APPROACHES TO MANAGEMENT OF VOLUNTEER POTATO PLANTS

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INTRODUCTION

Recent after harvest and spring field surveys have shown that there are a high number of tubers remaining in potato fields following harvest and that a large number of these tubers survive the winter and produce volunteer plants the following spring. The after harvest surveys have also identified the types of tubers that are being left in fields during harvest which helps identify why they are being left in the field. Knowing what tubers are left and why they are left is information needed to decide what can be done to reduce the amount of tubers being left. The field leavings fall into three groups, 1) Marketable size tubers, 2) small unmarketable tubers; and 3) cut and broken tubers. Each of these groups of tubers is left in the field for entirely different reasons, indicating management practices that will minimize the problem will have to be quite different. The marketable size tubers are left in the field as a result of spillage from around the nose of the harvester, spillage off the truck during loading or in transit, or left at the end of the row from incomplete movement of the tubers off the blade and into the harvester. Small unmarketable tubers are those that fall through the harvester chains along with the separated soil or fall out at the transfer points between the various harvester conveyors. Cut tubers are the result of the harvester blade not being deep enough. Type of tuber leavings and possible methods for minimizing are listed in Table 1.

Table 1. Types of tuber leavings and potential solutions.

Marketable Tubers
Harvester Management (loading, spill out)
Crop Maturity
Cut/broken Tubers
Harvester Management (blade depth)
Small Tubers
Cultural Practices (tuber size distribution)
Harvester Management and Design

The types of tuber left by harvesting operation and the solutions identified, address only the issue of potential for volunteer plants. Spring surveys of the same fields have shown that not all tubers left after harvest produce volunteer plants and that the cultural practices associated with different rotation crops influences the amount of volunteer plants that develop. What has been learned about tuber leavings and volunteer plants suggest several approaches that can be considered to try to address the volunteer issue (Table 2).

Table 2. Approaches to Management of Potato Volunteer Plants.

Reduce Production of Small Tubers
Nutrient Management
Seed Piece Size and Spacing
Reduce Harvester Leavings
Operator Ability
Blade Depth Management
Forward Speed/Chain Speed Ratio
Reduce Tuber Viability
Sprout Inhibitors
Reduce Tuber Survivability
After Harvest Tillage

REDUCING PRODUCTION OF SMALL TUBERS

Nutrient Management-Greenhouse studies have shown that both nitrogen and calcium rates impact the percent of small tubers produced by individual plants. These same studies show that the source of nitrogen has an impact on the number of tubers per plant, which effects tuber size distribution (Table 3).

Table 3. Impact of Nitrogen and Calcium on Percent Small Tubers.

Nitrogen & Calcium Impact on % Small Tubers

N Rate	Low	Medium	High
	35%	29%	37%

Ca Rate	Low	High
	70%	17%

Nitrogen Source Impact on Tuber Number/Plant

N Form	NO3	NH4	NO3+NH4
	35	9	13

In these studies both low and high N rates had higher percent of small tubers than the medium rate. Since these were greenhouse studies it is not possible to translate the actual amounts of nitrogen into meaningful field application levels. A low calcium rate also resulted in higher percentage of small tubers than did the high rate. As with nitrogen, these greenhouse calcium rates can not be translated into field application rates. Plants grown with nitrate nitrogen (NO^3) as the only source of N had a higher number of small tubers than plants grown with either ammonia nitrogen (NH^3) alone or those grown with a combination of NO^3+NH^3. Plants with higher tuber numbers have been shown to have more small tubers compared to those with fewer tubers per plant. These results indicate that the rates of these nutrients play a role in tuber size

distribution and suggest that where large numbers of small tubers remain in the field following harvest the nutrient management program for these two elements should be reevaluated.

Seed Piece Size and Spacing-Extensive research over a number of years and varieties has shown that seed piece size and seed piece spacing, both the actual distance between seed pieces and the lack of regular spacing, have an impact on tuber size distribution which will influence percent of tubers under 4 oz. in size that are produced. In a 1988 study, seed pieces weighing less than 1.5 oz. produced 64 cwt. of less than 4 oz. tubers at harvest. When the same cutting operation cut seed with an average weight of 3.02 oz. the seed pieces weighing less than 1.5 oz. in a cut seed piece lot that averaged 1.34 oz. produced 5.5 cwt. of tubers less than 4 oz. in size. Irregular seed piece spacing has been shown to be an especially important factor influencing production of < 4oz. tubers (Table 4).

