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PREVENTION OF SEED PIECE DECAY OF PORATO USING LEAVES AND TREE ASHES

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ABSTRACT

Potato (*Solanum tuberosum* L.) is one of the world's favorite root vegetable. Virus and bacteria contamination in a potato breeding program can seriously disrupt the variety development process. Much potato propagation involves taking cuttings from a germ potato. Cut the germ potatoes into 4 equal pieces with a sterilized knife. The cut potatoes were covered with ash (0%, 25%, 50%, 75%, and 100%). The potatoes were planted in agriculture fields in April and harvested in July. When cut potatoes were completely covered with ash, 3.5% showed *Potato leaf roll virus* (PLRV) infection. When cut potatoes were completely covered with ash (100%), 1.2% showed *Potato virus Y* (PVY) infection. 1.6% showed bacterial soft rot infection, and 1.4% showed bacterial wilt infection. Ash contains about 1.5 percent phosphorus and 7 percent potassium, two essential nutrients for plant growth. Using ash in this study may reduce the infection of some bacteria.

KEYWORDS: Potato, *Potato leaf roll virus* (PLRV), *Potato virus Y* (PVY), virus contamination.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the world's favorite root vegetable, a member of the nightshade family *Solanaceae*, it originated in South America and has been grown in Europe since the 16th century.[1] They are the swollen portion of the underground stem which is called a tuber and is designed to provide food for the green leafy portion of the plant. If allowed to flower and fruit, the potato plant will bear an inedible fruit resembling a tomato (USDA, unknown).

Much potato propagation involves taking cuttings from a germ potato. Namely, potato grow through the eyes of the severed stem (the underground stem known as a tube). These tubers develop nodes, commonly called potato eyes, from which shoots and roots emerge, creating new plants. Potatoes have an invasion of pathogens from the cut. Plant viruses are among the smallest plant pathogens, but can cause loss of yield and quality in a lot of important crops. Virus diseases can cause significant losses in potato yields.[2] The microorganisms that comprise the microflora of potatoes and potato products are numerous and varied. As with all fresh produce, the populations of these microorganisms on potatoes can vary greatly depending on environmental conditions existing during growing, harvest, postharvest handling, and processing.[3] Various bacterial pathogens attack potato plants and tubers. Historically, four viruses, *Potato leaf roll virus* (PLRV), *Potato virus S* (PVS), *Potato virus X* (PVX), and *Potato virus Y* (PVY), and a viroid, *Potato spindle tuber viroid* (PSTV), have been important disease agents considered to be problematic pathogens limiting potato production and trade. Potato virus A (PVA) is ssRNA virus with filamentous particles, normal length c. 730nm, in the genus *Pot virus*. The only known host are in the Solanaceae.[4] *Potato virus Y* (PVY) is one of the most prevalent and economically important plant viruses in potatoes. Members of this group are responsible for important virus diseases affecting all types of vegetable, forage, fruit, ornamental and field crops.[5-6] Recently, strains of PVY which can cause necrosis (dead spots on leaves and in tubers) have been discovered, creating more concern about this widespread virus. PVY is a *Pot virus*, the type member of the largest group of plant viruses. It is transmitted by aphids in a nonpersistent manner, by sticking to aphid mouthparts (stylet). The virus can be acquired from the infected plant within seconds, and transmitted to a healthy plant just as fast. PVY can also be transmitted mechanically by machinery, tools, and damaging plants while walking through the field. Aphids are by far the most efficient means of transmission. *Potato virus S* (PVS) is of increasing importance in potato. Many plant pathogen including *Phytophthora infestans* is also capable of infecting several species of Solanaceae worldwide, with *Solanum* species being the most frequent hosts.[7] *Spongospora subterranea* f. sp. *subterranea* (*Sss*) causes two diseases on potato

(*Solanum tuberosum*), lesions on tubers and galls on roots, which are economically important worldwide.[8] These pathogens have the potential to cause severe economic losses to crops, ornamental plants, or forests, and can lead to severe problems in human or livestock nutrition.

Soft rot of potatoes has been caused by a range of bacteria around the world such as *Erwinia carotovora* subsp. *Carotovora, E. carotovora* subsp. *Atroseptica, E. chrysanthemi*, *Pectobacterium carotovorum* subspecies *carotovorum*, *P. atrosepticum* and *Dickeya* species. Initially, the healthy part of a tuber is clearly distinguishable from the macerated, creamy infected part but eventually the whole tuber becomes infected. There may be a foul smelling odour as the potato is broken down by the bacteria and when secondary invaders occur. Soft rot can occur from as low as 16°C to above 35°C. High temperatures create ideal conditions as oxygen in the tuber is rapidly replaced by high levels of carbon dioxide, causing stress on the tuber.

