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TITLE: THE INTEGRATED PEST MANAGEMENT PROGRAM SUMMARY FOR MUCK VEGETABLE CROPS, 2014

An Integrated Pest Management (IPM) program is provided to growers in the Holland/Bradford Marsh, Ontario, by the Muck Crops Research Station (MCRS). This project was funded in part through Growing Forward 2 (GF2), a federal-provincial-territorial initiative. The Agricultural Adaptation Council assists in the delivery of GF2 in Ontario. Funding was also provided in part by the Bradford Cooperative Storage Ltd., agrochemical companies, and growers participating in the Muck Crops Research Station IPM program. The main objectives of the project are: to scout growers' fields for diseases, weeds, and insect pests, to provide growers with disease and insect forecasting information, to identify and diagnose diseases, insect pests and weeds, and to implement roto-rod spore traps to trap and analyze spores of various vegetable crop pathogens.

SCOUTING

In 2014, 79 commercial vegetable fields, totalling 843 acres (onion 378 A., carrot 405 A., and celery 60 A.), were intensively scouted for 27 growers. Fields were scouted twice per week during the growing season and growers received scouting reports after each field survey.

DIAGNOSTICS, EXTENSION & DISSEMINATION OF INFORMATION

Any grower, whether in the IPM program or not, may bring in samples (plant and/or insect) for diagnosis. The 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 Ontario Ministry of Agriculture and Food, and Ministry of Rural Affairs (OMAFRA and MRA) recommendations for pesticides.

From 8 April to 1 December, 2014, the diagnostic laboratory of the MCRS received 229 samples for diagnosis. Of these, 80% were infectious diseases (183 in total) and 20% physiological disorders (46 in total). These samples were associated with the following crops: onion (48.7%), carrot (27.6%), celery (9.5%), lettuce (2.6%), brassicas (2.1%) and other crops (9.5%). Along with plant disease samples, a total of 17 samples of insects or insect damage were assessed and 8 weed samples were identified.

For extension services, data collected from growers' fields and the MCRS research plots were compiled twice per week, analyzed and summarized. The results were compiled in an 'IPM report' and updated twice per week and circulated to participating growers, academia, industry, OMAF and MRA experts, posted on the MCRS web site (www.uoguelph.ca/muckcrop), and a copy was displayed at the Bradford Co-op. During the 2014 growing season, more than 50 phone inquiries and email requests for information concerning plant problems and recommendations were addressed.

PEST PREDICTIVE MODELS

The IPM program provides disease and insect forecasting based on spore traps, disease forecasting models (BOTCAST (for botrytis leaf blight of onion), DOWNCAST (for onion downy mildew), and BREMCAST (for lettuce downy mildew)), degree day models, and insect traps. These disease and insect forecasts alert growers by predicting the potential for disease and insect pest incidence.

CROP PEST SUMMARIES

At the end of the scouting program, carrot samples were collected from each scouted field and assessed for damage from insects (Table 1) and diseases/physiological disorders (Table 2). Similarly, onions were assessed in mid-season and at the end of the scouting program for onion maggot damage and incidence of onion smut.

CARROT

Insects

In 2014, carrot fields were scouted for carrot weevil (*Listronotus oregonensis*), carrot rust fly (*Psila rosae*), aster leafhopper (*Macrosteles quadrilineatus*) and other insect pests. Degree day models were used to predict the occurrence of different life stages of these insects.

Table 1. Average percent carrot rust fly and carrot weevil damage on carrots at harvest in scouted fields around in and around the Holland Marsh, 2014.

Location	% Damaged Carrots	
	Weevil damage	Rust fly damage
West HM	0.7	0.7
South HM	2.0	1.9
Central HM	4.6	0.9
North HM	3.7	0.3
East HM	1.6	0.3
Bradford & surrounding area	0.0	0.0
Average	2.6	0.9

Carrot weevil adults were first found in wooden traps on 20 May in carrot fields. The threshold of 1.5 or more weevils/trap was reached by the end of May in most fields. The second spray threshold of 5 weevils was reached in most areas by the first week of June (Figure 1).

