AUTHORS: VAN DYK D & MCDONALD MR
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: THE INTEGRATED PEST MANAGEMENT PROGRAM SUMMARY FOR MUCK VEGETABLE CROPS, 2015

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 2015, 71 commercial vegetable fields, totalling 757 acres (onion 328 A., carrot 333 A., celery 74 A., potato 12 A., and beet 10 A.), were intensively scouted for 28 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 are visual inspection and laboratory inspection using a microscope and culturing. Diagnoses are 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 Rural Affairs (OMAFRA) recommendations for pesticides.

From 11 May to 6 October, 2015, the diagnostic laboratory of the MCRS received 225 samples for diagnosis. Of these, 81% were infectious diseases (183 in total) and 19% physiological disorders (42 in total). These samples were associated with the following crops: onion (35.5%), carrot (32.9%), celery (15.5%), lettuce (2.2%), brassicas (1.8%) and other crops (12.0%). Along with plant disease samples, a total of 20 samples of insects or insect damage were assessed and 5 weed samples 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, OMAFRA experts, posted on the MCRS web site (www.uoguelph.ca/muckcrop), and a copy was displayed at the Bradford Co-op.

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 at mid-season and at the end of the scouting program for onion maggot damage and incidence of onion smut.

CARROT

Insects

In 2015, 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, 2015.

Location	% Damaged Carrots	
	Weevil damage	Rust fly damage
West HM	1.3	0.3
South HM	3.0	0.3
Central HM	6.6	1.0
North HM	7.3	0.3
East HM	0	0.5
Bradford & surrounding area	1.0	0
Average	4.3	0.4

Carrot weevil adults were first found in wooden traps on 22 May in carrot fields. The threshold of 1.5 or more weevils/trap was reached by 30 May in south, central, and north regions of the Holland Marsh. In the south, central and north regions of the Holland Marsh the 5 weevil/trap threshold was reached one week later on 5 June (Figure 1).

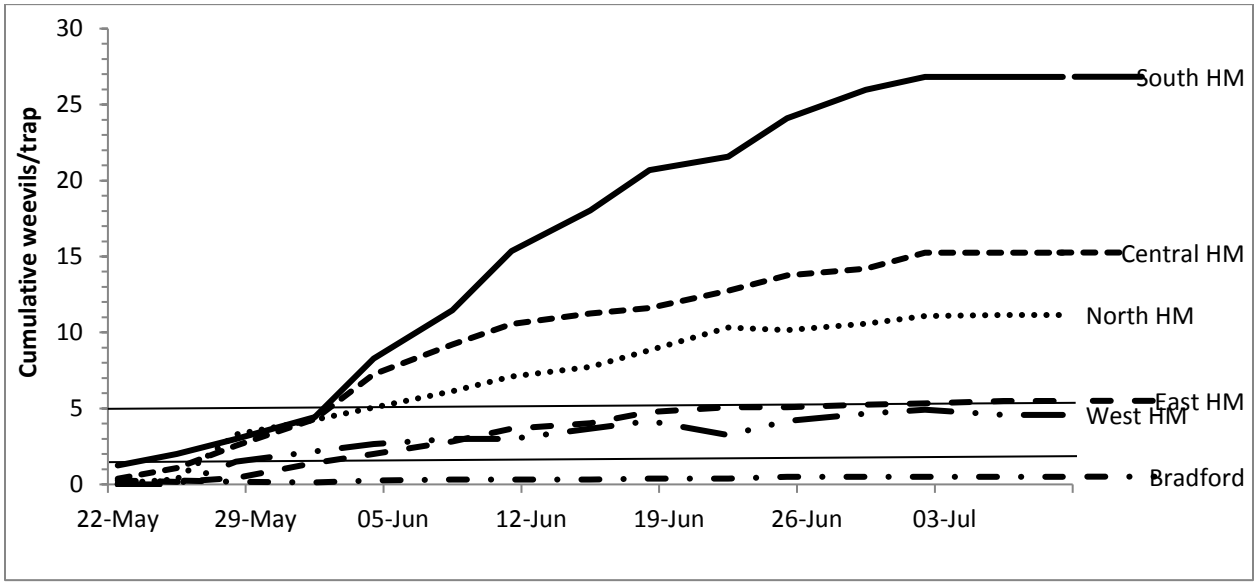

Figure 1. Cumulative number of carrot weevils/ trap averaged over different areas of the Holland Marsh, 2015.

