SOME ASPECTS OF THE VOLUNTEER POTATO PROBLEM

by
G. D. Newberry and R. E. Thornton, Washington State University

Introduction

Potato harvest does not remove all tubers from the field. Some tubers are missed, other tubers are cut and only part of them harvested. Tubers can fall through the chains. Others cling to vines or are so large they go over the back of the harvester. Some miss or fall off the truck. It doesn't matter how the tubers are left in the field. Once the tubers are in the soil they have the potential to overwinter and can create a volunteer problem the next season. If these volunteer plants aren't controlled during the following growing season they produce tubers that become potential volunteers the following growing season.

Volunteer potatoes are a very competitive weed. They grow rapidly in the early spring because of their starch reserves and compete with the rotational crop for light, water and nutrients. These volunteer potato plants are difficult to control with tillage or herbicides because of their ability to vigorously resprout. Unlike potatoes grown for a crop volunteer potatoes are not treated to control insects like the Colorado Potato Beetle or Green Peach Aphid or diseases like late blight and parasitic nematodes. Missed tubers and the volunteer plants they produce act as reservoirs for pests of potatoes even if the rotational crop does not, and thus the benefits of crop rotation are reduced. To add insult onto injury, potato foliage contains toxic substances and volunteer potato plants can contaminate rotational crops used for food, feed or forage.

Because of the climate in the Columbia Basin of Washington those tubers left in the field have a good chance of surviving the winter. Previous research has shown that a temperature of at least 28° F is needed to kill tubers (1). Dry undisturbed tubers have been shown to super cool as low as 20° F without damage (2). Although air temperatures in the Columbia Basin are often low enough to kill tubers, soil temperatures seldom get cold enough at depths sufficient to kill all the buried tubers (1). Consequently, tuber survival is high and volunteers are a problem almost every year.

Before effective methods to control volunteer potatoes can be developed the extent and location of the harvester leavings need to be identified. The size, location, and amount of tubers left in the fields must be known. Tuber buried in the soil are more likely to overwinter and cause volunteers the next spring. Previous research on the volunteer problem in Washington indicated that 65% of the tubers are in the top two inches of soil, 30% are located from two to four inches deep and 5% are located from four to six inches deep (1). Knowing the size of the tubers being left by the harvesting operation is an important factor in developing control measures. There are three potential sources of volunteer plants; cut tubers, small tubers, and larger marketable size tubers. Each of these originates from a different source and therefore reduces their impact requiring a different solution.

This Presentation is part of the 1998 Proceedings of the Washington State Potato Conference & Trade Show.

Cut tubers result from improper blade depth and are therefore a management issue. Small tubers remain in the field because they fall through the harvester chains and thus are a result of an equipment design problem. Harvest equipment needs to be designed to remove or destroy small tubers. Controlling tuber size distribution is important with the small tubers. If the bulk of the potato crop is made up of larger easily harvested tubers, there will be fewer small tubers to leave in the field. Larger marketable size tubers left in the field are also part of the problem. These tubers, originate by falling off the truck, being pushed around the throat of the harvester, or by being carried over the back of the harvester with the vines. If the crop is harvested when it is immature, more marketable size tubers will cling to the vines and go over the back of the harvester. Also very large tubers can straddle the deviner chain and end up in the field. Excessive forward speed for the soil conditions will result in spillout around the throat of the harvester. Spillout can also occur if the primary chain speed is not fast enough relative to the forward speed of the harvester. Like cut tubers marketable size tubers remain in the field due to improper management. A harvester operation with properly adjusted and well managed equipment should not leave large quantities of marketable sized tubers in the field.

Material and Methods

In order to better identify what the source(s) of volunteer plants is (are), in the fall of 1997 an after harvester survey was conducted to find out what potatoes are left in Columbia Basin fields. Eighteen potato fields located from Patterson to Quincy were utilized for the study. The fields in the study had been harvested with a wide range of harvesters, had differing soil types, and several cultivars (mostly vine killed Russet Burbank). Four 70 by 70 inch square sites were sampled within each field. Areas of the field where it was obvious potatoes had been dumped or pushed out around the harvester were avoided so the samples would represent the field leavings under "normal" harvester operation. Soil from each sample site was hand dug immediately after they were mechanically harvested. All the soil from the site was screened through a 3/8 wire mesh and tubers and tuber pieces of all sizes were removed and weighed. One half of one sample site per field was used to determine the distribution and characteristics of the tubers that were attached to the vine, were on the soil surface, or present in each two inch depth of soil down to the blade depth below 8 inches. This was accomplished by removing each two inch layer of the soil profile.