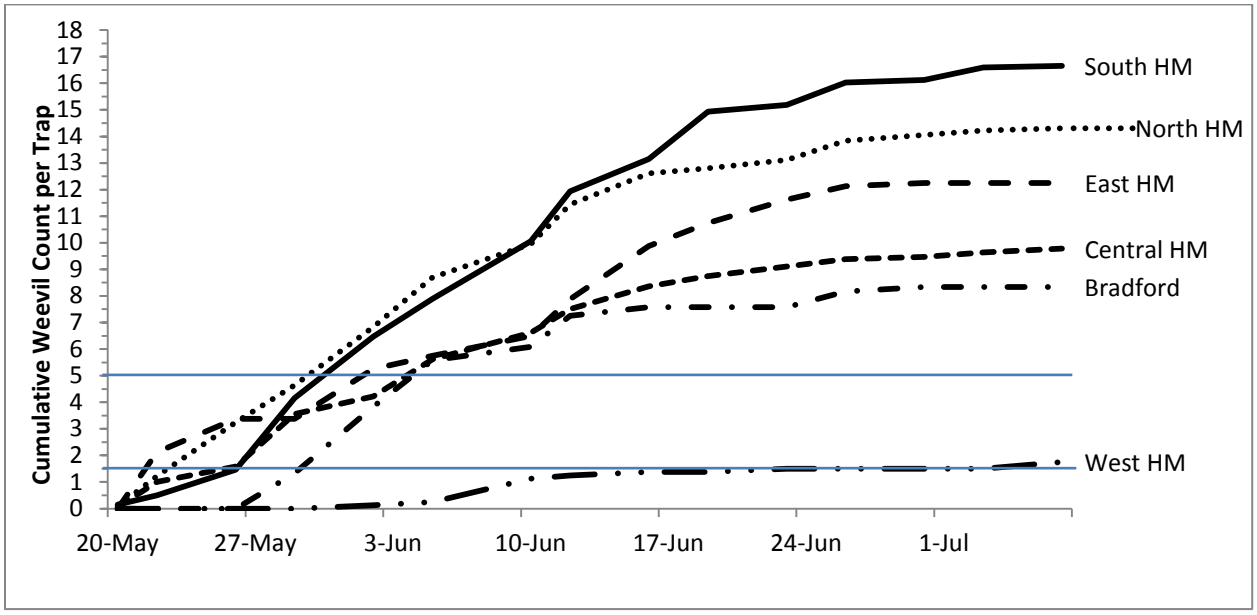

Figure 1. Cumulative number of carrot weevils/ trap averaged over different areas of the Holland Marsh, 2014.

The cumulative weevil/trap counts for the Holland Marsh have been increasing the past number of years. In 2010 and 2011 the first spray threshold was not reached until mid-end of June on average. From 2012-2014 the first spray threshold was reached before the end of May. The second spray threshold was reached 7-10 days later in 2012 and 2013 (Figure 2).

