AN EXPANDED LOOK AT THE VOLUNTEER POTATO PROBLEM IN WASHINGTON

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There are many fields of spring planted crops in the Columbia Basin that look a lot more like potato fields than the intended crop (Figure 1). These volunteer potato plants are growing from tubers that were left in the field after harvest the season before. The tubers survived the winter and are producing a vigorous unwanted 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. For example, a study published by the Morley Research Center reported in the May 1999 Potato Review, found that one volunteer plant/m^2 can reduce sugar beet yield by three ton/hectare. These volunteer potato plants are difficult to control with tillage or herbicides because of their ability to vigorously resprout from the buried tuber. Unlike potatoes grown for a crop, volunteers are not treated to control insects like the Colorado Potato Beetle or Green Peach Aphid, or diseases like late blight, or plant parasitic nematodes. Tubers left after harvest and the volunteer plants they produce act as reservoirs for these pests and others even if the rotational crop does not, and thus the benefits of crop rotation are reduced.

Because of the climate in many potato growing areas in the state 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. Dry undisturbed tubers have been shown to super cool to as low as 20° F without damage. Although air temperatures are often low enough to kill tubers, soil temperatures seldom get cold enough at depths sufficient to kill all the buried tubers. Consequently, tuber survival is high and volunteers are a problem almost every year. For example, during the El Nino winter of 1997/98 there were many days with air temperatures low enough to kill tubers left on the surface (Figure 2) at a Moses Lake research site, however soil temperatures at that location did not get cold enough to kill the deeper buried tubers (Figure 3). As a consequence volunteer potatoes were common in 1998. The La Nina winter of 1998-1999 delivered some very cold air temperatures in December (Figure 4). Soil temperatures at the Othello research station have been below the lethal temperature of 28° F down to four inches depth for four days (Figure 5). These conditions should help reduce the over winter survival of the 1998 harvest leavings as compared to 1997 leavings.

Harvester Leavings Survey

Before effective methods to control volunteer potatoes can be developed; the extent and location of the harvester leavings need to be identified.

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The size, location, and amount of tubers left in the field gives a good indication of where the leavings are coming from. In order to better identify what the sources of volunteer plants are, in the fall of 1997 and 1998 after harvester leavings surveys were conducted. Eighteen Columbia Basin fields were sampled in 1997, and a total of 15 fields in the Columbia Basin and nine fields in the Skagit Valley were sampled in 1998. The fields in the study had been harvested with a wide range of harvester makes, had differing soil types, and included many different cultivars. 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 during normal harvester operation. Soil from each sample site was hand dug and screened through a 3/8-inch wire mesh. Tubers and tuber pieces of any size were removed and weighed. One-half of one sample site per field was used to estimate the distribution and characteristics of the tubers that were attached to the vine, 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 and screening each two-inch layer of the soil profile separately.

Both the 1997 and 1998 surveys indicate a large number of tubers that have the potential to produce volunteer plants the next season are left after harvest. Tuber number ranged from a low of 25,600 tubers per acre in a 1997 sample (Figure 6) to a high of 183,485 tubers per acre in a 1998 field (Figure 7). A normal commercial planting in the Columbia Basin would have around 18,500 tubers per acre. Even the cleanest field in the surveys had more leavings than is normally planted. In the field with the most leavings, if 90% of the tubers winter killed, there would still be 18,349 viable tubers per acre, nearly the same amount of tubers that are planted for commercial production!

The size of the tubers found in both the 1997 and 1998 surveys (Figures 8 and 9) show that a majority of the tubers in the leavings are very small. Tuber size in most of the locations sampled averaged under one ounce. Those locations with the higher average size tubers were fields harvested when vines were still green or in one case the harvester was poorly adjusted. Cut tuber data from the surveys (Figures 10 and 11) show that with a few exceptions each year, a low percentage of the left tubers are cut, an indication that harvester blade depth management is not a major contributing factor. These data combined with the small average tuber size indicate that a majority of the leavings are small tubers that are apparently falling through the harvester conveyer chains.

Both the 1997 and 1998 Harvester Leavings Surveys found tubers distributed throughout the soil profile, to depths below eight inches. Only the 1998 survey results are shown because refinements in sampling techniques make the 1998 sample information more representative of the actual distribution (Figure 12). Nearly 50% of the leavings are attached to vines (4.3 %), left on the soil surface (22.6 %), and in the top two inches of the soil (22.2 %). These tubers would be exposed to lethal temperatures almost every winter, even during the El Nino winter of 1997/98 (Figure 3). The rest are buried, 18.1 % of those below 6 inches where lethal temperatures are rare in our growing areas (Figures 3 and 5).

Spring Survival Survey

The 1998 Spring Survival Survey of some of the fields sampled in the fall of 1997 found many volunteer plants (Figure 13). The volunteer potato plants were growing very well and were in many cases smothering out the spring planted sugar beets, carrots, and corn. Tuber size data from the spring sample confirmed the small size of tubers that was found in the 1997 Harvester Leavings Survey (Figure 9). Average seed tuber size producing volunteer plants in the spring of 1998 was less than 0.75 ounces (Figure 14). The small tubers apparently fell through the harvester conveyor chains the fall before. Vigorous plants were produced from garbanzo bean sized tubers located as deep as eight inches, confirming that it doesn't take a very big tuber to survive the winter and produce a volunteer plant the following spring. A somewhat alarming finding was that as early as the second week of May, some of the volunteer plants at some locations were producing daughter tubers (Figure 15). A south basin location had already produced more than 250,000 daughter tubers per acre.

Impact of Early Vine Senescence on Leavings

The 1998 After Harvest Survey found a wide range of leavings from three Russet Norkotah fields. One of the Russet Norkotah fields sampled had been severely affected by the early dying complex. This field had the highest tuber number and hundred weights per acre of leavings (Figure 16), as well as the largest average tuber size (data not shown). The overall tuber size distribution was altered by the shortened growing season caused by the early dying complex and more leavings were the result.

Impact of Vine Condition at Harvest on Leavings

The results of the 1998 After Harvest Leavings Survey indicate that vine condition at harvest impacts the tuber size, size distribution and tuber number of the leavings. Russet Burbank fields harvested when the vines were dead and when the vines were green were sampled. The average tuber number left in the three green vine harvested fields (164,212) was nearly double that left in the three dead vine harvested fields (82,462) (Figure 17). The average hundredweight per acre was more than doubled when harvest occurred when the vines were green (39 vs. 96 cwt/acre) (Figure 18). Distribution of the leavings within the soil was also modified by vine condition. A greater portion of the leaving are four inches or deeper in the soil following harvest from dead vines than after harvesting with green vines (Figure 19). The green vine harvested fields had a large portion of the leavings on the surface and buried within the top four inches of soil. These shallow buried tubers have much better odds of being winter killed than those tubers buried deeper in the soil. The survey found that size distribution of the leavings is changed by the vine condition at harvest. Except for those tubers located on the surface, the tuber size was less than one ounce in the vine killed fields at all depths (Figure 20). In green vine harvested fields tubers attached to the vines averaged over 2.5 ounces and the tubers left on the soil surface averaged 2.25 ounces. The tubers buried at all depths below the soil surface averaged less than one ounce.

