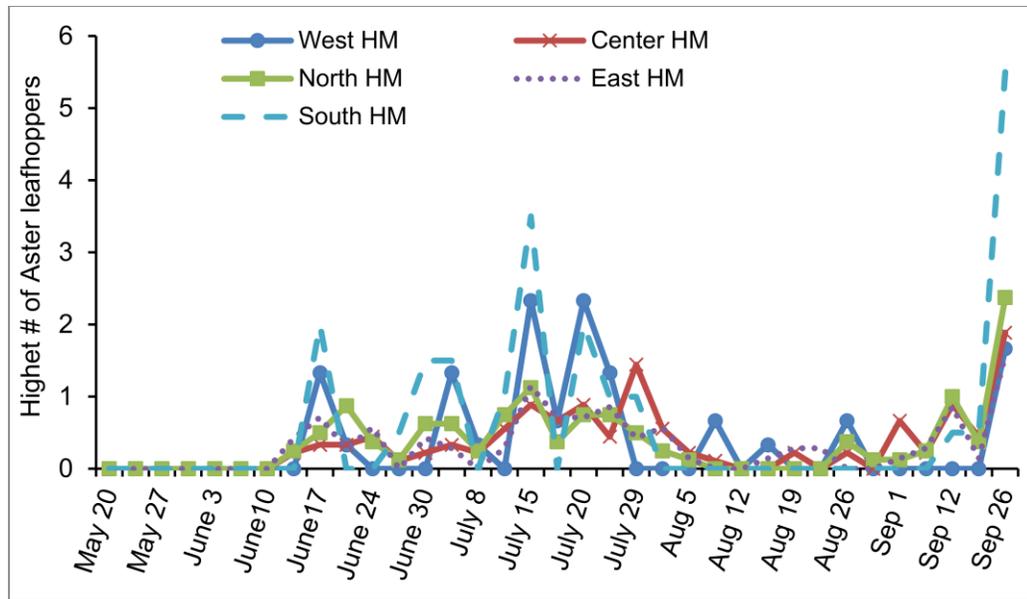
### CARROT RUST FLY AND ASTER LEAFHOPPER

Orange sticky traps were used to monitor and estimate carrot rust fly and aster leafhopper numbers. Carrot rust flies were first found on sticky traps on 2 June (Fig. 2). The DD model predicted first generation emergence on 24 May. The fresh carrot threshold of 0.1 flies/trap/day was reached in early June.

Aster leafhoppers are pests of carrots, celery, lettuce and leafy greens. Aster leafhopper adults were first found on orange sticky traps on 14 June in carrots, lettuce and celery (Fig. 3). The degree day model predicted local adult emergence on 24 June. In 2011, aster leafhopper infestation and the disease caused by the infestation (aster yellows) were very low.



**Fig. 2.** Number of carrot rust flies caught on orange sticky traps around the Holland Marsh carrot fields, 2011.



**Fig. 3.** Highest numbers of aster leaf hoppers caught on any particular day around the Holland Marsh, 2011.

#### 4.1.2. Diseases

Carrot fields were scouted for all the important diseases of carrots around the Holland Marsh. Carrot leaf blight caused by the fungi *Alternaria dauci* and *Cercospora carotae* were observed in most carrot fields. Leaf blight symptoms were first seen in mid-July and certain fields reached the spray threshold within one week. The timely announcement of leaf blight incidence helped to keep the disease pressure at the threshold of 25% disease incidence.

Weather conditions in the 2011 growing season were conducive for most pathogens including *Pythium*, *Sclerotinia* and *Rhizoctonia*. Total monthly rainfall was below the previous long term 10 year

average for June and July, average for September, and above average for May and August, which likely resulted in excessive soil moisture. The excessive soil moisture especially in August in turn created ideal conditions for soil borne pathogens, particularly *Pythium*, resulting in a high incidence of cavity spot.