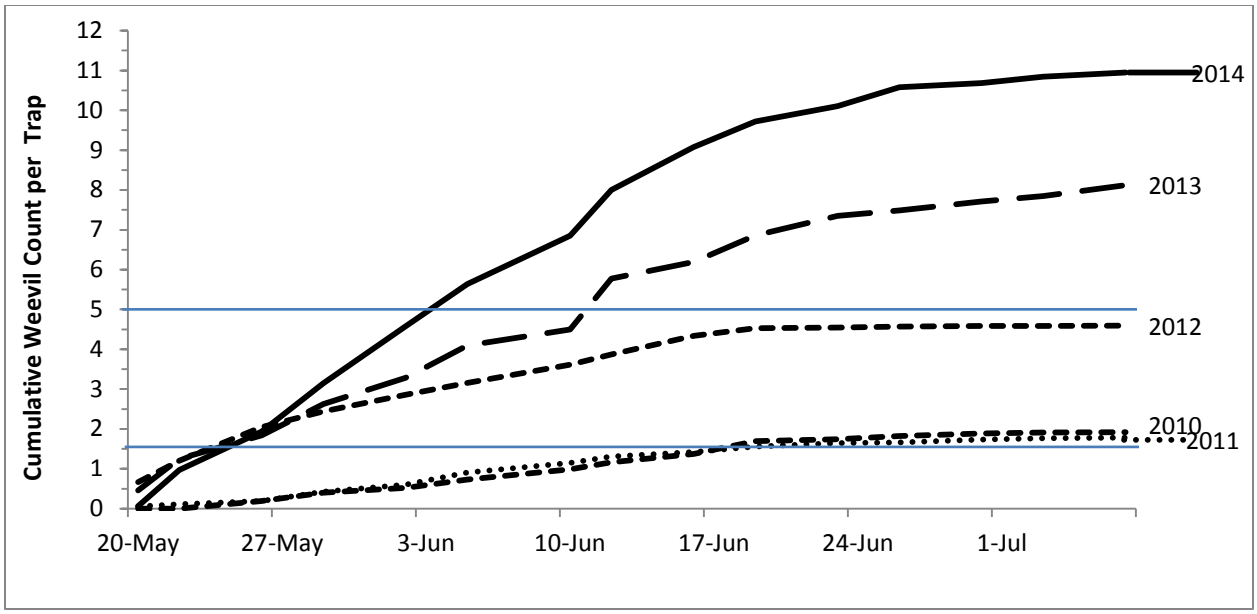

Figure 2. Cumulative number of carrot weevils/ trap averaged over the last five years in the Holland Marsh, 2014.

Orange sticky traps and degree day models were used to monitor and estimate carrot rust fly and aster leafhopper numbers. Carrot rust flies were first found on sticky traps on 29 May, which was 5 days after the degree day model predicted emergence, and 1 week earlier than the 2013 growing season. The spray threshold for fresh market carrots (0.1 flies/trap/day) was reached by the second week of June (Figure 3). Generally weevil and carrot rust fly damage was higher than the 2013 growing season.

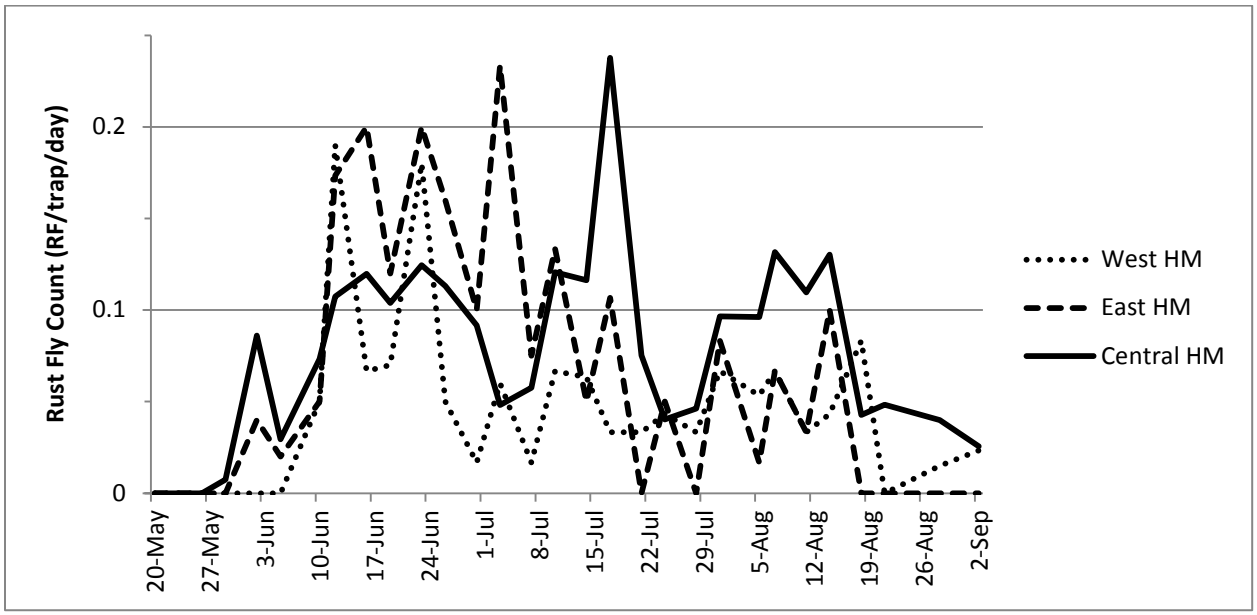

Figure 3. Carrot rust flies/trap/day counts from fields averaged over different areas of the Holland Marsh, 2014.

Aster leafhoppers are pests of carrots, celery, lettuce and leafy greens. Aster leafhopper adults were first found on orange sticky traps by the middle of June in carrots and celery. In 2014, aster leafhopper counts and aster yellows (the disease caused by the infestation) was low compared to previous years.

Diseases

Carrot fields were scouted for the main carrot diseases found around the Holland Marsh. Leaf blight, which is caused by the fungi *Alternaria dauci* and *Cercospora carotae*, was first seen by the middle of July and certain fields reached the spray threshold within 7-10 days.