Carrot weevil counts around the Holland Marsh have been increasing since 2010. The first and second spray thresholds are now being reached in most areas by the beginning of June, almost 2 weeks earlier than just 2 years ago in 2013. This increase in counts has been accompanied by an increase in carrot weevil damage seen around the Holland Marsh (Figure 2). There was almost a 2% increase in carrot weevil damage in 2015 compared to 2014.

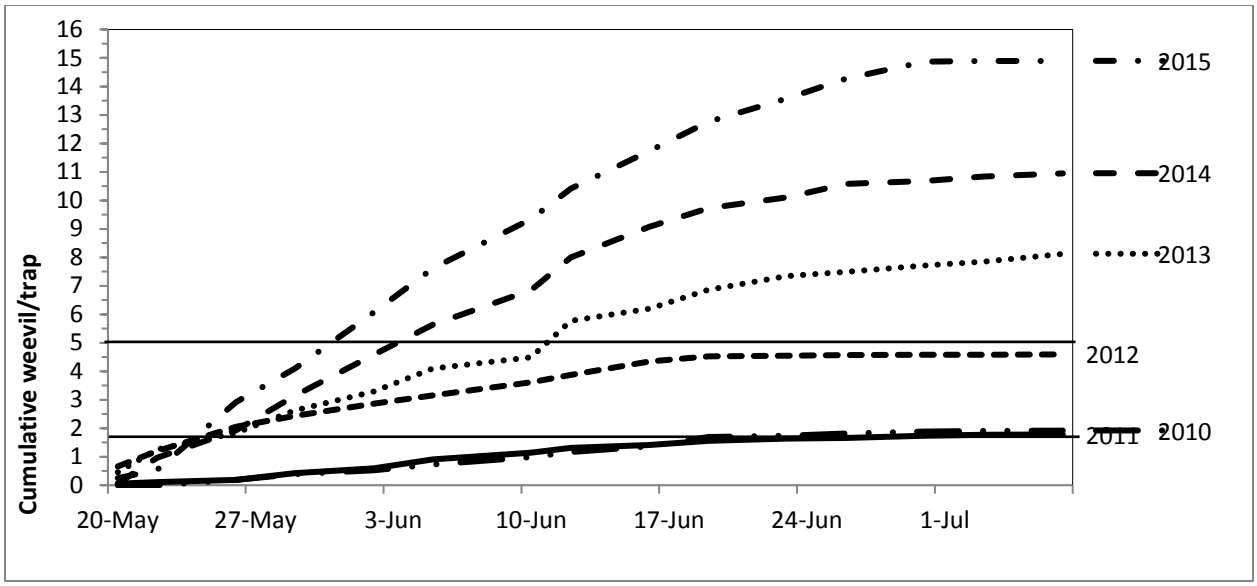

Figure 2. Cumulative numbers of carrot weevils/ trap averaged over the past five years in the Holland Marsh, 2010-2015.

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 28 May, which was 5-7 days after the degree day model predicted emergence. The spray threshold for fresh market carrots (0.1 flies/trap/day) was reached by the 11 June (Figure 3).