As part of the IPM program, a survey of carrots for the presence of diseases and physiological damage was conducted in late August and September 2011 when the carrot harvest season for early and late carrots respectively started (Table 2). One hundred carrots were randomly collected from five sites (20 per site) of each of the 32 commercial carrot farms scouted. All 32 commercial carrot fields surveyed showed pythium root dieback and cavity spot.

Fifteen (47%) of the fields sampled had crown gall (*Agrobacterium tumefaciens*) with disease incidence ranging from 1 to 26%. Fusarium rot (*Fusarium* spp.) was found on carrots from one field with an incidence of 1%. The weather was ideal for sclerotinia rot (*S. sclerotiorum*) development. Although no sclerotinia rot infection was found in the carrot samples collected at the end of the scouting season, incidence of sclerotinia rot was observed in most of the fields during scouting.

Crater rot (*Rhizoctonia carotae* Rader) was found in three of the 32 carrot fields surveyed, which was less than the number of fields surveyed in 2010 with crater rot (11 fields (46%)). No aster yellows was found in the carrots from surveyed fields, which coincided with very low infestation of aster leaf hoppers during the growing season.

Carrot roots from 86% of the fields surveyed showed splitting (growth cracks) which most likely resulted from fluctuating moisture levels during the growing season. Forking of carrots was observed in 97% of the fields surveyed with incidence of 1-36%. The incidence of splitting and forking was higher in carrots surveyed in 2011 than the carrots surveyed in 2010. This increased incidence of splitting and forking in turn may affect marketable yield of fresh market type of carrots.

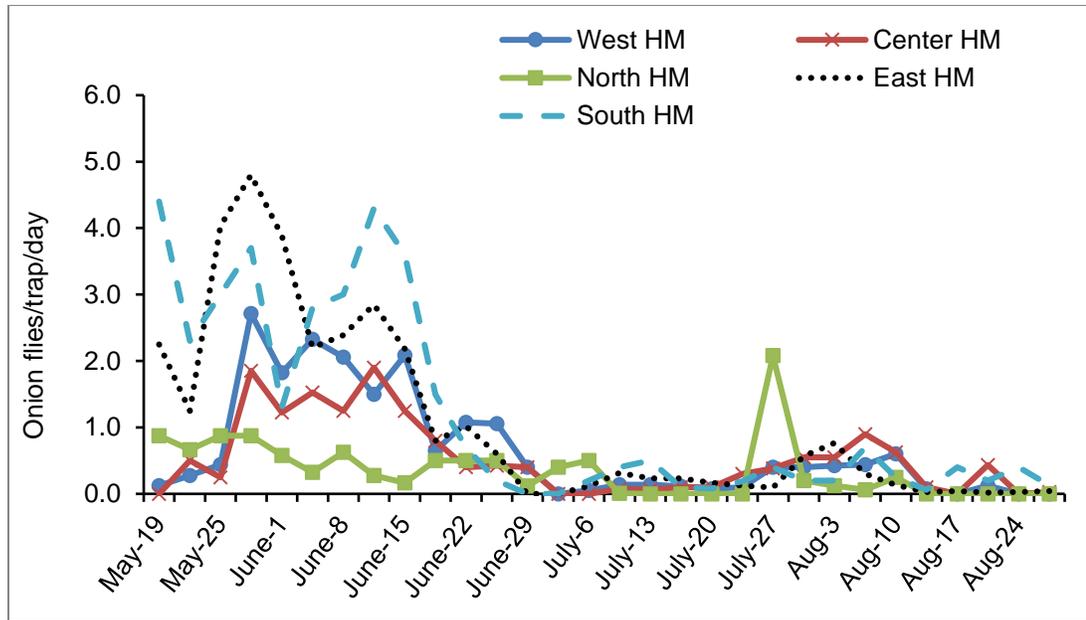
**Table 2.** Disease incidence on carrot samples collected from commercial fields in the Bradford/Holland Marsh, Ontario in 2011.