Weather conditions in the 2014 growing season were conducive for most pathogens including *Pythium*, *Sclerotinia* and *Rhizoctonia*. There was above average rainfall in April, June, and September, average temperatures from April to September and below average temperatures in July. This led to adequate soil moisture throughout the growing season and in turn created ideal conditions for soil borne pathogens, particularly *Pythium* and *Rhizoctonia* spp., resulting in a high incidence of cavity spot, pythium root dieback and crater rot.

All the surveyed fields had cavity spot (*Pythium* spp.) with incidence ranging from 5 to 45% and all fields had pythium root dieback (*Pythium* spp.) with incidences from 1-15%. Crater rot (*Rhizoctonia carotae*) was found in 31 of the 35 carrot fields surveyed with incidence ranging from 1 to 17 %. In 2014, 3% of the surveyed fields had aster yellows, which was low compared to the 2013 and 2012 growing seasons where of the surveyed carrot fields, 19% and 64% had aster yellows respectively.

Carrots in 16 (46%) of the 35 fields sampled had crown gall (*Agrobacterium tumefaciens*) with disease incidence ranging from 1 to 20%. Sclerotinia rot (*Sclerotinia sclerotiorum*) was observed in carrot fields throughout the Holland/Bradford Marsh during the growing season. During the assessment Sclerotinia rot was found on carrots from 9 sampled fields with incidence from 1 to 19%. Fusarium rot (*Fusarium* spp.) was found on carrots from one surveyed field with an incidence of 2%.

Of the 35 surveyed carrot fields, 23 fields (66%) showed splitting (growth cracks) from 1 to 8% incidence, and forking was observed in 33 fields (94%) with incidence ranging from 1 to 15 %.

Table 2. Disease incidence on carrot samples collected from commercial fields in the Holland/Bradford Marsh, Ontario in 2014.

Disease	Pathogen	Mean incidence (%) (n = 35)	Fields affected
Cavity spot	*Pythium* spp.	19.3	35
Pythium root dieback	*Pythium* spp.	5.3	35
Crater rot	*Rhizoctonia carotae*	5.4	31
Crown gall	*Agrobacterium tumefaciens*	4.3	16
Sclerotinia rot	*Sclerotinia sclerotiorum*	4.6	9
Fusarium rot	*Fusarium* spp.	2.0	1
Aster yellows	*Phytoplasma*	1.0	1
Splitting (Growth cracks)	--	2.3	23
Forking	--	5.2	33