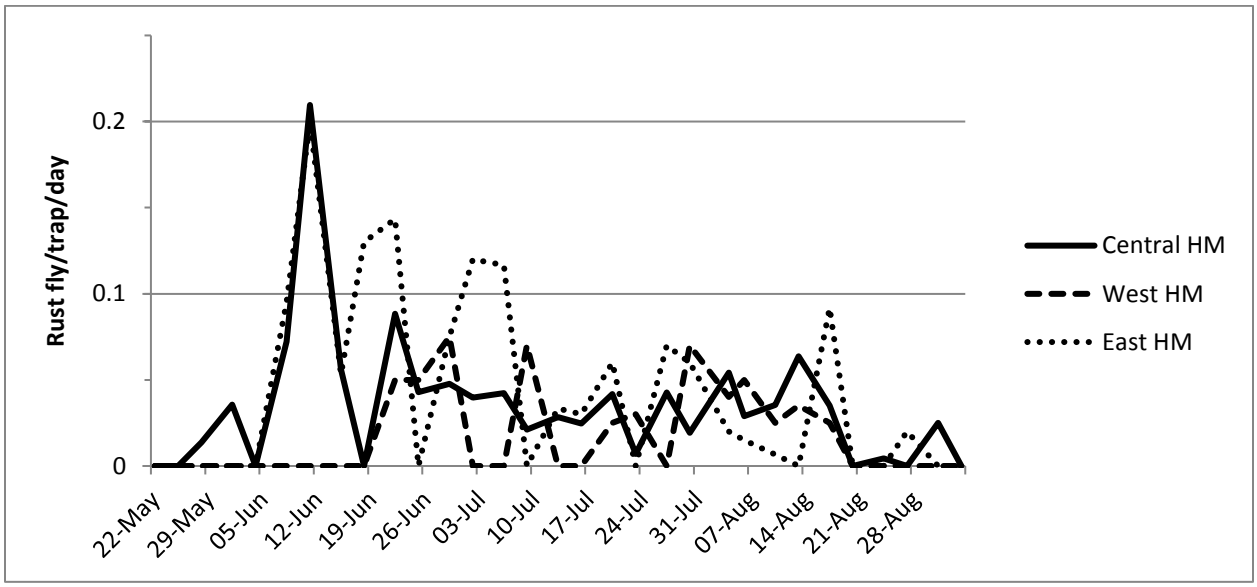

Figure 3. Carrot rust flies/trap/day counts from fields averaged over different areas of the Holland Marsh, 2015.

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 29 June but no field reached the spray threshold until 20 July.

Rainfall in 2015 was below average in May, July, September and October with above average rainfall for June. This excess of rainfall in June combined with below average June temperatures were conducive for soil-borne pathogens including *Pythium* and *Rhizoctonia*. This adequate soil moisture most likely contributed to high incidence of cavity spot and Pythium root dieback.

All the surveyed fields had cavity spot (*Pythium* spp.) with incidence ranging from 3 to 22% and 25 out of 26 fields had pythium root dieback (*Pythium* spp.) with incidences from 0 to 41%. Crater rot (*Rhizoctonia carotae*) was found in 19 of 26 carrot fields surveyed with incidence ranging from 0 to 13%. Carrots in 14 (53%) of the 26 fields sampled had crown gall (*Agrobacterium tumefaciens*) with disease incidence ranging from 0 to 41%. 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 6 sampled fields with incidence from 0 to 14%. Fusarium rot (*Fusarium* spp.) was found on carrots from two surveyed fields with an incidence of 1%. In 2015, none of the surveyed fields had aster yellows.

Of the 26 surveyed carrot fields, 15 fields (57%) showed splitting (growth cracks) from 0 to 6% incidence, and forking was observed in 20 fields (77%) with incidence ranging from 0 to 7 %.

Table 2. Disease incidence on carrot samples collected from commercial fields in the Holland/Bradford Marsh, Ontario in 2015.