Table 4. Effect of Seed Piece Spacing on Russet Burbank Tuber Size Distribution.

US #1 Tuber Size Distribution				
	< 4 oz.	4 - 10 oz.	10 – 14 oz.	> 14 oz.
Seed Piece Spacing	% Total	% Total	% Total	% Total
4.5" *	20	55	9	4
9"	9	49	16	7
9" (2x) **	21	54	8	4
18"	6	35	14	12
18" (2x) *	11	54	10	9
27"	4	17	15	16
27" (2x) *	8	38	17	10
27"(3x) ***	12	47	10	4

* 4.5" = Two seed pieces for a 9" spacing, but not at a single location
** 2x = Two seed pieces at indicated spacing
*** 3x = Three seed pieces at indicated spacing

As seed piece spacing increased from 9 to 27 inches the percent of total yield less than 4 oz. increased. A response to missing seed pieces (skips). Most often skips occur due to seed piece not ending up in the intended location. This frequently results in multiple seed pieces at a single location (2X and 3X in Table 4) or seed pieces at closer than intended spacing (4.5 in. spacing in Table 4). In all cases plants produced by the irregular spaced seed pieces have a higher percent of the tubers that are less than 4 oz in size. Less than 4 oz. size tubers have been shown to be those most frequently left in the field after harvest and are the tubers that produce the majority of the volunteer plants.

REDUCING HARVESTER LEAVINGS

Operator Ability-There is no official data concerning the contribution that harvester operator performance has on the number of tuber being found in potato fields following harvest. Observation of field leavings and volunteer plants during the spring surveys has however, shown that it is not uncommon for tubers and volunteer plants to show patterns that can only be accounted for by tubers that are pushed out around the throat of the harvester or spill off the truck. Adequate harvester operator skill and attention to harvester management are the only methods that can reduce the amount of tuber left for these reasons.

Blade Depth-One of the characteristics of the material found in the after harvest leavings surveys is cut tuber pieces. Cut tubers result almost exclusively when the harvester blade depth is too shallow to be below all tubers in the row. The amount of material, which remains in the field due to inappropriate blade depth, varies considerably between locations (Figure 1). Operator awareness and periodic examination of harvested tubers will minimize this portion of the problem.

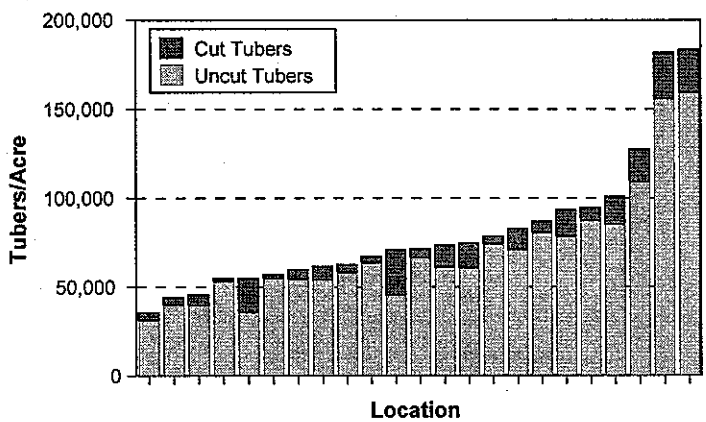

Figure 1. 1998 After Harvest Leavings --Cut and Whole Tubers per Acre.

Forward Seed to Chain Speed Ratio-As is the case with harvester operator ability there is no definitive data that confirms that operation a harvester at the appropriate chain speed to ground speed ratio reduces the number of tubers left in a field after harvest. There are however, visuals of the tuber leavings on the surface of fields following harvest that show a substantial difference in the amount of tuber leavings. Since the after harvest surveys have shown that many of the tubers that are not removed at harvest are below the soil surface these visuals may be give a false impression of the impact chain speed ratio has on tuber leavings, but should be considered when high numbers of volunteer plants are present in fields following potatoes in the rotation.

REDUCING TUBER VIABILITY

Sprout Inhibitors-In spite of efforts to reduce the production of small tubers and reduce the amount of tubers left in harvested potato fields, it is not possible to achieve complete control of volunteer plants with these methods indicating that additional measures are required. Reducing the viability of the tubers that remain after harvest that may produce volunteer plants with the use

of a sprout inhibiting chemical such as Maleic Hydrazide (MH-30) has been shown to have an impact on volunteer plant numbers. MH-30 has been used for a number of years to control sprouting of potato tubers intended for commercial trade. Results from trials, which involved the planting of market size MH treated tubers, have shown nearly complete control of volunteer plants (Figure 2).

