Colorado potato beetle insecticide resistance management during warmer than normal temperatures

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When I write extension articles about Colorado potato beetles, I mainly focus on insecticide resistance management. Here I will deviate a bit and consider some temperature related issues that may explain the unusually high beetle pressure many growers are seeing in their fields this year. However temperature and insecticide resistance are related, as I explain later.

During this growing season I heard from many vegetable growers with complaints about higher than normal insect pest pressure in many different crops. I also heard numerous reports of ticks being very abundant. Across the board increases in insect abundance can be the result of warmer than normal winter temperatures leading to high overwintering insect survival. Are winter temperatures changing? In recent years, fewer areas experience extreme cold winter temperatures and 2020 had the Earth's hottest recorded January average temperature. Here in Michigan, we also saw warmer than normal temperatures. Statewide, daily lows and highs for December 2019-March 2020 were 5ºF above-normal (Table 1; Midwest Regional Climate Center).

Table 1. Average temperatures in Michigan Dec. 2019-March 2020 and comparison to historic average (normal).

Month	Average Temp. (ºF)	Normal (ºF)
December	28.4	24.9
January	27	19.7
February	23.6	22.1
March	35	31

What does this mean for overwintering success of Colorado potato beetle? All insects-including Colorado potato beetle depend completely on ambient temperature for their development and survival during overwintering. Entomologists have discovered that overwintering beetles survive better when soil temperatures stay around 32ºF and that beetles tend to remain in the top 10 inches of soil if winter temperatures are warmer*, instead of having to expend energy to dig deeper. Sudden cold exposures, during for example a polar vortex, can drastically decrease overwintering beetle numbers. So, this past winter's warm temperatures may have been conducive to high overwintering success. This means plenty of beetles emerging in spring to cause issues.

Ground cover is important because it impacts soil temperatures. Survival of hibernating Colorado potato beetles were significantly increased when snow or mulch covers were on the soil surface. When mulch was removed from areas where beetles were overwintering, their mortality was increased, simulating the lack of snow insulation. Unfortunately using mulched trap crops to aggregate overwintering beetles in an area did not work, because beetles moved away from these areas to overwinter elsewhere*. However, any fluctuations or reductions in winter temperatures that drop temperature in the soil layers where overwintering beetles are located is going to contribute to reducing beetle emergence in the spring. Removing soil cover during the winter can help drop temperatures in the soil.

The other issue is that as I'm writing this article and looking up the MSU Enviroweather website, most of Michigan is 7-14 days ahead of normal in heat accumulation. So not only did we just experience some of the warmest winter

temperatures, but it was followed by a warmer than normal growing season, so far. We are about 100-300 degree days (base 50ºF) ahead of normal, with Colorado potato beetles needing about 700 degree days to complete a generation. As of July 28, the accumulated degree days, base 52ºF which is the temperature above which Colorado potato beetles can develop, is 1334 degree days. There can be 2-3 generations of beetles per year with 2 generations in Michigan in 'normal' years. Will this year see a complete third generation? The most important signal for Colorado potato beetles to start overwintering is daylength, so the shortening daylight will lead to beetles going into overwintering in August. However there may be populations of beetles that are able to complete a third generation, especially in southern Michigan.

Insecticide resistance and warm temperatures are related in several ways:

- Insecticide resistance and heat tolerance can be cross-resistant, this happens when these two share underlying genetics and can help insects to survive both stresses;
- Overwintering insects that experience stable, warmer than normal winter temperatures will come out of hibernation with a stronger immune system that can combat the toxin in insecticides more effectively;
- Shorter generation times and higher numbers of insects due to warm temperatures can speed up the selection for resistant insects;
- Insecticides efficacy is lower due a change in the rate of break-down of chemicals, this exposes insects to sub-lethal doses thus speeding the development of resistant populations;
- On the flip side, we know of instances when insects are more susceptible to insecticides in higher than normal temperatures because they can't handle the two stresses as well.

Currently, it is unclear which of these mechanisms are present in Colorado potato beetles, but it is likely that at least some of these apply to them. Therefore proper insecticide resistance management is ever more important in years like 2020.

Colorado potato beetles are notorious for developing insecticide resistance; therefore their management should follow appropriate guidelines to stop or slow this process. The most common way to manage beetles currently in commercial potatoes is to apply neonicotinoid insecticides (imidacloprid or thiamethoxam) in-furrow, at planting. In some cases this treatment provides sufficient control for overwintered beetles.

For the management of summer beetles (these typically emerge in July in many parts of Michigan), foliar insecticides are used. In order to slow down the development of resistance in Colorado potato beetles, it is recommended that insecticide classes are rotated, meaning that insecticides with the same mode of action are not applied to Colorado potato beetles twice within a season. All of the insecticides in Table 2 are non-neonicotinoid type, so they are good options for foliar beetle management if a neonicotinoid insecticide was applied at planting.

The National Potato Council prepared the following guidelines for Colorado potato beetle insecticide resistance management; for details click here.

Manage Colorado potato beetle insecticide resistance in the following ways:

• If a neonicotinoid insecticide (Group 4A) was applied at planting, either in furrow

or as a seed treatment, do not use a foliar neonicotinoid insecticide later in the season.

- Crop rotation with a minimum of ¼ of a mile between successive plantings is especially important for management of Colorado potato beetle.
- Apply insecticides only when necessary.
- Use scouting, sampling procedures and action thresholds.
- Preserve natural controls by using selective insecticides when possible (i.e.: Rimon)
- Spot treat when feasible (e.g. field edges). This can also be done by using a *potato trap crop* (untreated potatoes that are planted in field margins earlier than the main crop) and therefore will harbor large numbers of early emerging beetles that can be killed on the trap crop.
- Do not apply insecticides below labeled or recommended rates. Application of sub-lethal rates of any insecticide may result in poor product performance, insect damage to the crop and an increased risk of resistance development.

Table 2. Some foliar insecticide options for **Colorado potato beetle** management if an at-planting, in-furrow neonicotinoid insecticide (imidacloprid or thiamethoxam, Group 4A) was used. To look up labels for these and other insecticides please search in the CDMS database.

Group	Brand name	Chemical name	Rate per acre	PHI	Days between applications	Maximum use per season	Maximum number of applications
3 & 28	Voliam Xpress	lambda-cyhalothrin + chlorantraniliprole	6.0-9.0 fl oz	14 days	7 days	27 fl oz	3
5	Radiant SC	spinetoram	4.5-8.0 fl oz	7 days	7 days	16 fl oz	2
5	Blackhawk	spinosad	1.7-3.3 oz	3 days	7 days	14.4 oz	4
6	Agri-Mek 0.15 EC	abamectin	8.0-16.0 fl oz	14 days	7 days	32 fl oz	2
15	Rimon[1]	novaluron	6.0-12.0 fl oz	14 days	7 days	24 fl oz	2
28	Coragen	chlorantraniliprole	3.5-5.0 fl oz	14 days	5 days	10 fl oz	2
28	Exirel	cyantraniliprole	5-13.5fl oz	7 days	5 days	27 fl oz	2
21A	Torac	tolfenpyrad	14-21 fl oz	14 days	14 days	42 fl oz	2

[1] only effective on larvae, time application around 50% egg hatch or when small larvae are most abundant

For a more on potato insect management from MSU Vegetable Entomology, click here.

*Milner, M., Kung, K-J.S., Wyman, J.A., Feldman, J., Nordheim, E. (1992) Enhancing overwintering mortality of Colorado potato beetle (Coleoptera: Chrysomelidae) by manipulating the temperature of its diapause habitat. J. Econ. Entomol. 85(5): 1701-1708.