Disease	Pathogen	Mean incidence (%) (n = 26)	Fields affected (n = 26)
Cavity spot	*Pythium* spp.	10.6	26
Pythium root dieback	*Pythium* spp.	12.6	25
Crater rot	*Rhizoctonia carotae*	3.8	19
Crown gall	*Agrobacterium tumefaciens*	3.2	14
Sclerotinia rot	*Sclerotinia sclerotiorum*	1.9	6
Fusarium rot	*Fusarium* spp.	0.1	2
Aster yellows	*Phytoplasma*	0.0	0
Splitting (Growth cracks)	--	2.2	15
Forking	--	1.4	20

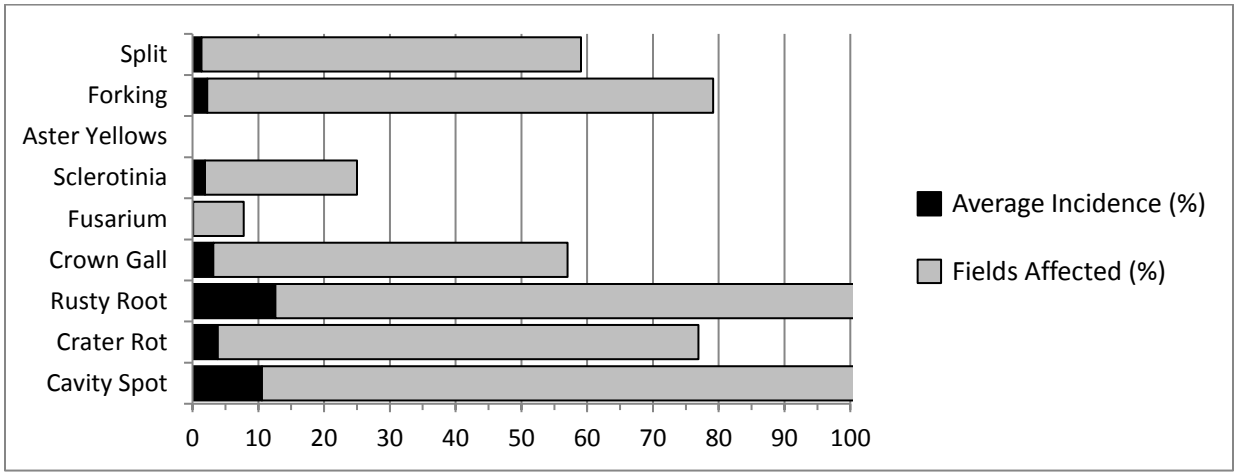

Figure 4. Disease incidence on carrot samples collected from commercial fields in the Holland/Bradford Marsh, 2015.

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 onion maggot generation peak. The average 1st generation onion maggot damage ranged from 0 - 40% (first generation) with an average of 6.5%. The degree day threshold for emergence of first generation onion flies was reached on May 10. The first onion flies were found on May 22 and we reached the first generation peak by June 12 (Figure 5).