Conclusion

Having identified the characteristics of the tubers left in fields after harvest enables research designed to solve the volunteer problem. Evaluating after harvest tillage operations for the ability to reduce the survivability of unharvested tubers, as well as research on the use of Maleic Hydrazide to reduce tuber viability is underway.

Acknowledgments

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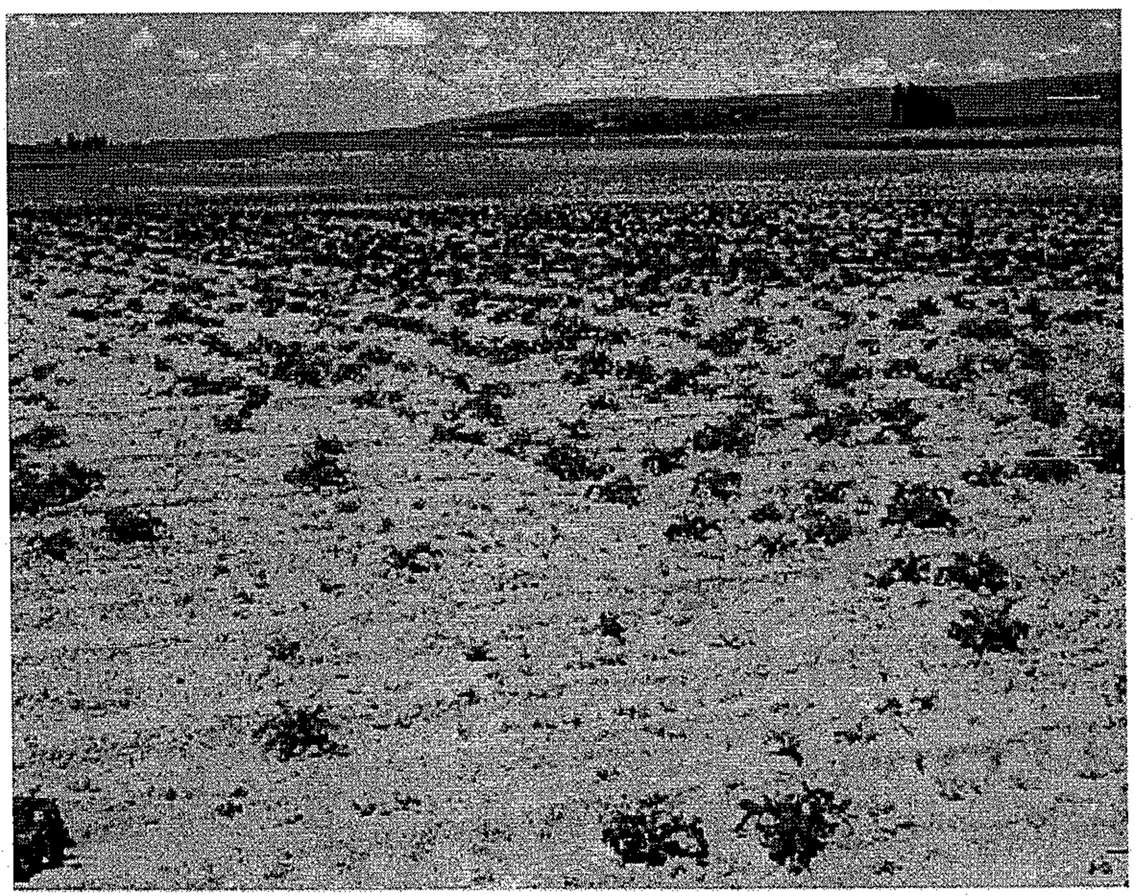

Figure 1: Volunteer potato plants in a sugarbeet field near Pasco, WA (May 1998).