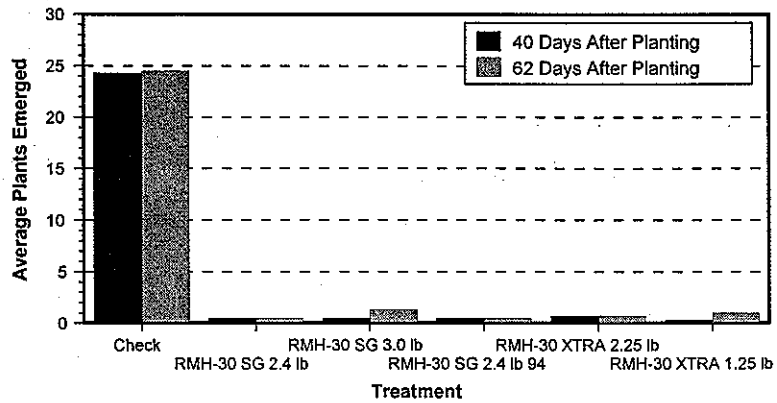

Figure 2. Percent of MH-30 treated tubers producing volunteer plants.

Recent industry experience and results of the spring volunteer plant surveys have found that there are instances where high numbers of volunteer potatoes are present in fields where MH was applied to the potato crop the previous growing season. As a result of this observation further studies were carried out to determine if tuber size and variety affect residue of MH in tubers. Results from several years of these trials indicate that the residue level differed between varieties and tuber size within a variety (Figure 3a and 3b).

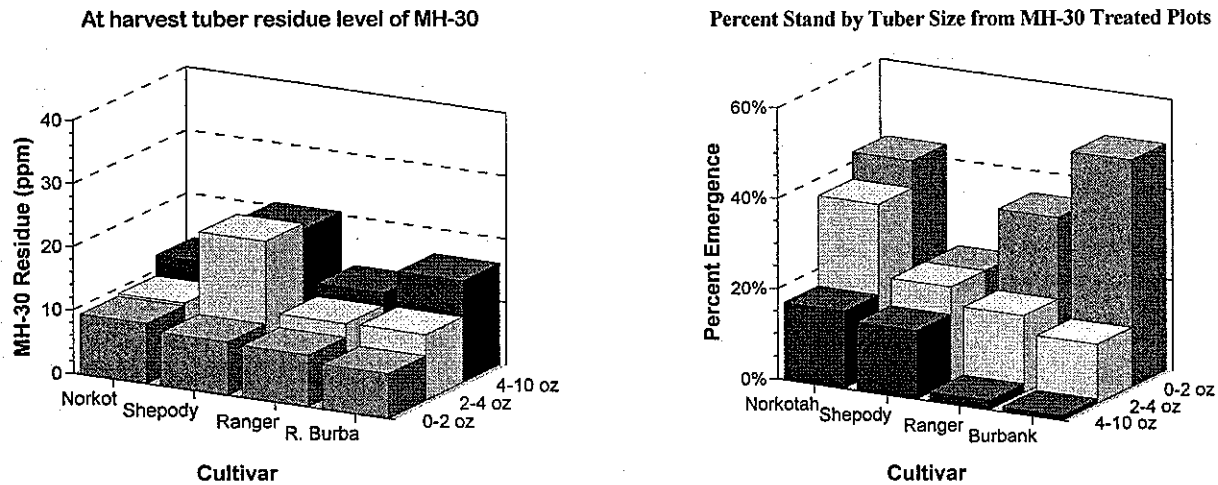

Figure 3. a)MH-30 Tuber Residue and b)Percent of Treated Tubers Producing Volunteer Plants.

Tubers less than 2 oz in size of all cultivars had the lowest MH residue and the highest percent of tubers producing volunteer plants. The MH residue in tubers of this size was in most cases just at or below the 10 ppm required for sprout inhibition. The percent of tubers < 2oz. in size of different varieties produced volunteer plant numbers consistent with the residue levels found in this size of tubers. The residue levels in tubers larger than 2 oz were higher than in the smaller size tubers and consistently above the 10 ppm sprout inhibiting level. In the larger size tubers there was a difference in the residue level based on variety. These results indicate that if MH is to be a part of the management strategies to reduce the number of volunteer plants in fields following potato production there is a need to develop application rate and timing that is appropriate for the individual varieties. In addition, management options that address the low residue level in the small tubers that are most frequently left in fields need to be developed.