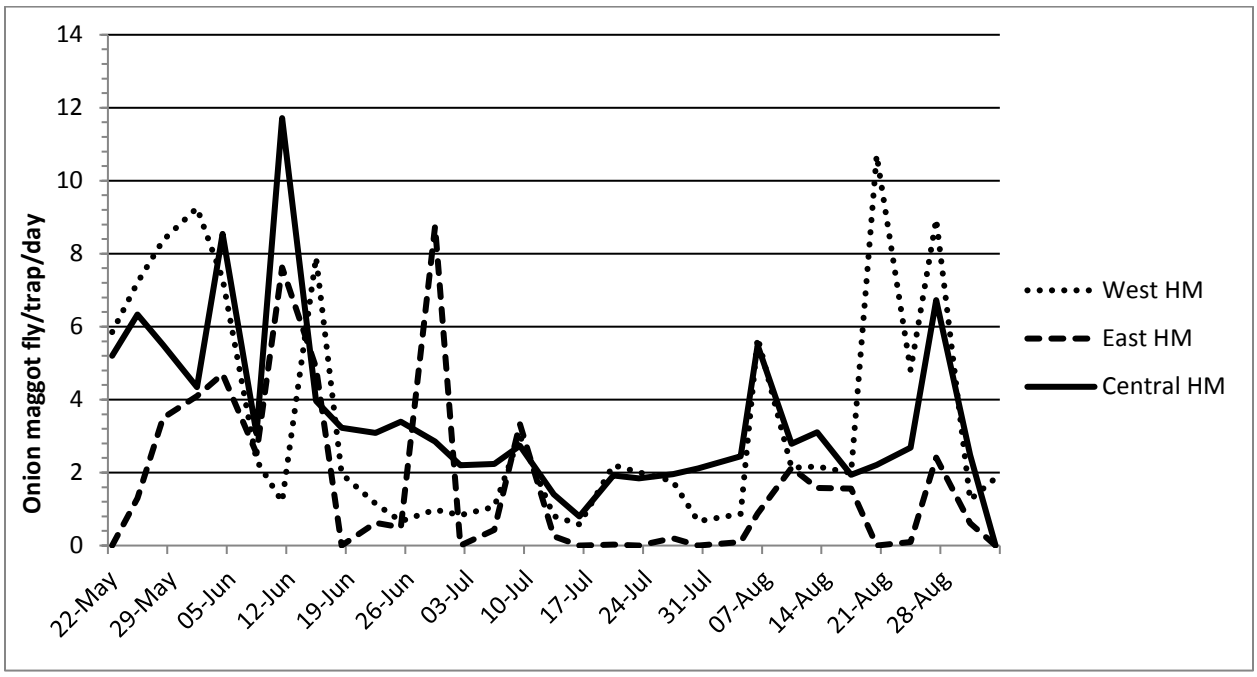

Figure 5. Onion fly/trap/day counts from fields averaged over different areas of the Holland Marsh, 2015.

Compared to the 2014 growing season, thrips infestation was higher in 2015 but not as severe as in 2012. Thrips were first found in one scouted field on 1 June, but were not found in a second field until 22 June. Two fields first reached the 1 thrips/leaf spray threshold on 13 July, with 6 fields above threshold by the end of August.

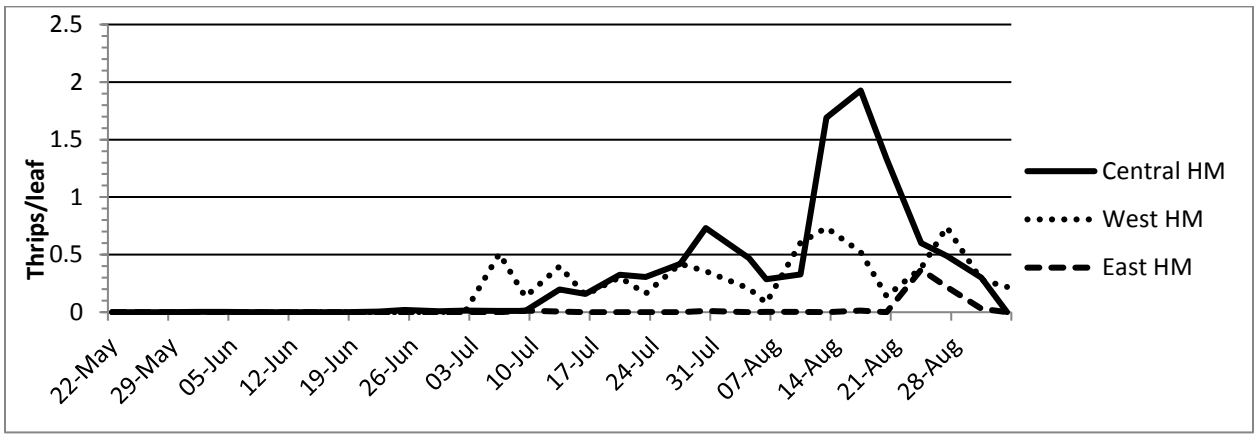

Figure 6. Thrips counts from scouted fields

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 diseases on onions in 2015 were stemphylium leaf blight and downy mildew. Of all scouted onion fields, 29 out of 31 (94%) had stemphylium leaf blight. Spores of *Stemphylium* were first found on 24 June and the first symptoms of stemphylium leaf blight were confirmed on 25 June, the earliest the disease has been found in the Holland Marsh. Stemphylium spores can be spread by rainfall so the high amount of precipitation in June may have led to the early emergence of this disease. Purple blotch was first found on onions on 29 June and by 20 July 68% of scouted onion fields had purple blotch symptoms. By the end of the season, all 31 onion fields had purple blotch.