Disease	Mean incidence (%) (n = 32)	Fields affected
Cavity spot	17.8	32
Pythium root dieback	5.3	32
Crown gall	1.4	15
Crater rot	0.1	3
Fusarium rot	0.03	1
Sclerotinia rot	0.0	0
Aster yellows	0.0	0
Forking	6.2	31
Splitting (Growth cracks)	3.8	28

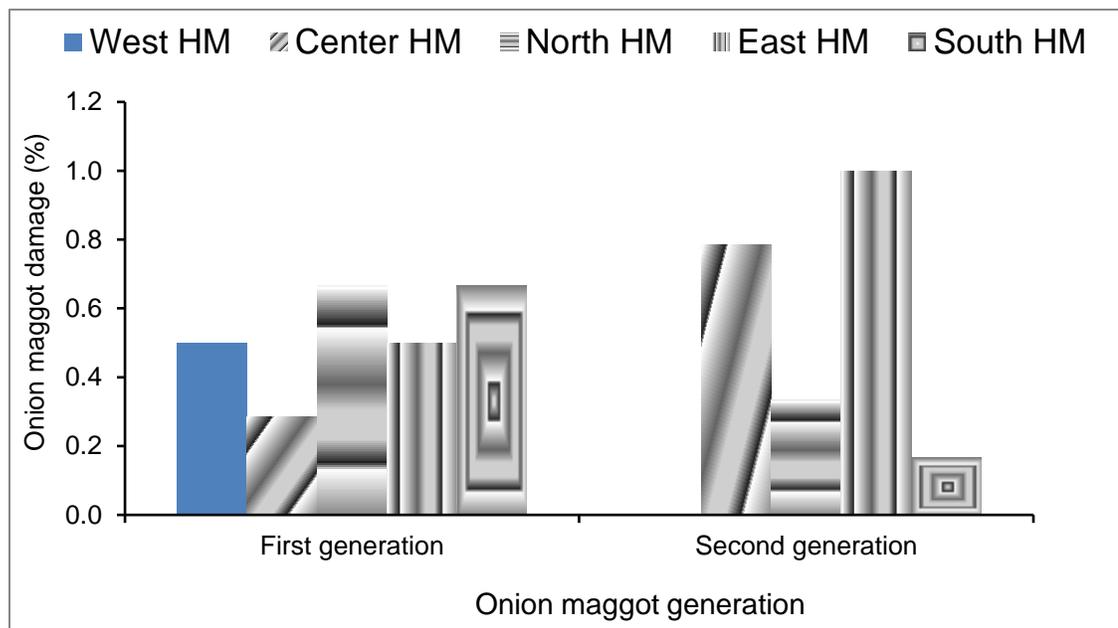
## 4.2. ONION

### 4.2.1. Insects

Onion insect pests mainly scouted for were onion maggot (*Delia antiqua*), onion thrips (*Thrips tabaci*) and cutworms. Predicted emergence of first generation onion flies was 17 May and flies were first trapped on 19 May (Fig. 4). The first generation peak occurred around mid to end of June. The first generation emergence was long and a definitive peak was not seen in 2011. Damage plots of one hundred onion plants were marked out at four sites at each scouted field to assess damage caused by onion maggot. Damage plots were assessed after the first generation peak and at the end of August to determine the overall damage caused by onion maggots. The average onion maggot damage was <1% (Fig 5).