Results and Discussion

Cut tubers were not the major portion of the material recovered from harvested fields in the Columbia Basin. Thirteen sites were evaluated for cut tubers and of those sites only two locations had more than 30% of the tubers in the sample that were cut (figure 1). Cut tubers in the other eleven locations ranged from 5% to 20% of the harvester leavings. The operations with higher percentages could reduce the amount of potential volunteers by managing the harvester blade so all of the tuber is harvested.

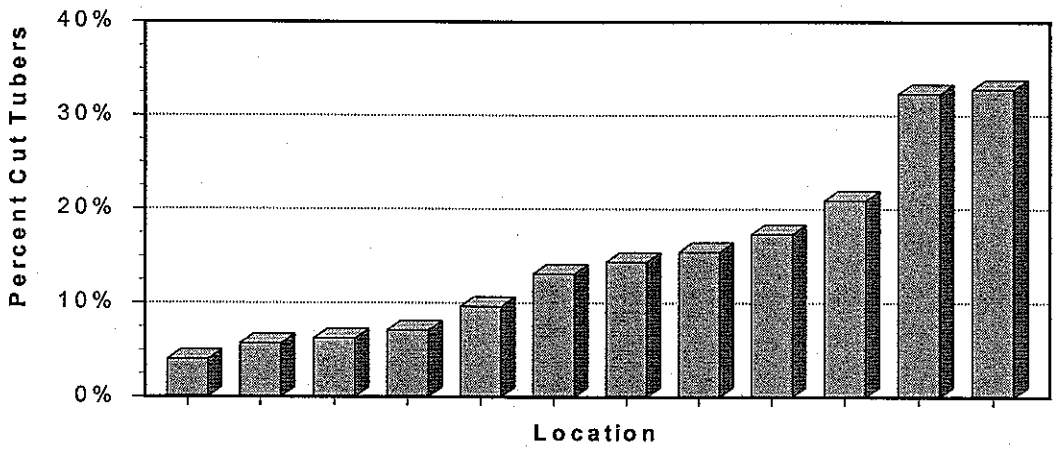

Figure 1. Percent of tubers in sample cut by harvesting operations.

Previous research has shown that anywhere from 43,000 to 110,000 tubers per acre are left in U.S. potato fields after harvest (1). Results of the 1997 survey were similar. The number of tubers per acre ranged from a low of 25,602 to a high of 120,076 (figure 2). The average was 68,419 tubers per acre. To put this in perspective, a normal potato planting at 10 inch in-row and 34 inch row spacing has 17,600 tubers per acre, so there are plenty of tubers left to cause trouble the following year.

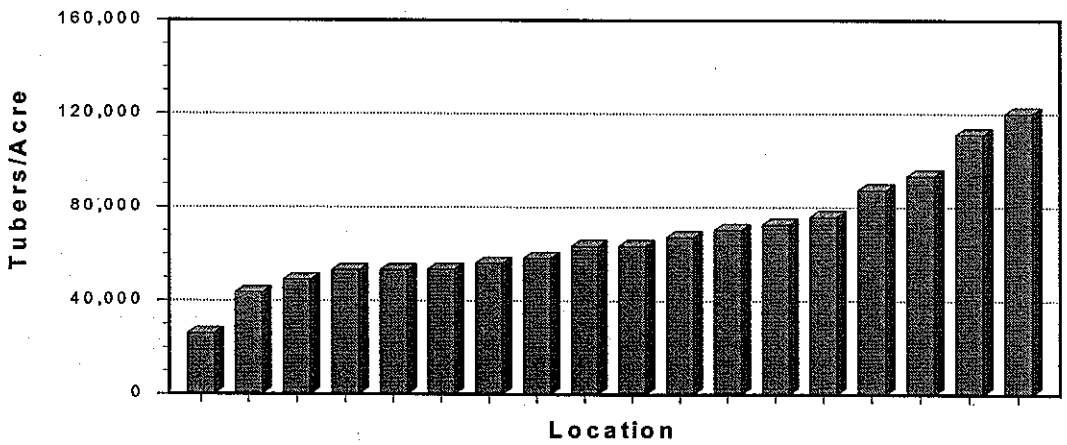

Figure 2. Total tubers per acre left in the field after mechanical harvest.