Onion downy mildew (*Perenospora destructor*) spores were first detected on 3 July. Symptoms of onion downy mildew were first found in onion fields on 20 July, 17 days after the initial spores were found. By 13 August, downy mildew symptoms were found in 39% of all scouted fields. In total, 21 out of 31 (68%) scouted onion fields had downy mildew symptoms present. Consistent with results found in 2014, spore trapping accurately predicted the first emergence of downy mildew symptoms two weeks after initial spores were seen (Figure 7).

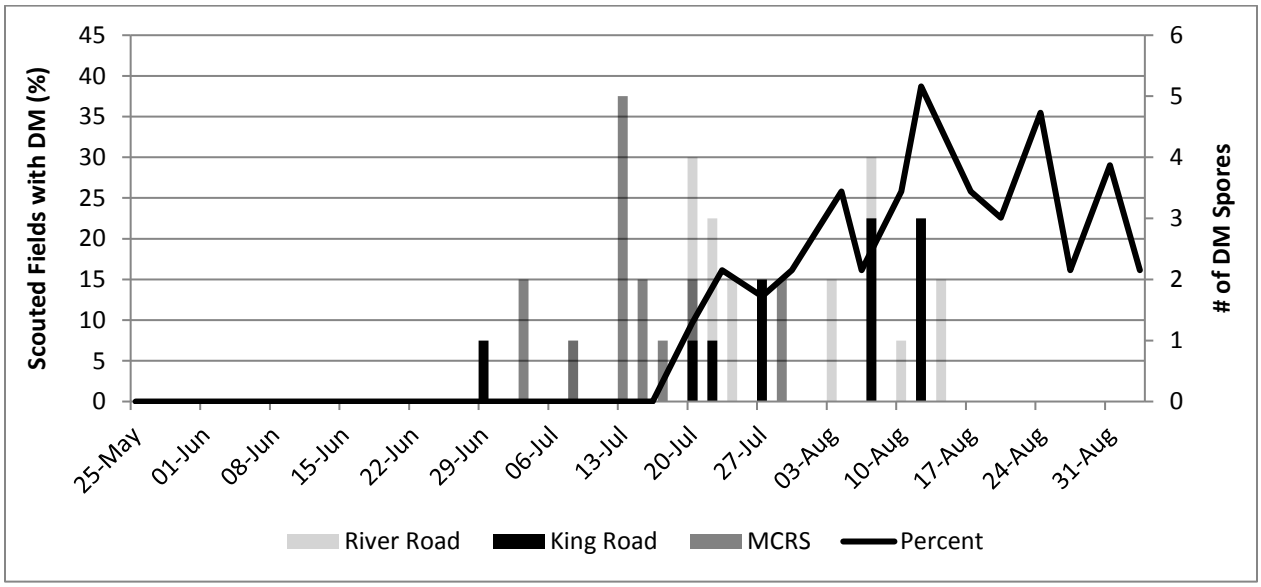

Figure 7. Onion downy mildew summary for the 2015 growing season. The bars represent the number of downy mildew spores found on roto-rod spore traps at 3 different areas of the Holland Marsh. The line represents the percent of scouted onion fields with symptoms of downy mildew present.

Onion white rot was only found in 3 scouted onion fields in 2015, and was significantly less of an issue than in 2014.