REDUCING TUBER SURVIVABILITY

After Harvest Tillage-It is apparent that the production of small tubers can not be entirely eliminated and that some tubers will be left in the field and remain viable. An additional approach to reducing the number of volunteer plants that are present would be to reduce the number of tubers that survive the winter. There are studies that report different amounts of volunteers associated with cultural practices used for producing different crops in potato rotations. Some of these studies indicate that the fall tillage associated with the different cropping patterns is a factor in the survivability of tubers. As a result of this information, studies were conducted to determine if the fall tillage practices commonly used by the potato industry in Washington influenced the amount of tubers that survive and produce volunteer plants the following spring. Small tubers (< 4 oz.) were planted at the five depths (surface, 2,4,6 and 8 inches). These are the depths used to characterize the profile of tuber leavings in the after harvest surveys. Following planting the area was tilled by different tillage methods (Table 5).

Table 5. Depth by Tillage Trial Tillage Treatments

1997	1998
Non-Tilled	Non-Tilled
Chisel/Rod Weed	Para-Plow
Light Disk (< 6")	Medium Disk (8-10")
Deep Disk (> 12")	Moldboard Plow

The percent of the planted tubers that survived the winter and produced volunteer plants was determined the following spring (Figure 4a and 4b).

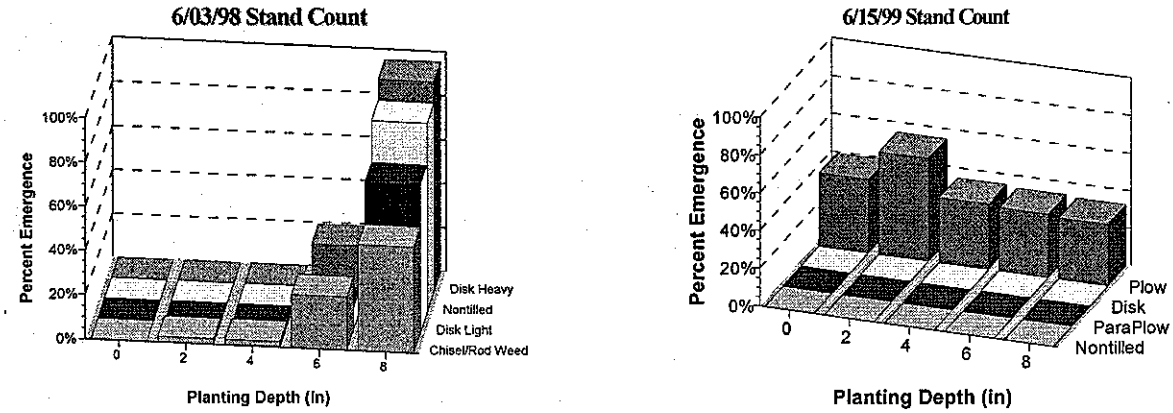

Figure 4. Percent of Planted Tubers That Survived and Produced Volunteer Plants the Following Spring a) 1997/1998 trial, b) 1998/1999 trial.

The survival rate in the 1997/1998 trial was higher than that in the 1998/1999 trial. In both trials the deeper the tubers the higher the rate of survival. In the 1997/1998 volunteer plants were produced in all tillage treatments and at all planting depths except those placed on the surface. The following year survival occurred only in the mold board plow treatment. In that treatment tubers survived and produced volunteer plants at all planting depths including those placed on the soil surface. These data show that any fall tillage practice that results in the placement of tubers deeper than 4 inches in the soil will inhance the survivability of tubers. Those tillage practices that bring tubers up to within 4 inches of less of the soil surface will reduce the number of the tubers left in fields following harvest that are able to produce volunteer plants the following spring.

CONCLUSIONS

- The majority of the tubers left in the field are white tubers.
- After harvest leavings are a result of small tubers falling through the conveyor chains of the harvester (design problem) or marketable tubers from operator error.
- The leavings are distributed throughout the soil profile in harvested potato fields.
- Small tubers are capable of surviving the winter and producing volunteer plants the next season.
- Many factors can change the amount and location of harvester leavings. Early vine senescence (small tubers) immature vines profile at harvest (marketable tubers) of can change the number, size and/or location within the soil profile of leavings.
- Cultural practices and harvester management may reduce, but not eliminate harvester leavings.
- Tuber viability can be reduced with MH-30.
- Tuber survivability is impacted by both fall and spring tillage practices.
- Rotation crop and the accompanying cultural practices impact tuber viability and survivability of tubers.