As discussed earlier, the size of the tubers left in the field will give some indication of where the leavings are coming from. This survey shows that the majority of the tubers are small ranging in size from 0.5 oz. to a high of 1.7 oz. with a mean of 0.8 oz. (figure 3). The location with the largest size tubers was being harvested with green vines and resulted in some marketable size tubers clinging to the vines and overriding the deviners. The location with the next largest tubers had a poorly adjusted harvester and was spilling marketable sized tubers between the rear cross and side elevator. Tubers at all the other locations were all 1 ounce or less in size. These results indicate that a majority of the tubers left in the field are very small and are falling through the chains of the harvester. Yield of tubers left in the field varied from a low of 14 cwt/acre to a high of 77 cwt/acre with an average 35 cwt/acre (figure 4).

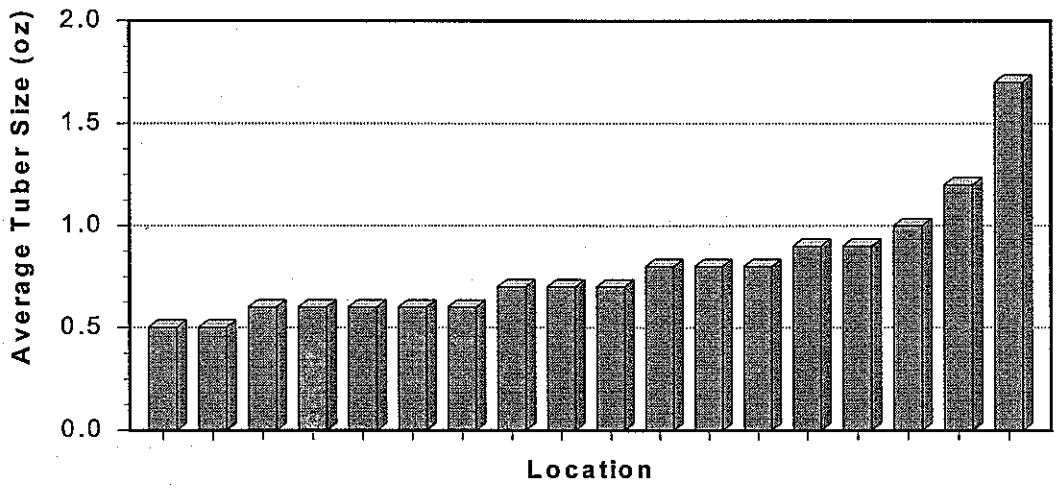

Figure 3. Average size of tubers left in the field after mechanical harvest.

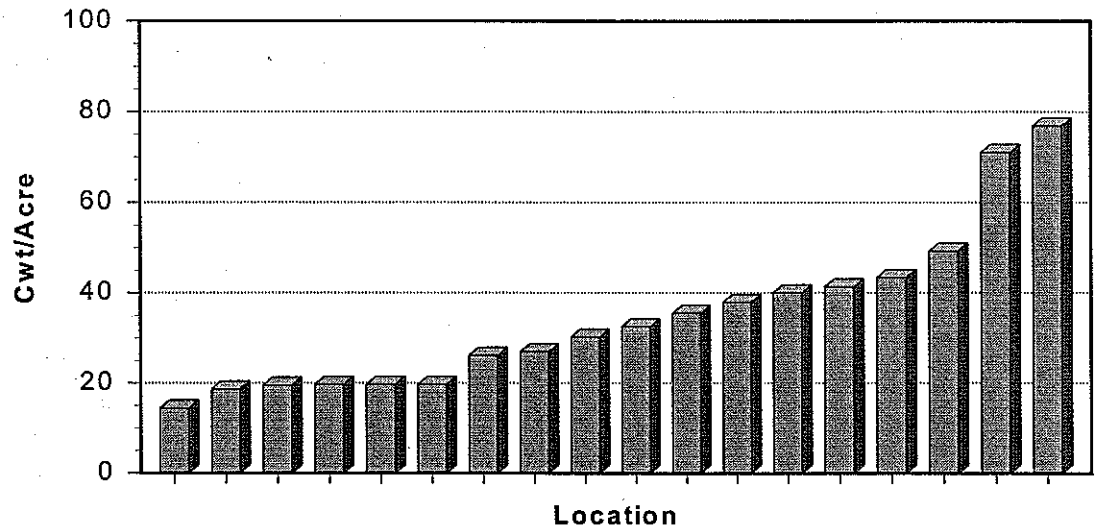

Figure 4. Total CWT per acre left in the field after mechanical harvest.