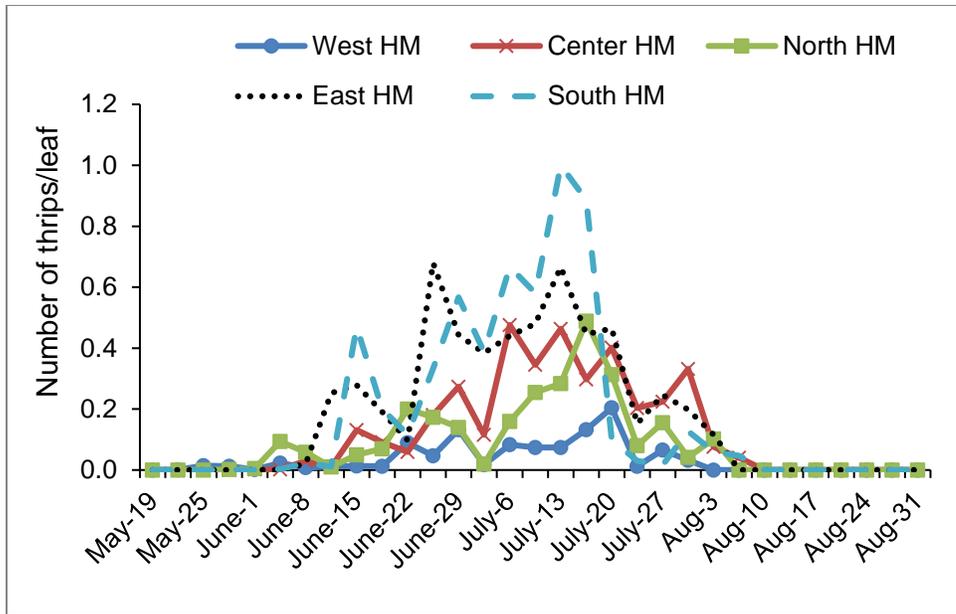


**Fig. 4.** Number of onion maggot flies caught on yellow sticky traps around the Holland Marsh onion fields, 2011.



**Fig. 5.** Percent damage caused by the first and second onion maggot generations around the Holland Marsh, 2011.

White sticky traps were used to determine when onion thrips first entered the fields. After thrips were found, plant counts were used to determine population numbers. Thrips were first found in onion plants in scouted fields on 9 June, 10 days later than in 2010. Several scouted fields reached the threshold of one thrips per leaf in early July (Fig. 6). Thrips thrive in hot, dry conditions and thus the weather condition of the 2011 growing season was favourable for thrips infestation.



**Fig. 6.** Number of onion thrips in onion fields around the Holland Marsh, 2011.

#### 4.2.2. Diseases

Onions were mainly scouted for botrytis leaf blight (*Botrytis squamosa*), downy mildew (*Peronospora destructor*), purple blotch (*Alternaria porri*), white rot (*Sclerotium cepivorum*), pink root (*Phoma terrestris*), stemphylium leaf blight (*Stemphylium vesicarium*) and other diseases. In 2011, stemphylium leaf blight was the main disease that affected onions. Stemphylium leaf blight symptoms are similar to purple blotch and both diseases are managed in the same manner. The incidence and severity of white rot was higher in onion fields in 2011 compared to the 2010 growing season.

The predictive model, DOWNCAST, was used to forecast downy mildew of onions. In 2011, onion downy mildew pressure was very low. DOWNCAST, the onion downy mildew predictive model, predicted a sporulation infection period around mid-July. No downy mildew was found in all onion fields scouted. However, one onion sample with downy mildew was submitted to the diagnostic laboratory around mid-August. The risk of downy mildew remained low to moderate throughout the growing season.

BOTCAST, a disease forecasting program for botrytis leaf blight, was used to predict the severity of *Botrytis squamosa* on onions. The cumulative disease severity index (CDSI) was calculated daily and summed over the season. The CDSI reached 21-30 (the first spray threshold) on 26 June to 10 July. Botrytis leaf blight pressure was low to moderate during the 2011 growing season.

A Rotorod spore trap was implemented to trap and quantify fungal spores of various disease causing pathogens mainly *Botrytis squamosa* (onion leaf blight), *Peronospora destructor* (onion downy mildew) and *Stemphylium vesicarium* (Stemphylium leaf blight of onions). The rotorod trap was set up late during the season (26 August – 21 September) due to technical problems and delayed arrival of the equipment. Between 26 August and 9 September, *B. squamosa*, *P. destructor*, *A. porri* and *S. vesicarium* spores were found on the traps. No spores were found on the traps between 12 and 21 September.

