TIMING OF SLUG EMERGENCE IN NEW PERENNIAL RYEGRASS PLANTINGS

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Introduction

Studies conducted from 2014 to 2017 detected moderately stable spatial patterns in emergence of gray field slugs (*Deroceras reticulatum*) over a total of 15 sites newly planted to perennial ryegrass, along with some damage to crop stands. Grower-applied slug baits (metaldehyde or iron-based products) provided sufficient control for all stands to be rated as being successfully established, although multiple applications of bait were needed in some cases and variation in stand uniformity was linked to slug numbers. This was especially so in cases where moderately high numbers (10 or more slugs per blanket) were present within the first 3 weeks after perennial ryegrass germination. The series of single-year analyses (Mueller-Warrant et al., 2015, 2016, 2017) left unresolved several important questions regarding the impact of weather on slug emergence patterns and the possibility of reliably predicting slug emergence in future years.

Materials and Methods

Raw data from tests conducted in the autumns of 2014, 2015, 2016, and 2017 were reanalyzed to quantify relationships between weather patterns and timing of slug emergence. Variables included in regression models included gravimetric moisture of (surface) 2-inch-deep soil samples taken at each individual sampling site on each date, corresponding counts of slugs found underneath "slug blankets" the following mornings, and various data from OSU's Hyslop Research Farm weather station, including daily precipitation, temperature, and evaporation over the summer.

Because slug counts late in the fall might be influenced by cumulative effectiveness of the slug bait applications made by growers and the naturally reduced activity of slugs in colder weather, regression analyses were restricted to the period from planting of perennial ryegrass through peak emergence of slugs. Regressions were conducted across various combinations of sites and years to identify those cases that could be safely grouped together, with the major reason for exclusion of two sites being their status as no-till plantings into old stands of white clover rather than conventional-till plantings following other crops. Because of wide variation in slug density between tests, slug counts at individual sites were expressed as a percentage of the maximum number found in any plot on any date over the whole season at a given site.

Results and Discussion

Our first question was, "What type of relationship existed between soil moisture and slug emergence?" Wetter falls saw slugs emerge over longer periods of time and at broader ranges in surface soil moisture content. Drier falls saw slugs emerge in narrower windows of time and more restricted ranges in surface soil moisture content. In order to accurately quantify this relationship, both the surface and subsurface environments had to be considered. After prolonged dry spells in late summer through early fall, both the deeper soil (depth of 1 foot or more) and the surface soil had to be moist if slugs that had survived the summer as eggs or juveniles were to appear on the surface and damage seedling crops. Our initial examination of the data suggested that thresholds existed somewhere around 30% surface soil moisture before slugs appeared in damaging numbers, but the critical level varied among sites and years, sometimes being as low as 24% or as high as 36%. It was also quite common for an individual slug blanket to have zero slugs even at calendar dates and soil moisture levels with damaging numbers of slugs (about 10) in other plots.

A multisite/multiyear composite model describing slug counts in terms of surface soil moisture and total August–September precipitation was developed that matched the data as well as separate regressions for each individual site-year once the two no-till-into-clover fields were excluded, along with one site in 2017 with almost no slugs (Figure 1). The fields with no-till plantings into clover had high numbers of slugs even at relatively low surface soil moistures early in the fall, unlike all other sites.

Nearly identical patterns were present for 2015 and 2017, the 2 years with the highest amounts of August–September rainfall (2.34 and 2.11 inches). In contrast, there was only 0.82 inch of August–September rainfall in 2016, producing a slug emergence curve that didn't start until soil moisture reached 23% but was higher than the other 3 years, the result of a shorter window in time over which the slugs were present (or equivalently, a later start to their appearance on the soil surface).

Coefficients for this regression were 20.083 for the intercept, -13.981 and 3.254 for linear and quadratic August–September rainfall, and -0.9902, 0.05637, and -0.00065 for linear, quadratic, and cubic surface soil moisture content. The curve for 2014 (August–September rainfall totaled 1.56 inches) spanned the entire range of soil moisture content displayed in the graph, with only slightly higher predicted slug counts for a given soil moisture than in 2015 and 2017.

Given the nuisance involved in measuring surface soil moisture content, the possibility of using weather data to predict soil moisture content was explored. The best model used rainfall in the 10 days prior to sampling and potential evaporation for the preceding 120 days (Figure 2). Predicted soil moisture more closely matched observed soil moisture when separate regressions were run for each year than when using a single model over all 4 years (R-square values of 0.797 versus 0.512). More elaborate methods for converting rainfall, temperature, and type of vegetation/ground cover into estimates for soil moisture exist in programs such as the Soil and Water Assessment Tool (SWAT). The coefficients from the 4-year model (41.535 for the intercept, 2.3961 for prior 10-day rainfall, and -0.7054 for 120-day evaporation) could be alternatives to directly measuring surface soil moisture, with the caveat that moisture is likely to be overestimated in the driest soils. Fortunately, slugs are unwilling to emerge to damaging numbers in relatively dry soils, and the model should satisfactorily predict soil moisture from 25% upwards, the range at which slugs become a concern in Figure 1.