A tuber left in the field has a better chance of overwintering if it is buried in the soil. Research by Dr. Boydston found that 65% of the tubers left in the field are on the soil surface or in the top 2 inches of soil (1). This 1997 survey found that tubers are distributed throughout the soil profile (figure 5). One third of the tubers are below 6 inches of soil.

With the Columbia Basin climate these tubers would rarely, if ever, be exposed to temperatures low enough to kill them and prevent sprouting the next year (1). The size profile of tubers at the various depths show the largest tubers are those clinging to the vines and on the surface of the soil (figure 6). The tubers found in the soil have an average size of less than one ounce. These small tubers are falling through the chains at various places on the harvester and are being buried by the soil falling from the harvester chains.

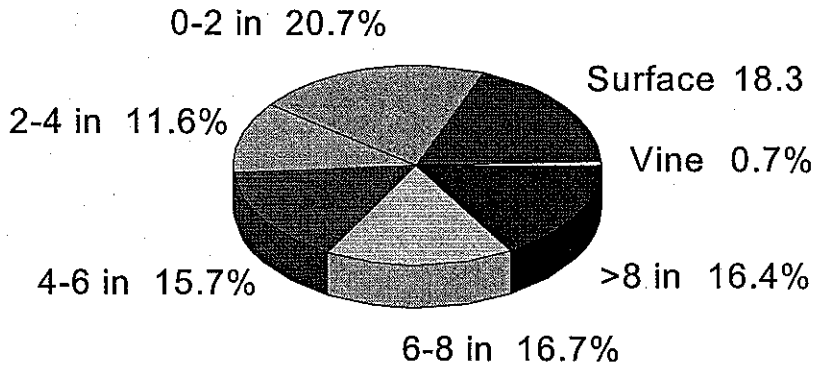

Figure 5. Percent tuber number by sample depth. It is important to note that although 40 % of the tubers are on the surface or in the first 2 inches of soil, 33 % of the tubers are buried below 6 inches.

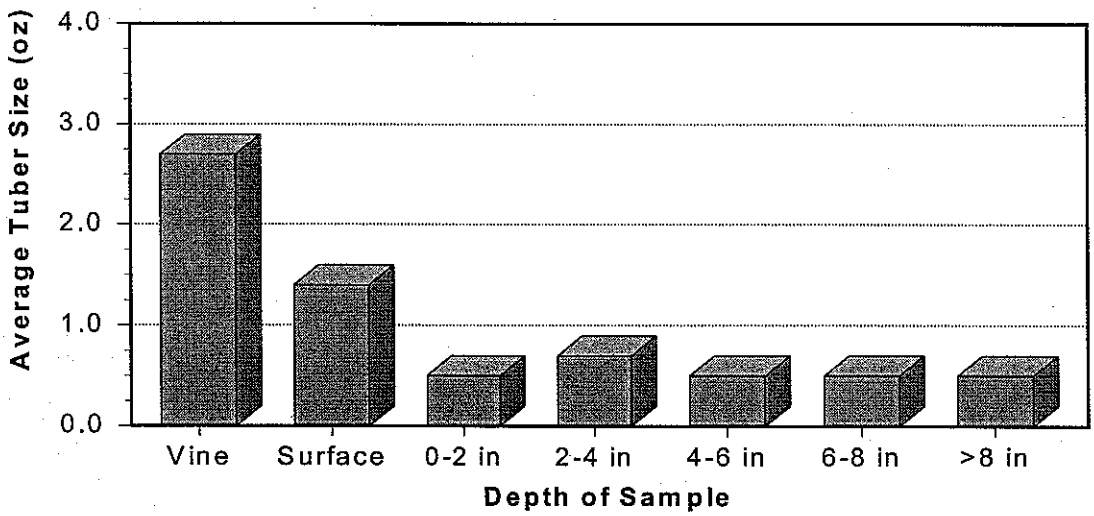

Figure 6. Average size of tubers by depth of sample.

The 1997 harvester survey indicates that a majority of the tubers left in the field are small. If harvest methods are developed that would remove all these tubers with the larger tubers and deliver them to the buyer, there are some potential economic impacts to consider. There would be costs involved in modifying or purchasing equipment to harvest these small tubers. Because of the increased tonnage removed from the field hauling costs would increase.

A less obvious impact is the potential loss of returns. Current processing potato contracts are written with size incentives that reward producers for percent of delivery of tubers either over 6 oz. or 10 oz. in size. An increase in the percentage of small tubers delivered would reduce the return for the product due to the reduced incentive payment. To estimate the magnitude of the impact a mock contract developed by Dr. Tom Schotzko was used to estimate the losses in return that would occur if what the grower harvested and what was found in the survey samples were delivered to a buyer.