### 4.3. CELERY

#### 4.3.1. Insects

In 2011, the insect pests of celery that were scouted for were carrot weevil (*L. oregonensis*), aster leafhopper (*M. quadrilineatus*), tarnished plant bug (*Lygus lineolaris*), the pea leafminer (*Liriomyza huidobrensis*), and aphids. The degree day models were used to predict the occurrence of different life stages of the carrot weevil, aster leafhopper and tarnished plant bug. The scouting results of carrot weevil and aster leaf hopper were discussed in the carrot crop section. Tarnished plant bugs are pests of celery, lettuce and leafy greens. Using plant inspections, orange sticky traps, and sweep nets, tarnished plant bug

populations were assessed. A few fields reached the damage threshold of six percent around early to mid-August.

Aphids are pests of celery, lettuce and leafy greens. The scouted data were used across both crops, especially if fields were next to each other, for the best assessment of each area in the Holland Marsh throughout the growing season, for extension purposes. Aphid counts remained low throughout the growing season.

#### 4.3.2. Diseases

Celery leaf blights in Ontario are caused by the fungi *Cercospora apii* (early blight) and *Septoria apiicola* (late blight) and the bacteria *Pseudomonas syringae* pv. *apii* (bacterial blight). The threshold for pesticide application is disease presence. The main issue in the 2011 growing season was bacterial blight. No late blight was observed in scouted celery fields. Pink rot (*Sclerotinia sclerotiorum*) incidence remained low throughout the season. Symptoms related to magnesium deficiency were seen in certain celery fields.

### 4.4. LETTUCE

#### 4.4.1. Insects

The insect pests of lettuce that were scouted for in 2011 were aster leafhopper (*M. quadrilineatus*), tarnished plant bug (*L. lineolaris*) and aphids. The degree day model used to predict the occurrence of different life stages of the aster leafhopper and the scouting results were discussed in the carrot crop section. The occurrence of leaf hoppers, tarnished plant bugs and aphids was low in lettuce fields.

#### 4.4.2. Diseases

The diseases of lettuce that were scouted for were downy mildew (*Bremia lactucae*), Sclerotinia drop (*Sclerotinia sclerotiorum* and *S. minor*) and gray mould (*Botrytis cinerea*). BREMCAST, the lettuce downy mildew forecasting model, predicted sporulation infection periods (SIP) during the growing season starting at the end of June and the risk of developing downy mildew remained moderate to high until September. Lettuce downy mildew symptoms started to develop around mid to late July in the Holland Marsh. Downy mildew incidence was low in all scouted fields. Sclerotinia drop, botrytis grey mould and pythium stunt were all first noted around mid-June.

### 5. WEEDS

In 2011, broad leaf, grass and sedge weed pressure differed among fields mainly depending on field location and management practices. In most fields, weeds were controlled during the critical weed free period for each crop. The critical weed-free period for carrots is the first three to six weeks after emergence. The critical weed-free period for celery is the first four to eight weeks after transplanting. The critical weed-free period for lettuce and leafy greens is the first three weeks after transplanting. The critical weed-free period for onions is the entire growing season. Although weeds that emerge after the critical weed-free period may not affect yield, growers usually control weeds after the critical weed-free period to make harvest more efficient and reduce weed problems in subsequent years. Some herbicide resistant redroot pig weed started to appear in few fields. Yellow nutsedge was a problem for a number of growers in all crops around the Holland Marsh.

**Funding for the IPM service was supplied by members of the Holland Marsh Growers' Association, the Agricultural Adaptation Council (AAC), Bradford Co-operative Storage Ltd., Lake Simcoe Region Conservation Authority, Bayer Crop Science, DuPont Canada, BASF, Engage Agro, UAP, Dow AgroScience and Syngenta Crop Protection.**