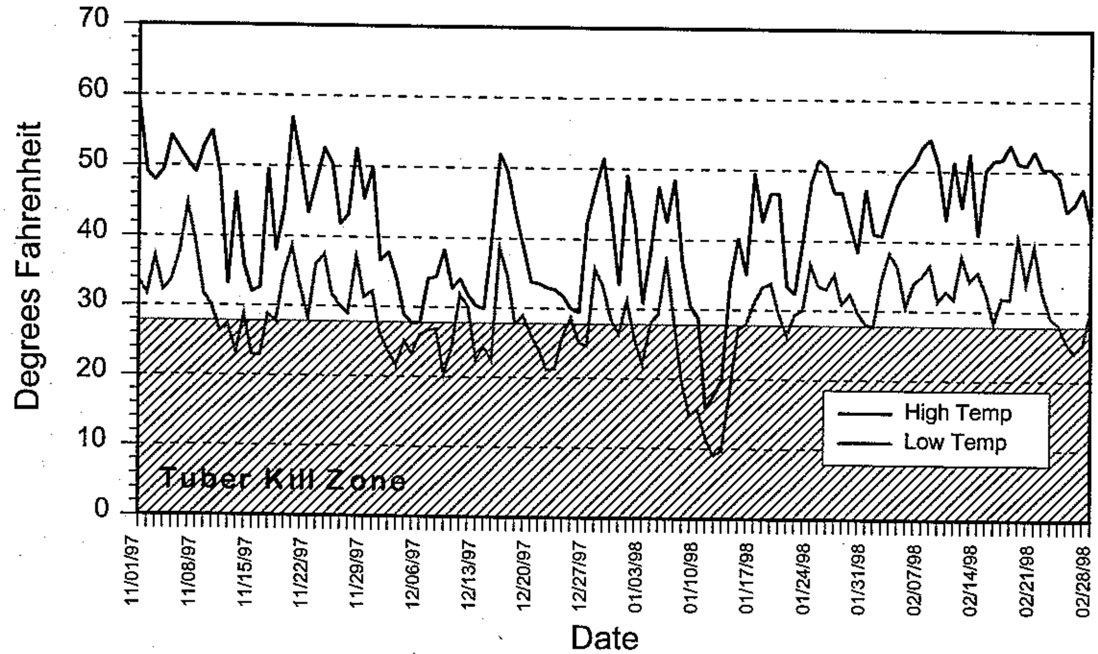

Figure 2: High and Low Air Temperatures 11/1/98 to 2/28/98 Moses Lake, WA

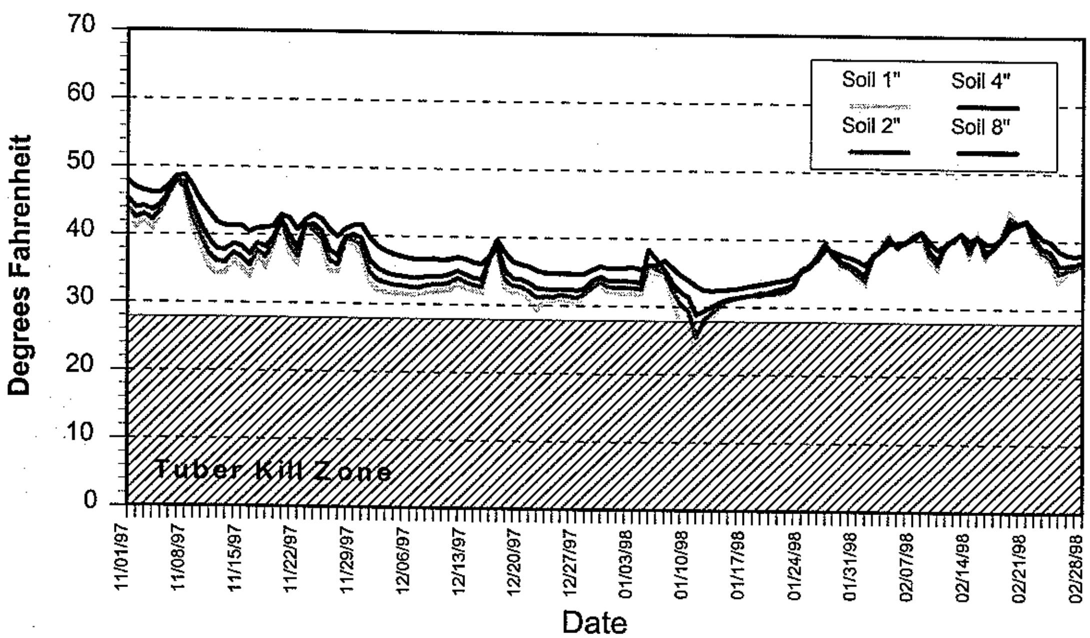

Figure 3: Soil temperatures 11/1/98 to 2/28/98 Moses Lake, WA

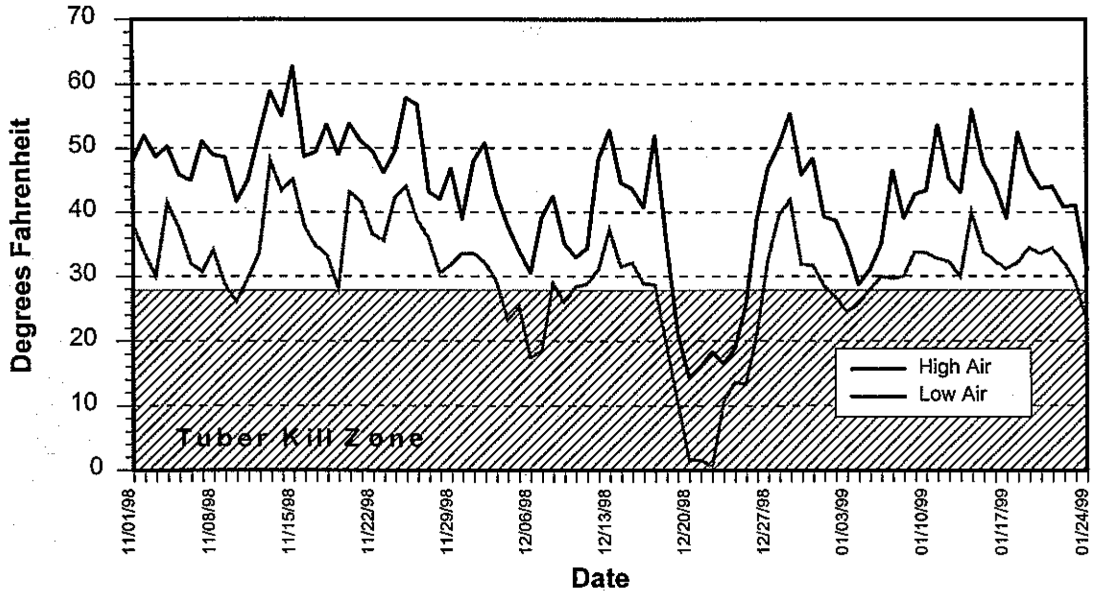

Figure 4: High and Low Air Temperatures 11/1/98 to 1/25/99 Othello, WA

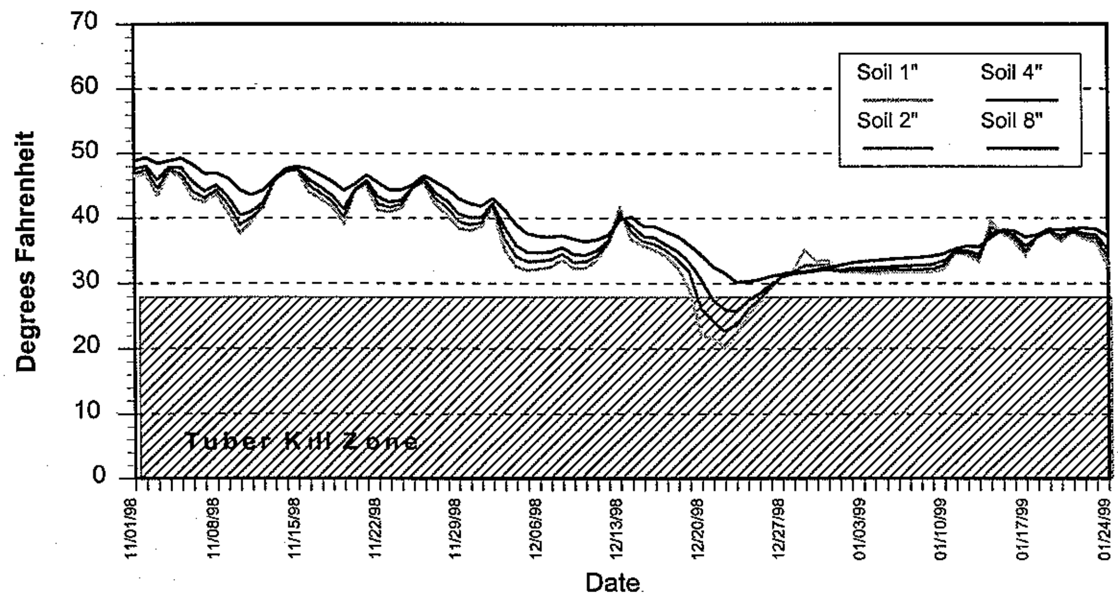