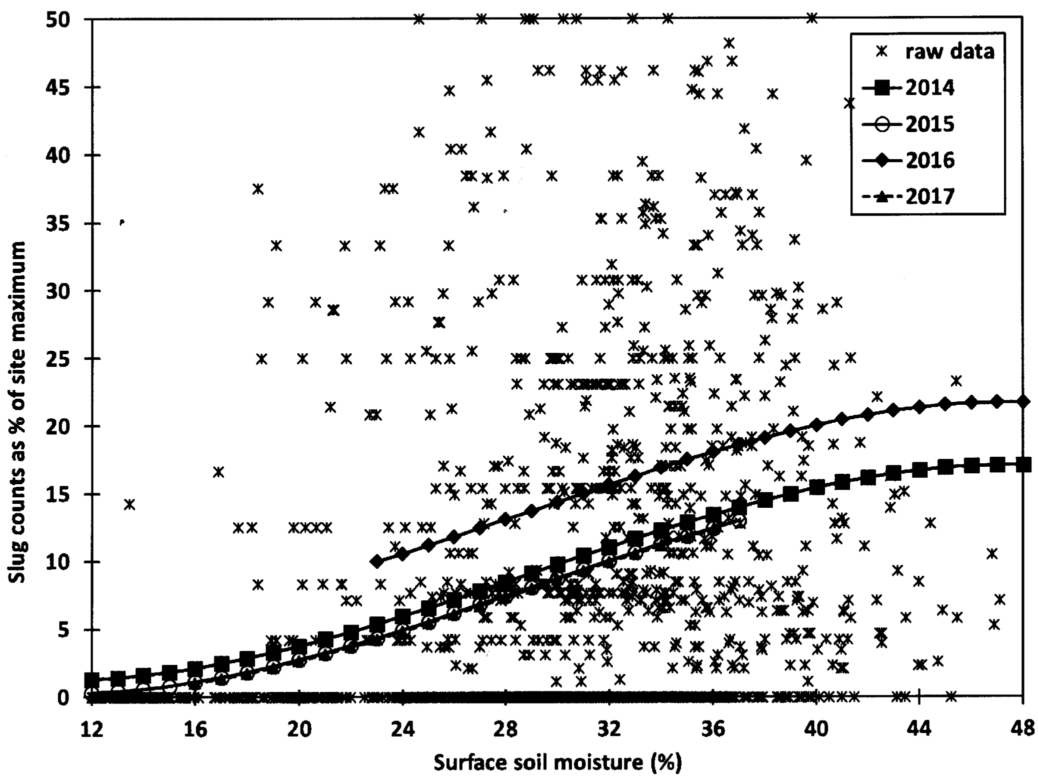

Figure 1. Slug counts over 12 site-years as a function of surface soil moisture content and August–September rainfall totals (1.56, 2.34, 0.82, and 2.11 inches in 2014, 2015, 2016, and 2017, respectively).

References

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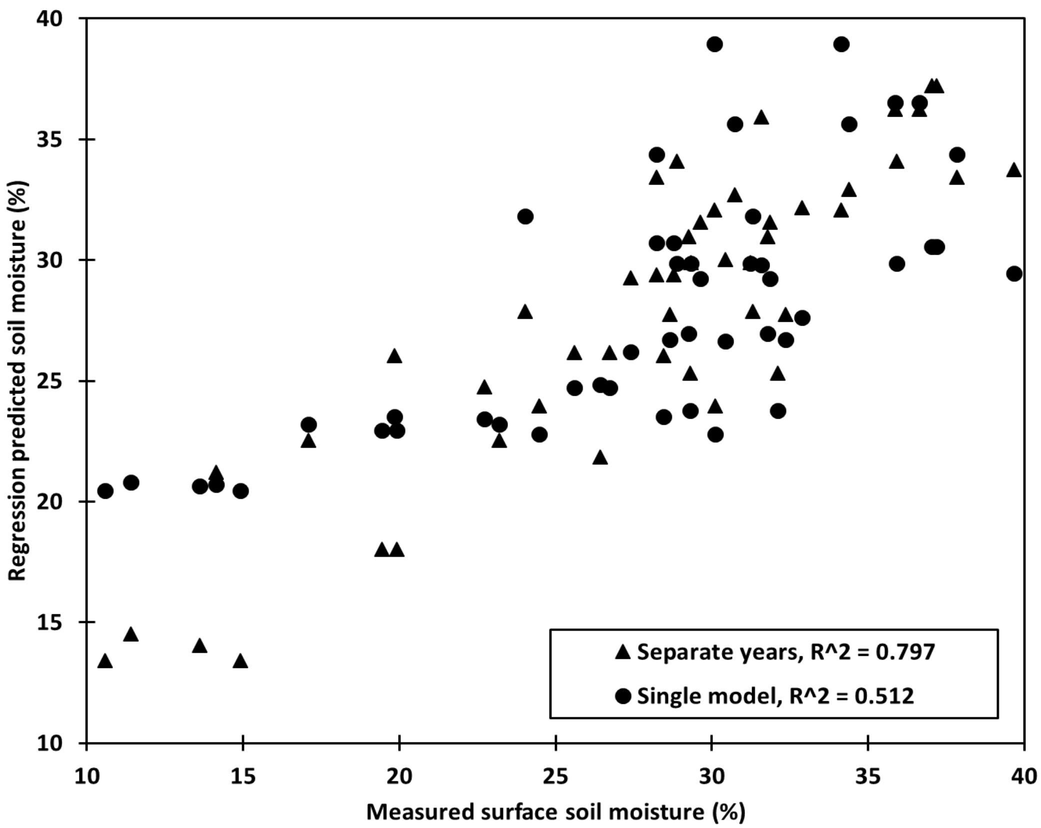

Figure 2. Predicted versus measured surface soil moisture using 10-day prior rainfall and 120-day prior evaporation.