Bacterial wilt is a serious problem in many developing countries in the tropical and sub-tropical zones of the world. Bacterial wilt is one of the most destructive diseases of the potato, which has a very wide host range. On potato, the disease is also known as brown rot, southern wilt, sore eye or jammy eye.

Efficient cutting propagation methods for potato have been developed. [9-10] However there is still room for simplifying and further developing the kind of methods that could be more attractive for a large scale commercial propagation.[11] Present-day potato production needs a method for producing disease-free planting material of good varieties.

In these experiments, the percentage of infected daughter tubers produced by seed tubers that were infected with either potato leaf roll luteo-virus (PLRV), potato poty-virus Y (PVY), bacterial soft rot, or bacterial wilt was determined.

MATERIALS AND METHODS

Fieldwork

The fieldwork was done in the county Busan, South Korea, between 11 March and 1 July, 2018. Under my fieldwork, we had access to a private agricultural field and house. The best starters are seed potatoes from which eyes (buds) protrude. Cut the germ potatoes into 4 equal pieces with a sterilized knife. Namely, use a clean, sharp paring knife to cut large potatoes into pieces that are roughly the size of a golf ball, making sure that there are at least 2 eyes on each piece. The cut potatoes were covered with ash (0%, 25%, 50%, 75%, and 100%). Spread the potato cuttings out in a cool location for about two days or until the cut area dries up and forms a callous. Plants were grown in agriculture fields which had grown potatoes in the previous year. The soil was reasonably moist, free of weeds, and in adequate nutrient status, so no preparation was undertaken beyond removing larger volunteer potato plants. The trial plot measured 5 by 15 m and was covered with weed-suppressant membrane. Potato plants were planted through holes cut in the membrane, spaced at 0.45 m between each of the three plants in a group, 0.50 m between groups. The groups were arranged in the field arbitrarily. Plants were watered when they were first planted, but after planting they were rained with no irrigation. 10 to 15 days after planting, when sprouts appear, use a hoe to gently fill in the trench with another 3 to 4 inches of soil, leaving a few inches of the plants exposed. Repeat in several weeks, leaving the soil mounded up 4 to 5 inches above ground level.

At harvest of the experimental plots, three randomly selected potato from each plant were collected. Taxonomic identifications are checked against the most current and widely accepted list of names for a particular group to ensure their validity and use.[12-16] Diseases of potato have relied on visual inspections of the potato crop and laboratory assays. For example, seed lots of potato varieties that do not exhibit clear symptoms when infected with PVY are assayed by enzyme linked immunosorbent assay (ELISA) after harvest to assess virus incidence. Infection of secondarily infected mother tubers was determined using ELISA on sprout sap after having been stored at 20°C in the dark with more than 60% relative humidity for a minimum of 5 weeks. This insured high virus concentration for subsequent ELISA tests.

Statistical analysis

To estimate the proportion, *p*, of infected plants in a field we used the estimator.[1]

$$p = 1 - (1 - \frac{Y}{M})^{\frac{1}{n}}$$

Where *m* is the number of samples, each consisting of *n* plants. *Y* is the number of samples infected among the *m*. A sample is infected if at least one of its *n* plants are infected.

In addition to calculate the estimator ˆ*p*, we calculated the approximate confidence interval for *p*, with confidence coefficient 1 – α, given by

$$p - Z\alpha/2 \frac{\sqrt{Y}(1 - \frac{y}{m})2/n^{-1}}{nm}$$

We used α= 0.05, and then Z21/2 =Z 0.025 ≈1.96.

The *p* values less than 0.05 were considered statistical significance. Categorical variables between groups were compared by Fisher's exact test. The t-test was used for continuous variables.

RESULTS

The percentage of infected potato tubers was calculated by summing up for each of the four virus classes studied the frequencies of tubers that were determined to be virus and bacteria infected or uninfected in the fields. A total of 426 tubers with 142 plants were enrolled in this study. 9.6 percent of them were infected with PLRV without control group (without ash) (Fig. 1). 8.2 percent of them were infected with PLRV when 25% of cut potatoes were covered with ash. If 50% of the potatoes were coated with ash, they would have an infection of 7.0 percent and if 75% were buried, they would have an infection of 4.9 percent. When cut potatoes were completely covered with ash (100%), 3.5% showed PLRV infection. Thus, the highest percentage of secondarily infected plants with symptoms was observed for PLRV, while the lowest was observed for PVY.