Figure 5: Soil Temperatures 11/1/98 to 1/25/99 Othello, WA

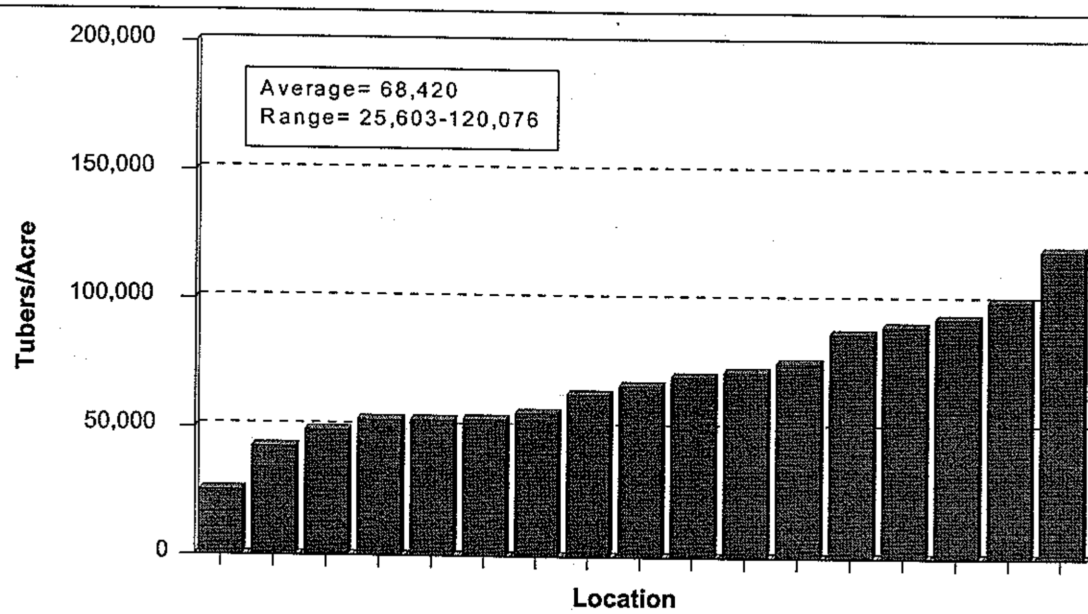

Figure 6: Average tuber number at each location- 1997 Harvester Leavings Survey.

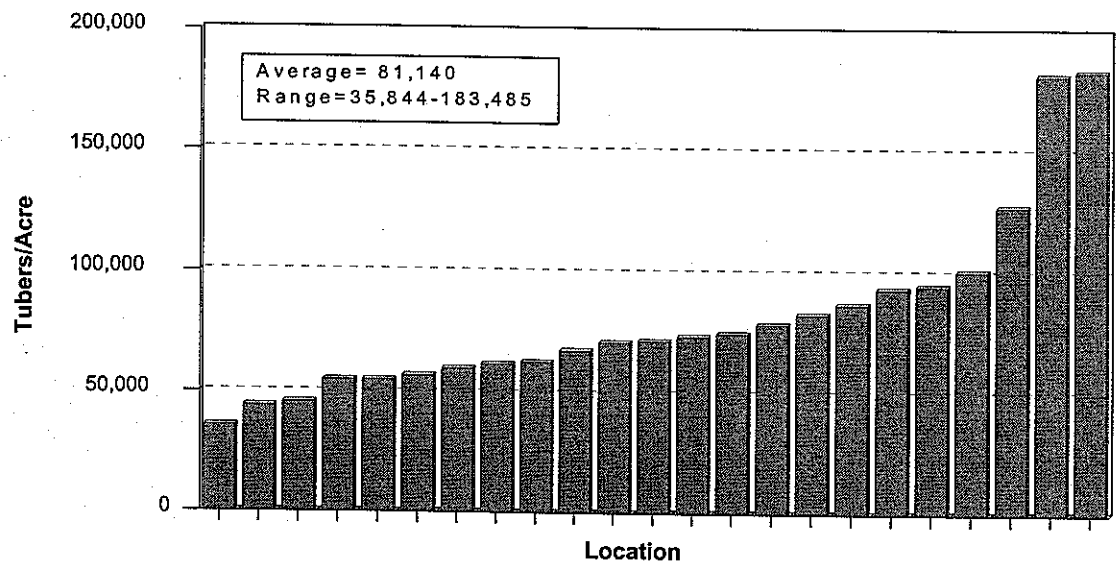

Figure 7: Average tuber number at each location- 1998 Harvester Leavings Survey.

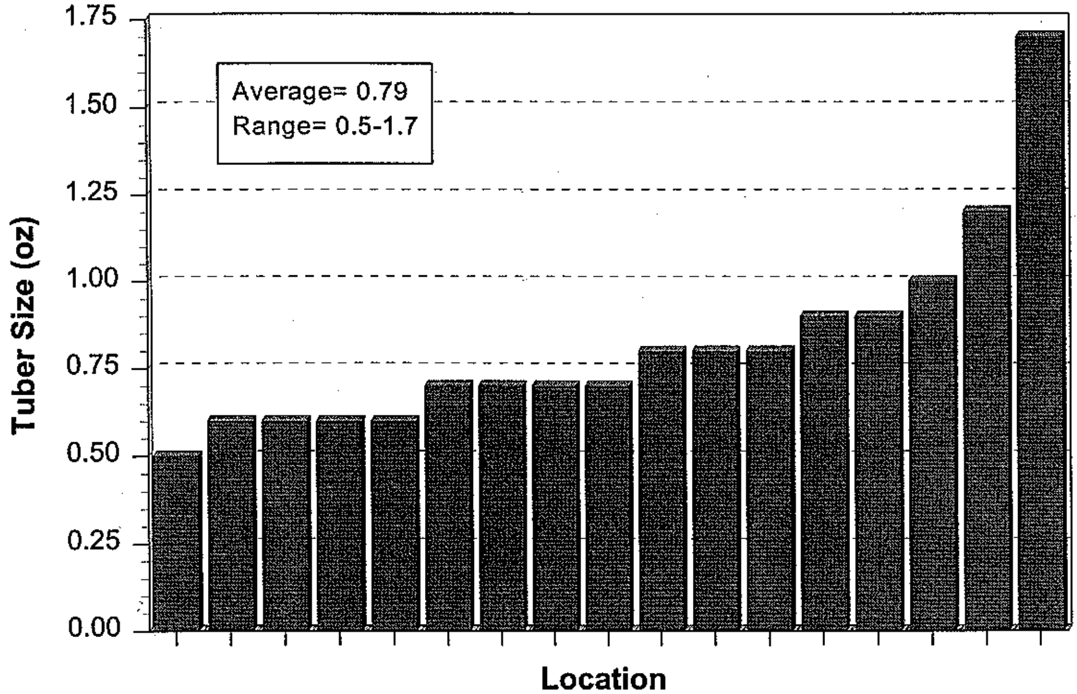

Figure 8: Average tuber size at each location- 1997 Harvester Leavings Survey.