The contract assumptions are: a 80$ per ton base price; >6 oz. clause with 50%=$0.00 with $0.60 for each percentage point above 50% and -$0.60 for each percentage point below 50%; 20$ per ton for processing culls up to 10% and $0.00 >10% culls. There were no U.S. #1 or other size incentives in this contract.

Adding the machine harvested (grower return data) and the hand dig (survey samples) resulted in an increase in total yield but a decrease in the percentage of >6 oz. tubers (table 1). The average loss of >6 oz. tubers over all the locations was 4.3%. A 5.8% reduction occurred in the three fields with the most leavings and of 2.8% reduction occurred in the three fields with the least leavings.

Table 1. Change in percent >6 oz. tubers if all potatoes are harvested

Harvester Leavings	Machine Harvested (tons/acre)	Machine Harvest + Hand Dig (tons/acre)	Machine Harvested % >6 oz.	Machine Harvested + Hand Dig % >6 oz.	Change in % >6 oz.
Average of All Samples	33.0	35.3	68.3	64.0	-4.3
3 Locations With Most	32.5	35.8	63.2	57.4	-5.8
3 Locations with Least	33.9	35.3	69.3	66.7	-2.6

Schotzko 98

Adding the tubers in hand dug samples to the machine harvest data increased the amount of processing culls by 5.8 % (table 2). At the three locations with the most leavings the amount of processing culls increased by 8.3% and at the three locations with the least leavings the amount of processing culls increase by 3.5 %. Adding the increased cull percentages from the hand dug samples to the actual cull percentages increases the percent culls to above 10% in all comparisons (table 2). Any culls delivered over 10% result in a $0.00 return.

Table 2. Change in processing culls if all potatoes are harvested

Harvester Leavings	Machine Harvested (tons/acre)	Machine Harvest + Hand Dig (tons/acre)	Machine Harvested % Proc. Culls	Machine Harvested + Hand Dig % Proc. Culls	Change in % Proc. Culls
Average of All Samples	33.0	35.3	7.7	13.5	+5.8
3 Locations With Most	32.5	35.8	10.1	18.4	+8.3
3 Locations with Least	33.9	35.3	8.4	11.9	+3.5

Schotzko 98

Plugging this data into the contract the dollar returns for the harvest can be calculated. By harvesting all potatoes there is a net loss in dollar return (table 3). These results show a loss of $4,100 to $11,300 per 125 acre circle could result from delivery of the small processing cull size tubers.

Table 3. Change in Dollar Return if All Potatoes are Harvested.

Harvester Leavings	Return / Acre Without Sample	Return / Acre With Sample	Net loss / Acre
Average of All Sampes	$ 2,676.17	$ 2,621.12	$ 55.06
3 Locations With Most	$ 2,488.29	$ 2,398.03	$ 90.26
3 Locations With Least	$ 2,748.20	$ 2,715.43	$ 32.77

Schotzko 98

Where do we go from here? In 1998 there will be a more extensive harvest survey. The 1997 survey was started late in the harvest season so most of the fields sampled were vine killed Russet Burbank. The 1998 survey will include early varieties harvested when vines are green which could have an effect on the size and amount of the leavings. The potential for reducing the amount of tubers left in the field that produce volunteers plants with MH30 and the impact of different tillage methods on tuber viability need to be researched.

If in fact the bulk of the volunteer plants are produced from very small tubers, then the residual effect of MH30 on these tubers needs to be known. Dr. Boydston's volunteer research used marketable size tubers to establish the temperatures needed to kill a tuber (1). The 1997 survey indicates that these may not be the tubers causing the problems. Lethal temperature research needs to be conducted on the small tubers. Harvest methods that destroy or harvest the small tubers need to be developed. Mechanical methods to bring the buried tubers to the surface where they stand a better chance of exposure to lethal temperatures need to be developed. Control of the volunteers in rotational crops with herbicides is a viable method and research on more effective methods should continue.

Literature Cited

1. Boydston R., Seymour M. 1994. Volunteer potato control in rotational crops. Proceedings, *1994 Washington State Potato Conference and Trade Fair*, Washington State Potato Commission, Moses Lake, WA.

2. Irritani, W. 1986. Seed performance - influence of low temperatures and other factors. Proceedings, *1986 Washington State Potato Conference and Trade Fair*, Washington State Potato Commission, Moses Lake, WA.