Spores of *Botrytis* spp. were first found on 24 June (Figure 7). Botrytis leaf blight symptoms were first found in growers' fields on 9 July. Only one field reached the 1 lesion/leaf spray threshold by the end of August. (Figure 8).

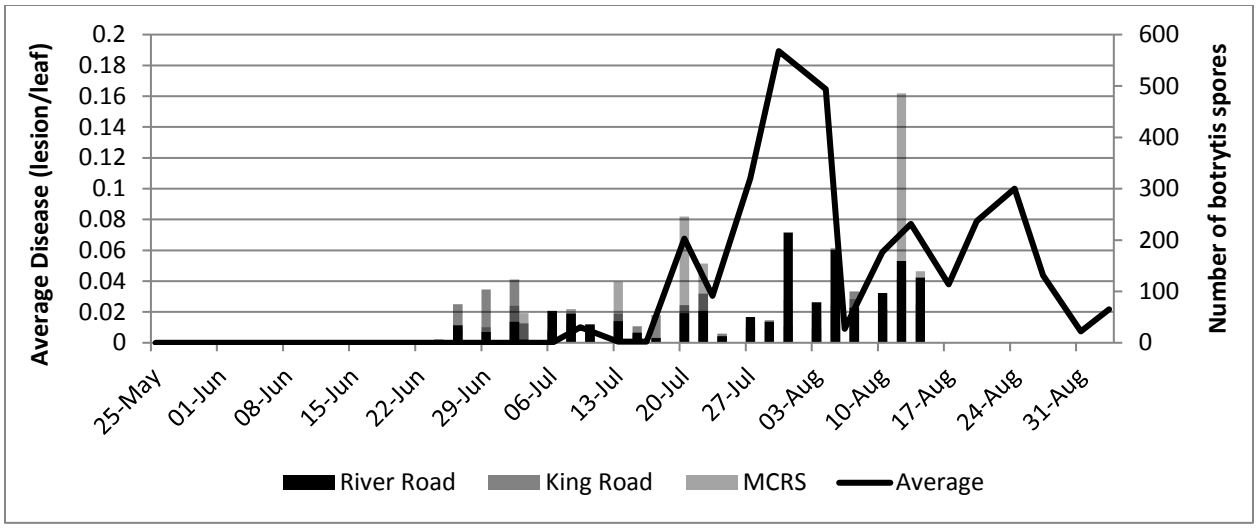

Figure 8. Botrytis leaf blight summary for the 2015 growing season. The bars represent the number of botrytis spores found on roto-rod spore traps at 3 different areas of the Holland Marsh. The line represents the average lesions/leaf of all scouted fields.

CELERY

Insects

In 2015, 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 low to moderate in 2015 with 3 out of 7 fields showing some tarnished plant bug damage. Only one field reached the spray threshold for tarnished plant bug in 2015. Carrot weevil damage on celery was seen in one celery field in August but no damage was reported in other fields. Aphids were present and over the spray threshold in 1 out of 7 scouted celery fields in 2015. No leafminer damage was reported in the 2015 growing season.

Diseases

Celery leaf curl or celery anthracnose (*Colletotrichum fioriniae*), is a relatively new disease threatening celery production in Ontario. Celery leaf curl was found in all seven scouted celery fields this past season. Incidence ranged from 1-5% with some patches of 100% incidence. Celery leaf blights in Ontario are caused by the fungi *Cercospora apii* (early blight) and *Septoria apiicola* (late blight) and by the bacteria *Pseudomanas syringae* pv. *apii* (bacterial blight). Incidence of early blight and late blight was observed in 2 of 7 scouted celery fields. Pink rot (*Sclerotinia sclerotiorum*) was found in some areas but incidence was low in 2015. Bacterial leaf blight and bacterial rot incidence was lower than the 2014 season.

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 for the IPM program was also provided by the Bradford Co-operative Storage Ltd., growers participated in the program, Bayer Crop Science, E.I. DuPont Canada, BASF, Engage Agro, UAP, Syngenta Crop Protection and Dow AgroScience.