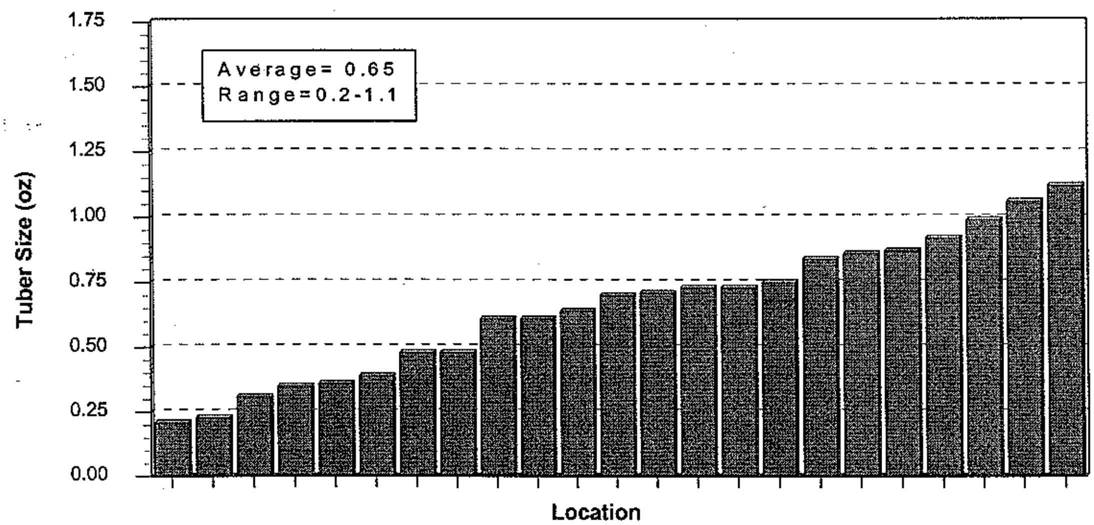

Figure 9: Average tuber size at each location- 1998 Harvester Leavings Survey.

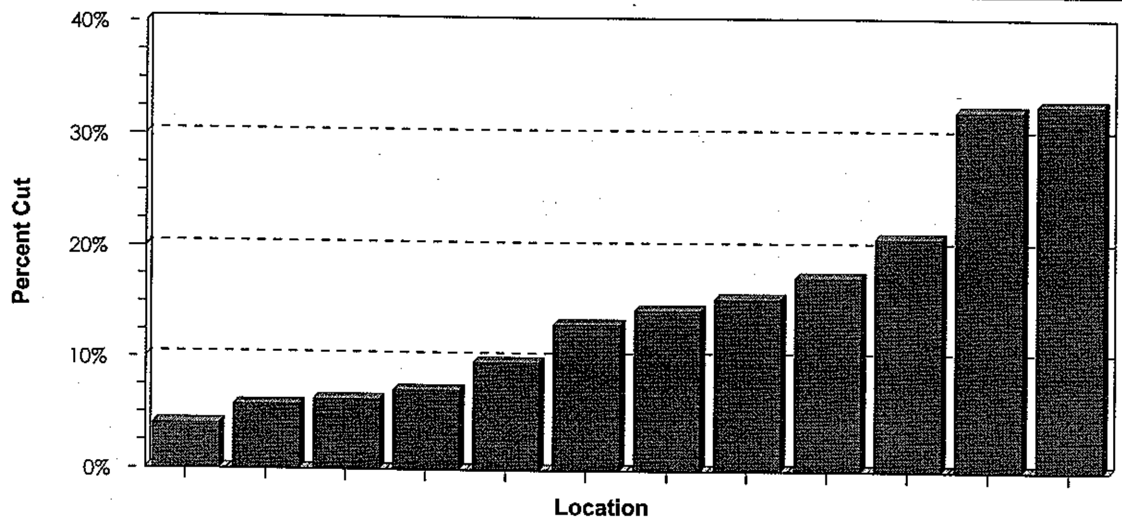

Figure 10: Percent of cut or damaged tubers- 1997 Harvester Leavings Survey.

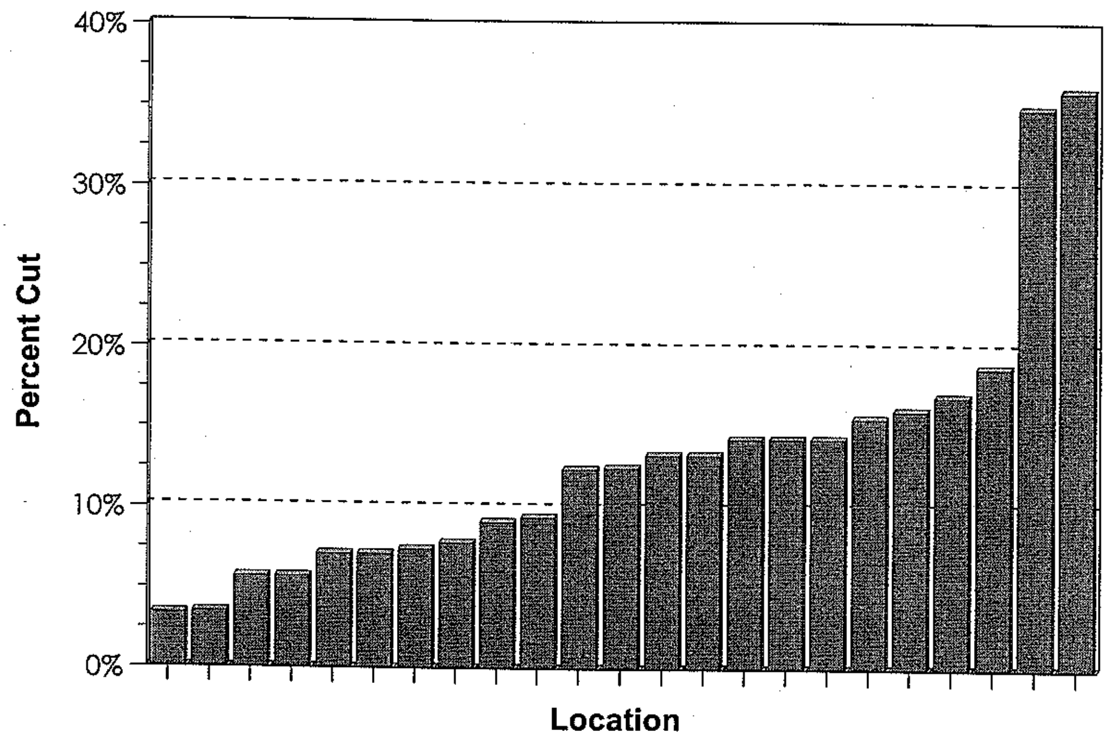

Figure 11: Percent of cut or damaged tubers- 1998 Harvester Leavings Survey.