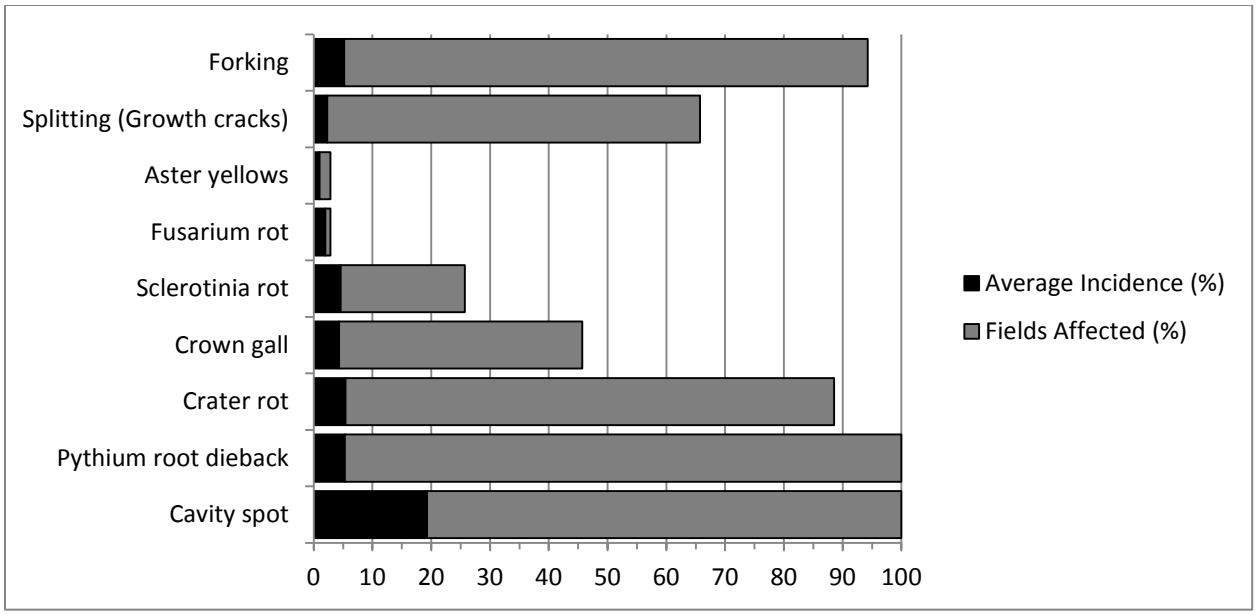

Figure 4. Disease incidence on carrot samples collected from commercial fields in the Holland/Bradford Marsh, 2014.

ONION

Insects

Onion fields were scouted for onion maggot (*Delia antiqua*), onion thrips (*Thrips tabaci*), cutworms and other insect pests. Damage plots were assessed for onion maggot damage and smut incidence after the first and second onion maggot generation peaks. The average onion maggot damage was 1.6 - 2.3% (first generation) and 0.7 – 1.3% (second maggot generation). The degree day threshold for emergence of first generation onion flies was reached on May 15. The first onion flies were found on May 20 and we reached the first generation peak by the first week of July (Figure 5).

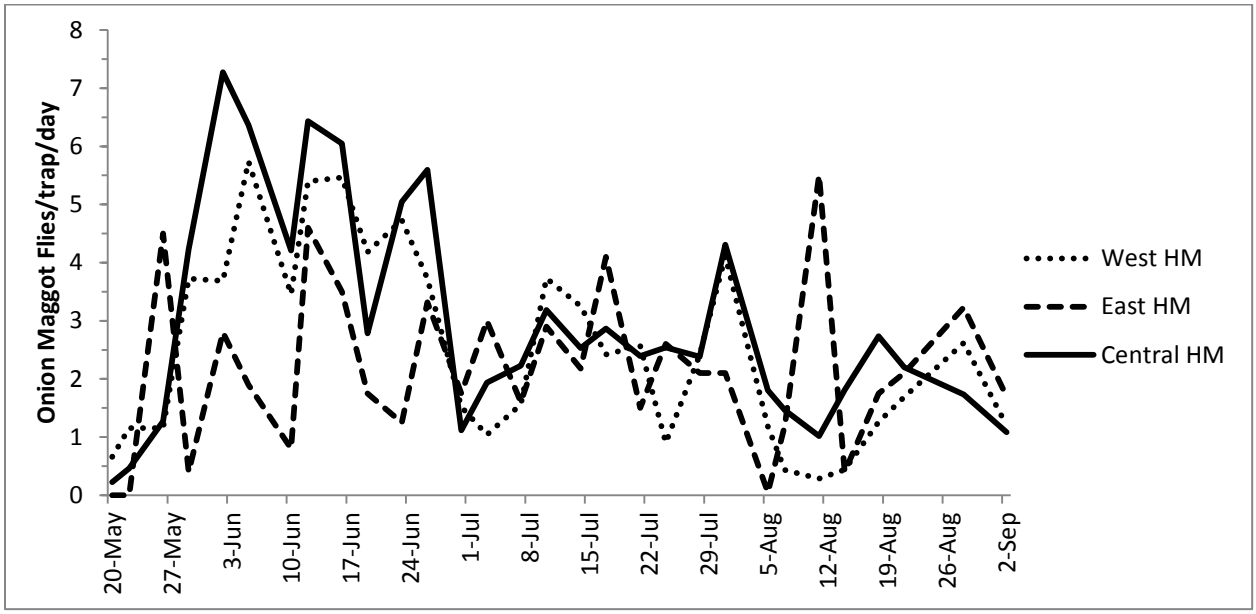

Figure 5. Onion fly/trap/day counts from fields averaged over different areas of the Holland Marsh, 2014.

Compared to the 2013 growing season, thrips infestation in the 2014 growing season was low. Thrips were first found in onion plants in scouted fields on 23 June, a week and a half later than in 2013, and a month later than 2012. Only one scouted field reached the 1 thrips/leaf spray threshold in mid-July while a few more fields reached threshold in early-August.

Diseases

Onions were 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.

The main disease on onions in 2014 was onion white rot. By August, 35% of scouted fields were found to have onion white rot. Some fields had up to 50% losses at harvest. White rot incidence has been low the past few years but was high in 2014 due to conducive spring weather conditions.

