Identifying Potato Varieties with Increased Levels of Mature Plant Resistance to Potato Virus Y for Improved Organic Seed Potato Production

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Potato is one of the most economically important crops in the world. Wisconsin hosts the second most organic farmers in the United States behind only California. Potato Virus Y (PVY) (Fig. 1 and Fig.2) has been recognized as the top one disease in seed potato production and this viral disease can be vectored by more than 40 species of aphids in a non-persistent manner. Foliar applications of highly refined mineral oils seems to be the only action organic growers can take during the growing season to prevent aphid transmission, but is not as effective or efficient as desired.

Mature plant resistance (MPR) is a phenomenon which has long been observed in potato and other crops, yet is not a well-defined concept. It describes a reduction in disease incidence occurring as a result of aphid inoculations that occur later in the crop season which coincides with the time when the majority of aphids are migrating into potato fields. Funded by Ceres Trust, our goal has been to investigate mature plant resistance in selected varieties of potato against infection by Potato Virus Y and generate valuable information about the level of MPR in these tested varieties. Organic growers can be benefit from our outcome to adjust their management plans by incorporating varieties that possess this phenotypic attribute and by avoiding other varieties which appear to possess no MPR.

In Brief:

Potato Virus Y poses more challenges to organic farmers to produce clean seeds and limited strategies are available in the tool box. Mature plant resistance has been investigated in other crops and should be considered as a valuable trait when selecting varieties and improving management plan. However, to date, response of potato varieties to PVY at different developing stages on organically grown potatoes has not been investigated. Our goal with this project is to identify varieties with mature plant resistance to PVY in organic production systems.





Figure 1: Typical mosaic symptom on Figure 2: Leaf dropping at plant bottom Potato foliage caused by PVY due to PVY infection

Project Objectives

To investigate the effects of different inoculation times on disease incidence of Potato Virus Y among potato varieties under organic field production.

Aim 1: To evaluate potato varieties against disease incidence of Potato Virus Y in early and late development stages.

Potato Virus Y has reemerged to be the major problem of conventional seed potato production and the targeted disease which seed certification programs have made all efforts to eliminate from seed lots. However there are no specific certification standards for organic seed potato production yet. All organic seeds have to be both certified as organic and go through the conventional seed certification process mandated by the state of origin. Previously, researchers have conducted field experiments to reveal the phenomenon described as mature plant resistance in potatoes. But most of the studies were done in Europe and none of the currently and widely planted potato varieties in the US have been screened under conventional or organic farming systems. Due to the fact that aphids migrate into potato fields later in the growing season (late July to early August), our intent was to understand if MPR could be exploited. Our goal is to artificially inoculate PVY into selected potato varieties under organic field conditions and test for the disease incidence in different growing stages. That information can greatly enhance our understanding of MPR in organic seed potato production.

Aim 2: To further investigate the occurrence of Mature Plant Resistance in selected varieties through serial inoculations imposed later in the growing season.

All of the MPR studies on potato were performed decades ago and none of them have been conducted under organic conditions or with currently sought after seed varieties. We need to specify the exact time/period of occurrence over which this MPR occurs on tested varieties and the information we generate will be useful for growers to improve their management plan. Therefore, we set up multiple inoculation times in post flowering stages of crop development in commercially important varieties and attempted to determine the trajectory of disease reduction trends over time. In that way, the results can be better utilized by growers when compared with aphid flight activity obtained from the North Central Region, Aphid Suction Trap Network (http://www.ncipmc.org/traps/).

Conclusion

Potato virus Y is currently the most important problem in seed potato production. Especially in the context of organic potato production, there are limited strategies available in our tool box for disease reduction. Here we reported a phenomenon/trait, termed Mature Plant Resistance (MPR), which was observed in certain varieties: Significantly increased levels of MPR was observed in YKG against both strains, in SLR particularly against the strain O and again in DRN against strain O. Overall we observed a reduced incidence in all investigated varieties, with the exception of RNK. We can conclude that as plant developmentally age in the field, the susceptibility to PVY infection in the variety RNK would remain constant under organic production conditions. The remaining varieties tested were observed to have enhanced resistance to PVY in later season.

Given the results from experiment II, we were unable to conclude that there was a discrete developmental stage in this variety YKG after which PVY would not move to developing tubers and experimental errors caused by efficiency of inoculation and sub-sampling problem may result in low disease incidence of preflowering inoculation. In variety SLR, the level of MPR against the strain O would start to enhance at first post-flowering inoculation point through post-flowering stages. Though an increase in disease incidence during post-flowering, the overall trends of disease incidence were decreasing. All first three inoculation times in YKG were statistically similar in disease incidence. In cultivar SLR and all post-flowering inoculation times, were the incidence significantly different from pre-flowering inoculations. This result agreed with conclusion on SLR of experiment I.

Under field conditions and in an organic farming system, most varieties demonstrated some form of MPR. In the YKG variety in particular, an increased level of MPR against O and N:O was observed among the experimental intervals (e.g. inoculation times). It is our hope that these results can provide an improved guidance to growers in making variety selections and disease management decisions with respect to the phenomenon of mature plant resistance.

Most of the tubers sized in the category 6-10 ounces either in count or weight. DRN has the lowest total weight compared to other three varieties (Fig. 5). No significant difference in weights among inoculation times was observed (Fig. 5). However the yield data was taken from the field inoculation trial, but does not reflect the effect of inoculation time on yield when those tubers were used as seeds. This again indicated that current season infection of PVY does not affect yield in the same season dramatically.

Further study under greenhouse environment on mature plant resistance is currently ongoing and these include two different varieties DRN and RNK.