Figure 2 showed the PVY infection of the cut potato. 3.1 percent of the potatoes in the slice showed PVY infection. 2.3 percent of them were infected with PVY when 25% of cut potatoes were covered with ash. When potato slices are coated with 50% and 75% ash, they show 1.9% and 1.4% PVY infections, respectively. When cut potatoes were completely covered with ash, 1.2% showed PVY infection.

Water-soaked areas of soft tissue are typical of a soft rot infection. Figure 3 showed the bacterial soft rot infection of the cut potato. 6.8 percent of the sliced fragments in potatoes without ashes showed bacterial soft rot infection. 4.9 percent of the sliced fragments in potatoes were infected with bacterial soft rot when 25% of cut potatoes were covered with ash. When potato slices are coated with 50% and 75% ashes, they show 4.0% and 2.6% bacterial soft rot infections, respectively. When cut potatoes were completely covered with ash, 1.6% showed bacterial soft rot infection.

Bacterial wilt is caused by a soil-borne bacterium named *Ralstonia solanacearum* (earlier known as *Pseudomonas solanacearum*). Figure 4 showed the bacterial wilt infection of the cut potato. 4.7 percent of the potatoes in the slice showed bacterial wilt infection. 3.5 percent of them were infected with bacterial wilt when 25% of cut potatoes were covered with ash. When potato slices are coated with 50% and 75% ash, they show 2.8% and 1.9% bacterial wilt infections, respectively. When cut potatoes were completely covered with ash, 1.4% showed bacterial wilt infection.

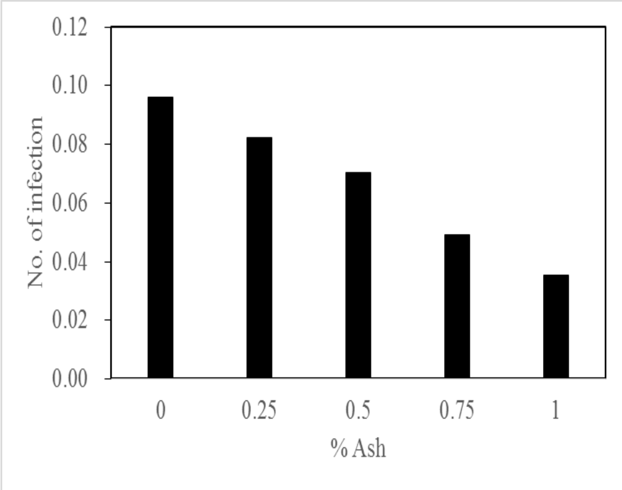

Figure 1: Tuber infection (% infected tubers) of potato plants with PLRV in agricultural fields in this study.

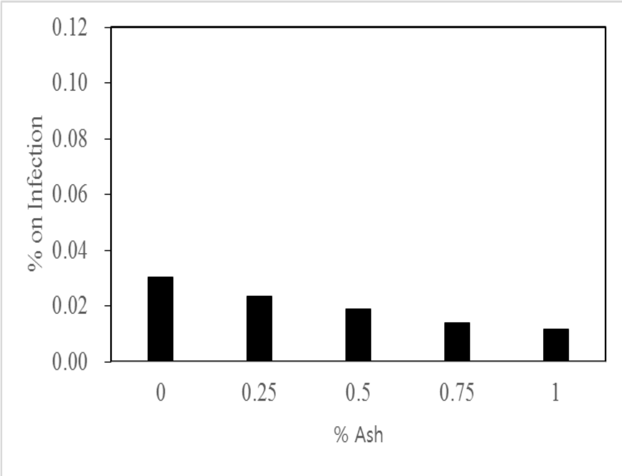

Figure 2: Tuber infection (% infected tubers) of potato plants with PVY in agricultural fields in this study.