Onion downy mildew (*Perenospora destructor*) spores were first detected on 28 July. Symptoms of onion downy mildew were first found in onion fields on 14 August, 14 days after the initial spores were found. By 21 August, downy mildew symptoms were found in 30% of all scouted fields. Spore trapping and disease forecasting provided valuable forecasting information to predict the risk of onion downy mildew in 2014 (Figure 6).

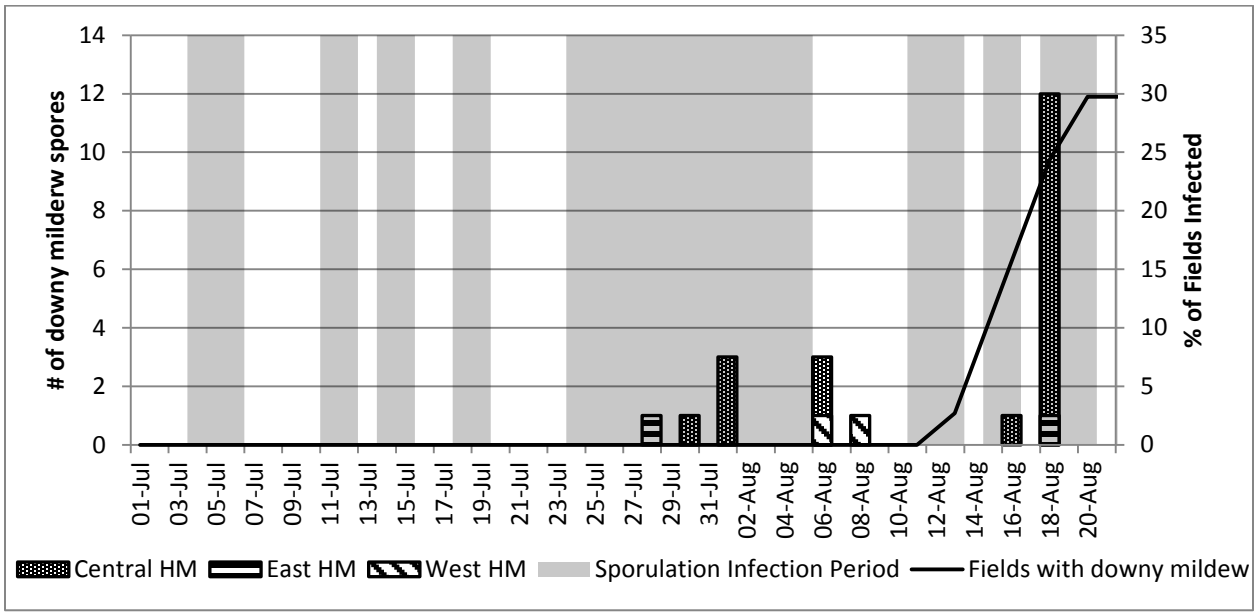

Figure 6. Onion downy mildew summary for the 2014 growing season. Shaded areas represent sporulation infection periods (SIP) as calculated by the disease forecasting model DOWNCAST. The bars represent the number of DM spores found on roto-rod spores traps at 3 different areas of the Holland Marsh. The line represents the percent of scouted fields infected with onion downy mildew.

Spores of *Botrytis* spp., *Stemphylium vesicarium, Alternaria* spp., *Perosnospora destructor*, and *Fusarium* spp. were detected with the roto-rod spore traps during the growing season. Stemphylium spores were first found on 2 July. Smut incidence was observed in most of the scouted fields with a mean incidence of 0.25 to 4%.

Spores of *Botrytis* spp. were first found on 23 June (Figure 7). Botrytis leaf blight symptoms were first found in growers' fields on 7 July. On 5 August, 37% of scouted fields had botrytis leaf blight symptoms. Only one field reached the 1 lesion/leaf spray threshold at the end of July.