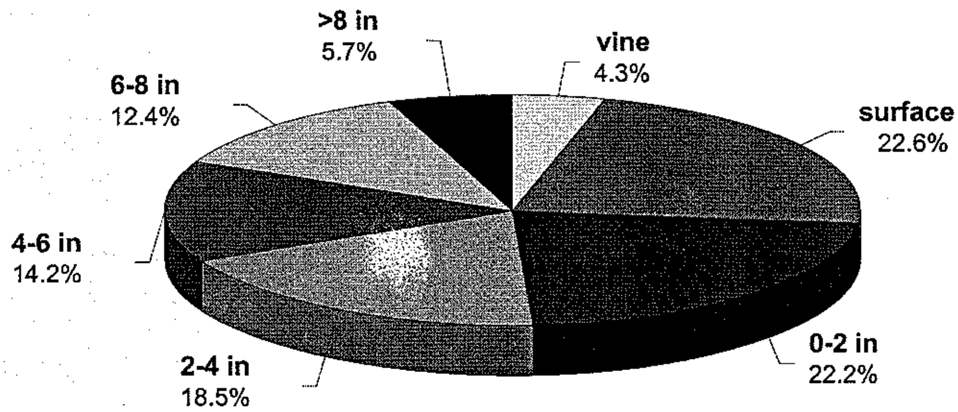

Figure 12: Percent of tubers at each location of the soil profile averaged over all locations- 1998 Harvester Leavings Survey.

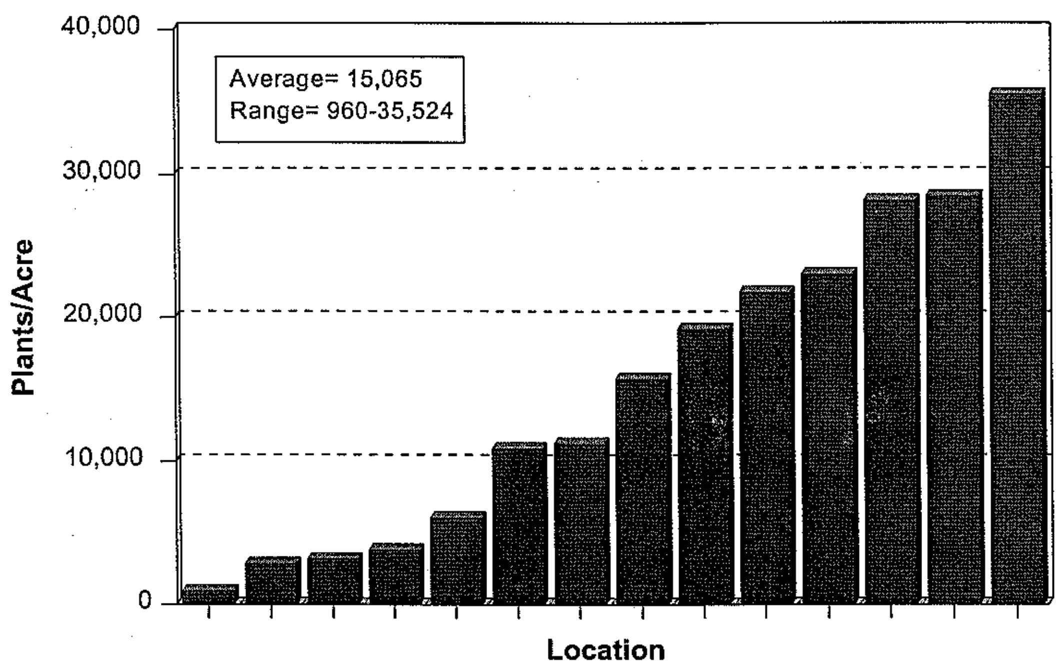

Figure 13: Volunteer plants per acre- 1998 Spring Survival Survey.

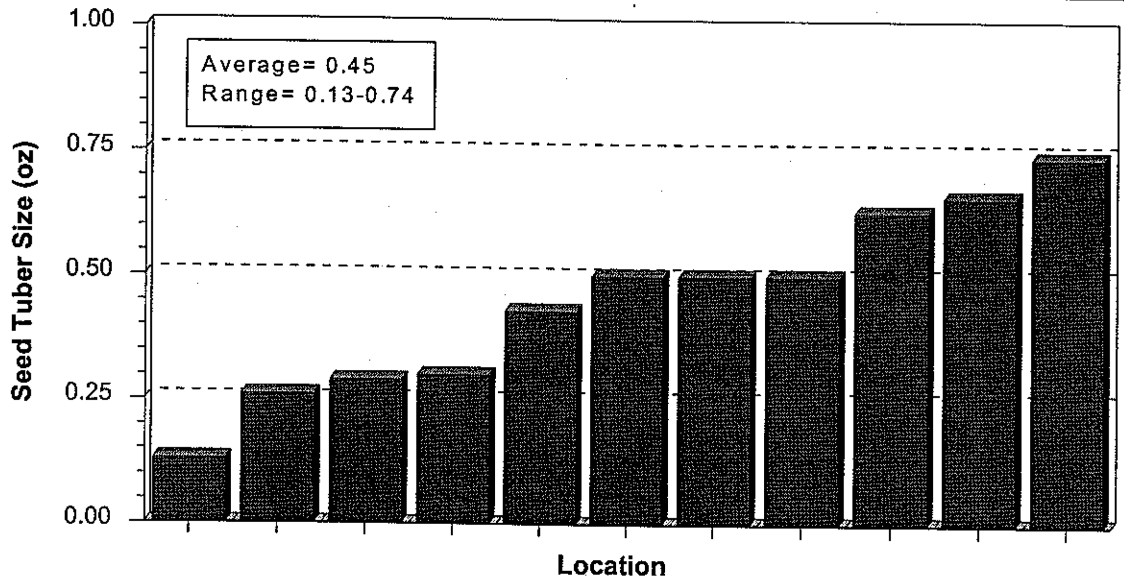

Figure 14: Average seed tuber size producing volunteer plants- 1998 Spring Survival Survey.