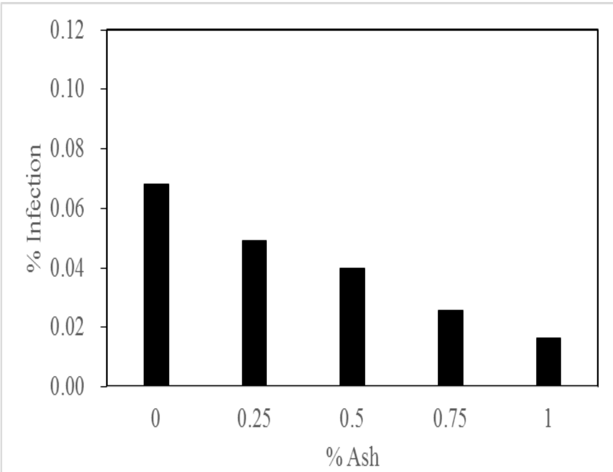

Figure 3: Tuber infection (% infected tubers) of potato plants with bacterial soft rot **in agricultural fields in this study.**

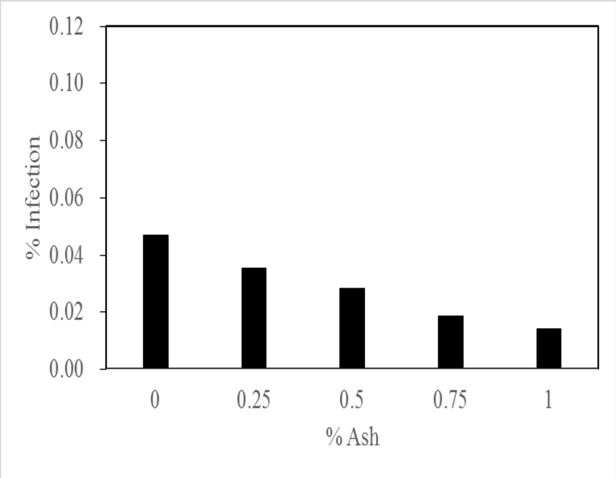

Figure 4: Tuber infection (% infected tubers) of potato plants with bacterial wilt **in agricultural fields in this study.**

DISCUSSION

Vegetative plant production plays a large role in food production worldwide. Most major non-grain starchy food crops and most fruit crops are vegetative propagated, meaning that plants are propagated by planting rhizomes or tubers, or by making nodal stem cuttings in nurseries or tissue culture.[17] The cutting and germinating of the seed potatoes has been used for a long time. However, there is a problem of infection caused by cutting. If a potato seed tuber (mother tuber) is virus infected, the plant grown from this tuber becomes systemically, so-called secondarily infected, i.e., the pathogen moves through the plant vascular system and eventually reaches, i.e., infects, the daughter tuber tissue, produced by this same plant.[18] While several terms have been used for systemic infection of vegetative propagated "seed," such as "autoliberation" for potato viruses[19] or "reversion".[20]

Wood ash is a residual material produced when wood is burned for energy production. It is a useful soil amendment because it raises soil pH and has the potential to supply plant nutrients.[21]. Both wood and leaf ash has been used for centuries by gardeners to amend soil. One of the reasons folks use ash in their gardens is its nutritional content. The calcium carbonate equivalence of the ashes used ranged from 26 to 59%, indicating that the acid-neutralizing power of wood ash varies from source to source.[22] The percentage of plant nutrients released from wood ash to soil varied with the particular nutrient. The average nutrient release percentages were: phosphorus (P), 5.7%; potassium (K), 40%; magnesium (Mg), 48%; calcium (Ca), 74%; sodium (Na), 16%. Wood ash application altered the equivalent fraction of K, Mg and Ca in soils. Ash contains about 1.5 percent phosphorus and 7 percent potassium, two essential nutrients for plant growth. Wood ashes are a great homemade source of potassium, whose name comes from the word "potash," literally the substance made from soaking ashes in a pot. Because ashes are alkaline, adding them to the soil also raises the pH, making it less acidic. Scientists are investigating whether the Chalara fungus can survive in compost or whether the heat produced as material rots is enough to kill the disease. High alkaline can be effective in preventing germs from proliferating. Using ash in this study may reduce the infection of some bacteria. However, studies on whether alkali allowed the potato to reduce the infection of bacteria will need to be investigated further in the future.

CONCLUSION

A potato breeding program needs an effective testing scheme to detect and remove viruses at the beginning of the selection process. The highest percentage of secondarily infected plants with symptoms was observed for PLRV, while the lowest was observed for PVY. Using ash in this study may reduce the infection of some bacteria because high alkaline in ash can be effective in preventing germs from proliferating.

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