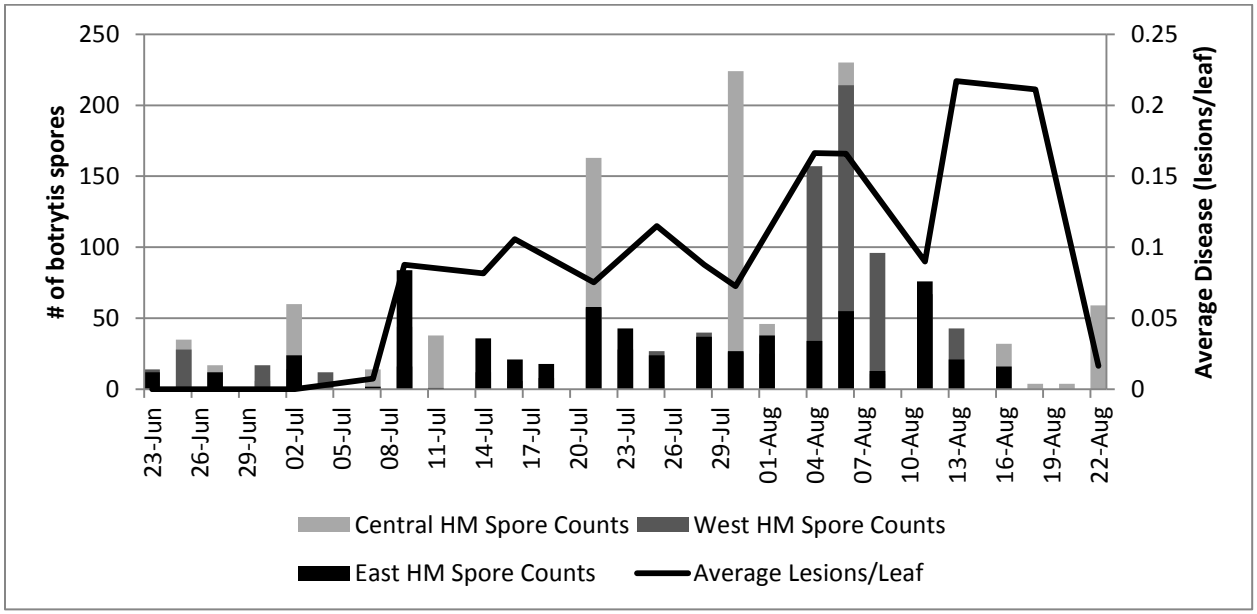

Figure 7. Botrytis leaf blight summary for the 2014 growing season. The bars represent the number of botrytis spores found on roto-rod spore traps at 3 different areas of the Holland Marsh. The line represents the average lesions/leaf of all scouted fields.

CELERY

Insects

In 2014, celery fields were scouted for carrot weevil, aster leafhopper, tarnished plant bug (*Lygus lineolaris*), pea leafminer (*Liriomyza huidobrensis)*, and aphids. Insect traps and degree day models were used to predict the occurrence of the various life stages of carrot weevil, aster leafhopper and tarnished plant bug. Tarnished plant bug pressure was lower than the 2013 growing season. No scouted fields reached the tarnished plant bug per plant threshold or the damage threshold of 6% at any point during the growing season. The scouting results of carrot weevil and aster leafhopper were as discussed in the carrot crop section. Aphid, carrot weevil, and leafminer infestations remained low throughout the growing season.

Diseases

Celery leaf curl or celery anthracnose (*Colletotrichum acutatum*), is a relatively new disease of celery and was first seen around the Marsh in the 2013 growing season. Celery leaf curl was found in almost all celery fields this past season. Incidence was still relatively low but higher than the 2013 growing season. It will be important to monitor the spread of this disease since there are no registered fungicides in Ontario as of yet.

Celery leaf blights in Ontario are caused by the fungi *Cercospora apii* (early blight) and *Septoria apiicola* (late blight) and the bacteria *Pseudomanas syringae* pv. *apii* (bacterial blight). Bacterial leaf blight and bacterial rot was found in most celery fields and incidence was higher than 2013.

Incidence of early blight and late blight was observed in most scouted fields but remained low throughout the season compared to previous years. Pink rot (*Sclerotinia sclerotiorum*) was found in a number of celery fields and incidence was higher than previous years due to milder wet weather.

LETTUCE

Diseases

BREMCAST, the lettuce downy mildew forecasting model, predicted sporulation infection periods (SIP) during the growing season starting on 11 July. The risk of developing downy mildew remained moderate to high until September. Downy mildew on lettuce was confirmed at the end of July. Sporulation infection periods were predicted for 9 straight days from 18 August – 26 August so conditions were very favourable for disease spread.

WEEDS

In 2014, 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. Some herbicide resistance redroot pig weed and yellow nutsedge were also problems for growers in all crops around the Holland Marsh.

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