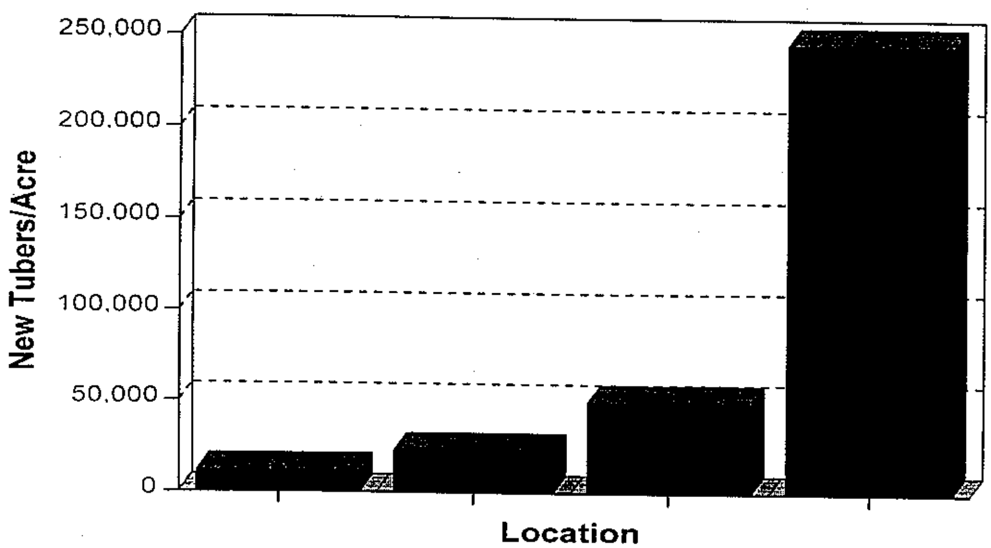

Figure 15: Number of new tubers produced by volunteer plants before the second week in May- 1998 Spring Survival Survey.

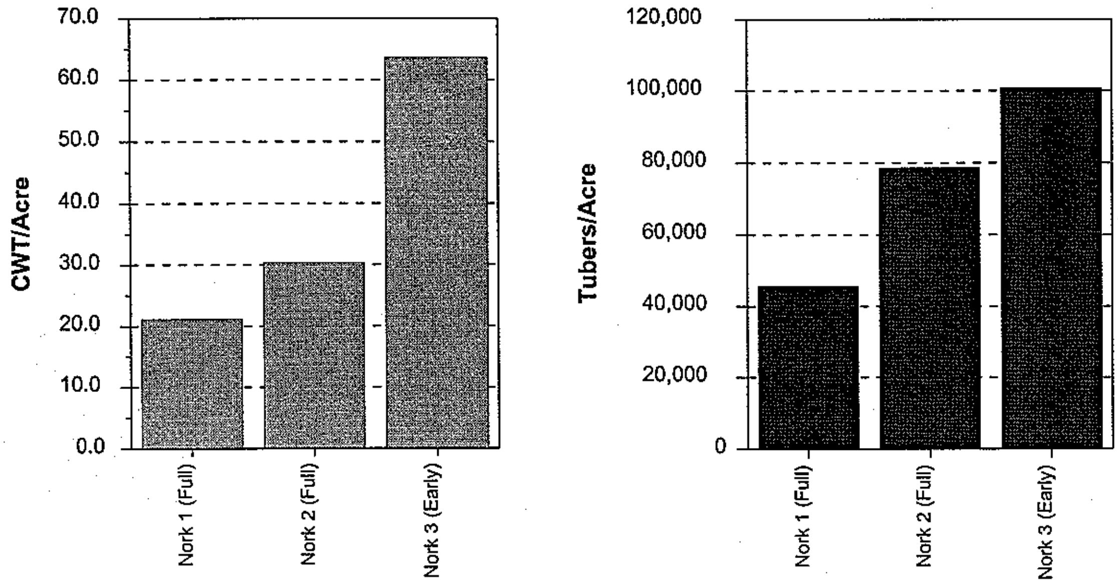

Figure 16: Tuber number and hundredweight per acre of three Norkotah fields sampled in the fall 1998. **Full** indicates a full growing season and **early** indicates early senescence of vines caused by early dying complex.

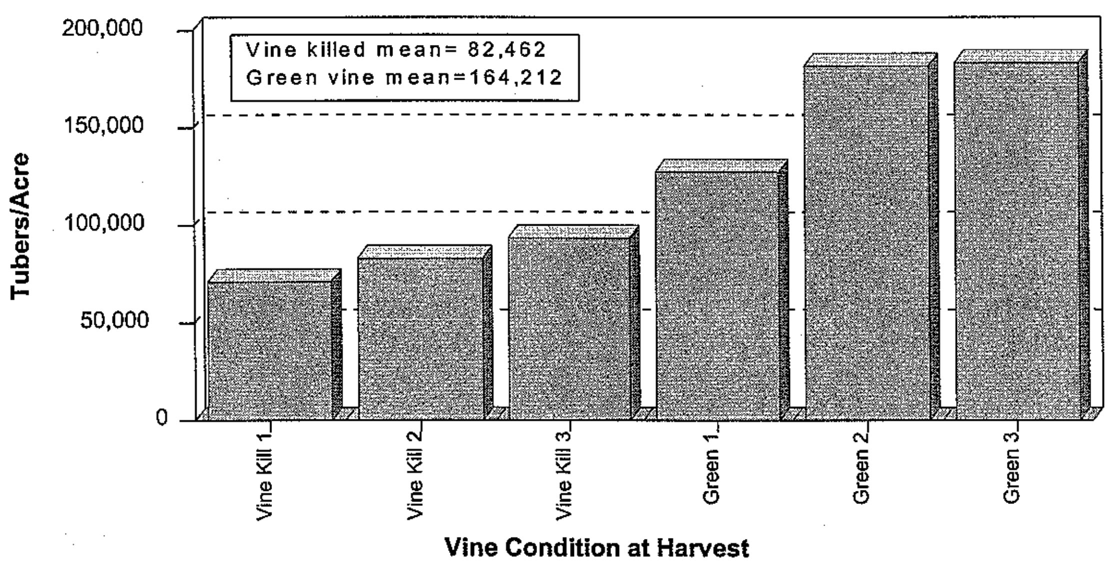

Figure 17: Affect of vine condition at harvest of Russet Burbank potatoes on tuber number- 1998 Harvest Leavings Survey.

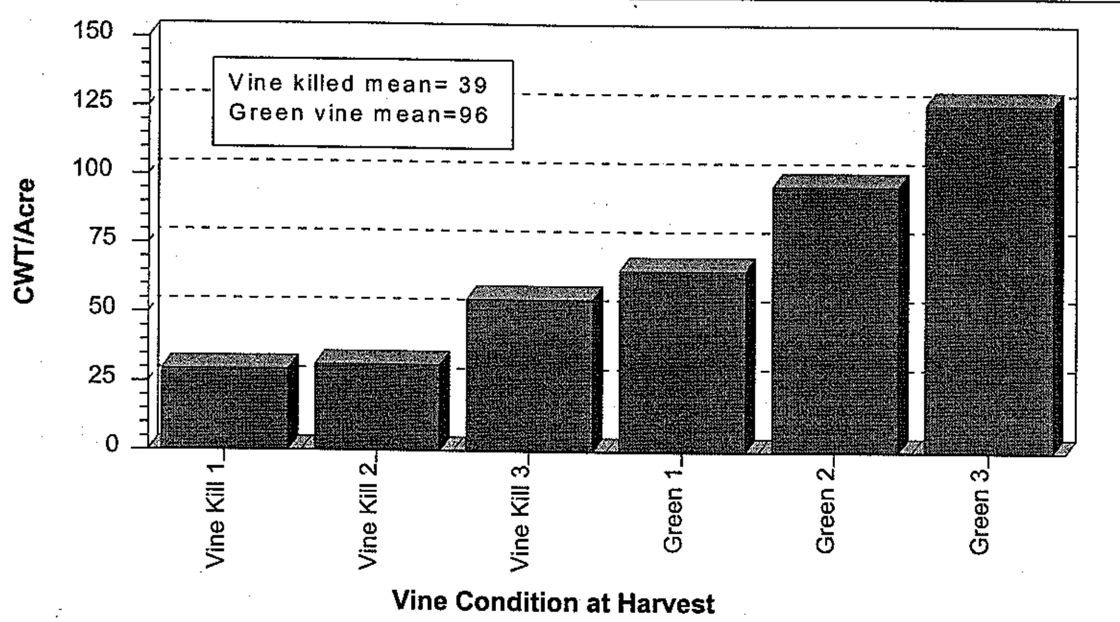

Figure 18: Affect of vine condition at harvest of Russet Burbank potatoes on the hundredweight per acre of leavings- 1998 After Harvest Leavings Survey.

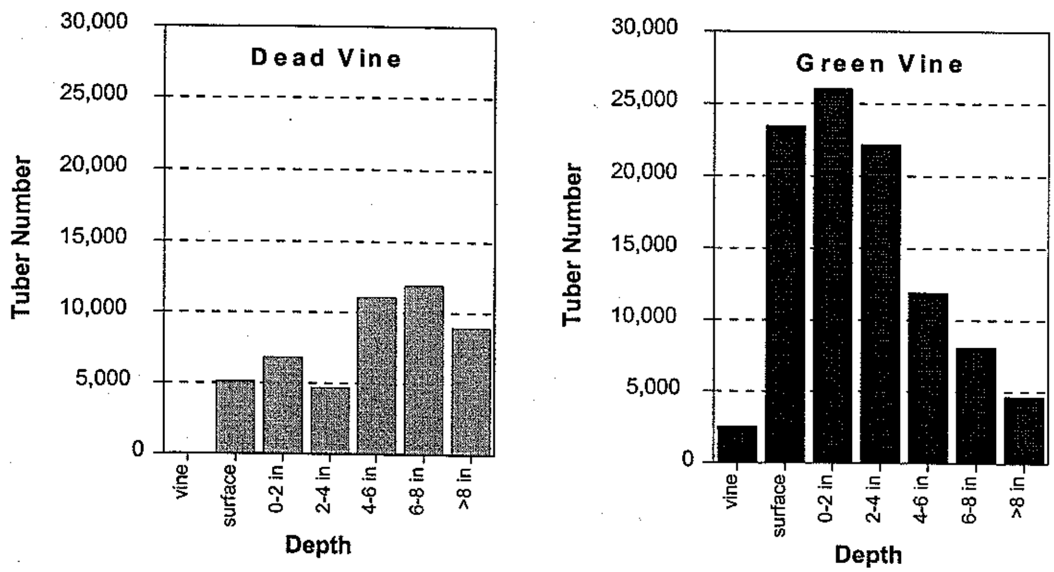

Figure 19: Affect of vine condition at harvest of Russet Burbank potatoes on the tuber depth distribution in the soil- 1998 After Harvest Leavings Survey.

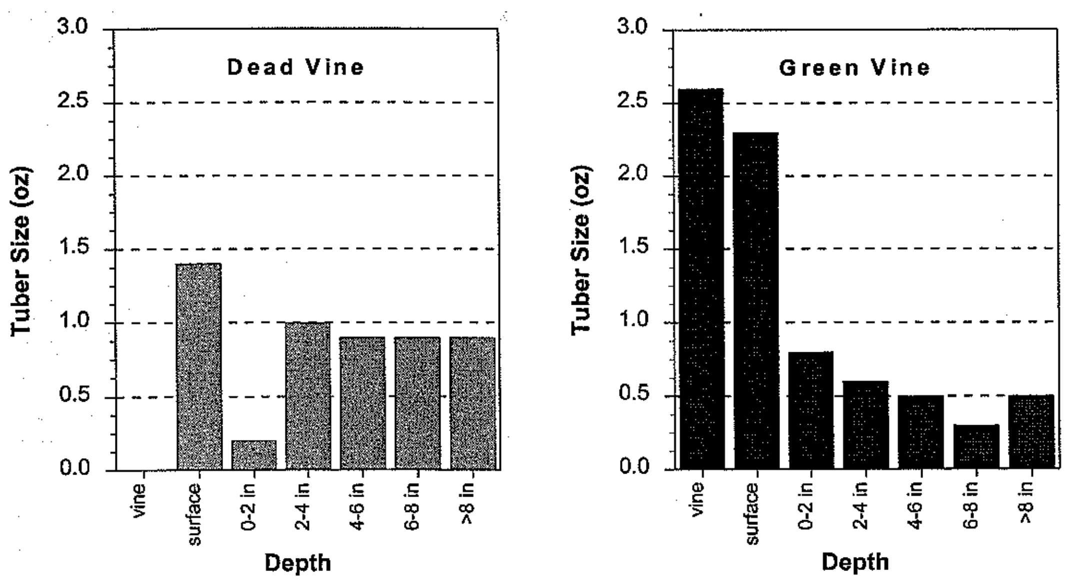

Figure 20: Affect of vine condition at harvest of Russet Burbank potatoes on the size of tubers at different depths in the soil profile- 1998 After Harvest Leavings Survey.