VARIETY CHOICE AS A TOOL TO MANAGE STRESS

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Stressful growing conditions, resulting from environmental or management-induced conditions, are directly related to potato tuber yield and quality. Stress-induced tuber defects directly impact the value of a potato crop. Some of the most common tuber problems that result from stress include second growth, growth cracks, malformations, hollow heart, sugar ends, heat necrosis, stem-end discoloration, heat sprouts, shatter bruise, and blackspot bruise.

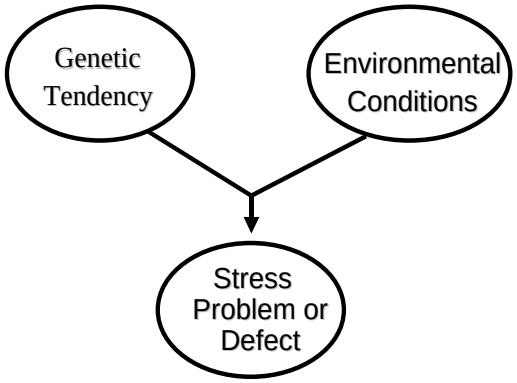
Widespread drought conditions the past few years have imposed considerable stress on potato crops. However, stress of one type or another is a normal occurrence in any cropping year. Stress conditions can be a result of either environmental conditions or incorrect management decisions (Table 1).

Table 1. Causes of environmental and management-related stresses on a potato crop.

Environmental Stresses	Management-Related Stresses
Drought/excess rainfall	Soil moisture deficits/excesses
Temperature extremes	Nutritional excesses/deficits
Pest pressure	Inadequate pest control
Hail	Improper soil preparation/cultivation
	Improper rotations
	Poor stand establishment
	Tuber injury

The occurrence of stress-related quality problems is the result of interactions between the genetic tendencies of a variety and the environmental conditions (natural or imposed) surrounding the crop (Figure 1). Serious quality problems are associated with producing a susceptible variety under stressful conditions that clash with existing genetic weaknesses. This association is made more complex by interactions among types of stress and between varieties and those stresses. As a result, managing a

Figure 1. Interaction between genetic and environmental factors producing tuber quality problems.



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potato crop often becomes a process of balancing between extreme responses to stress factors. For example, managing early season soil moisture conditions often becomes a tight rope act between avoiding diseases and problems prevalent under low moisture conditions versus those that occur at high moisture conditions (Figure 2).

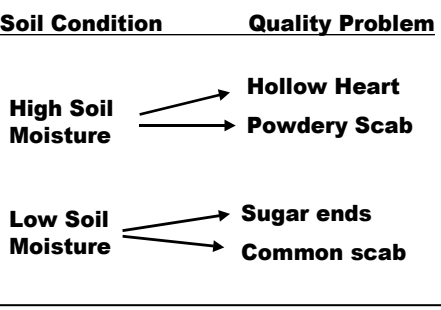


Figure 2. Potential tuber quality problems resulting from high or low soil moisture levels during tuber initiation.

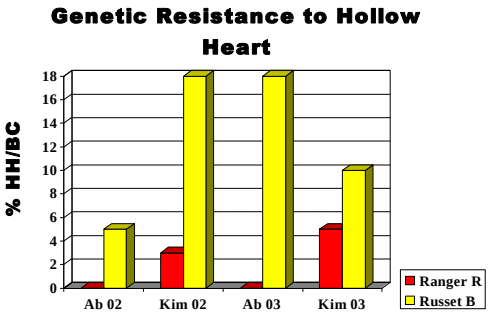
In large measure, managing a potato crop is a process of managing the weaknesses and susceptibilities of the variety produced. A variety that is susceptible to stress-induced yield losses, defects, and quality problems requires more (and more expensive) inputs than a variety that is resistant (Table 2). A variety that has a broad range of resistances to biotic (pests and diseases) and abiotic (physical environment) stresses can be managed less intensively and without as much risk.

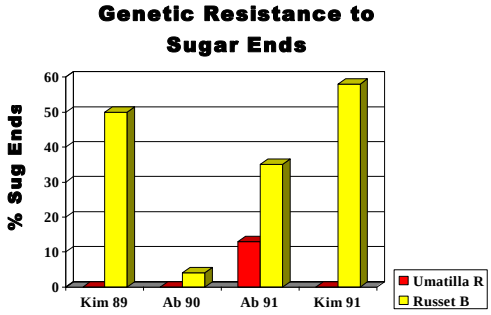
Table 2. Relative intensity of management inputs based on the level of varietal resistance.

Resistance Level	Level of Management Inputs
High	Low
Moderate	Moderate
Low	High

Many years of potato variety trials have demonstrated that varieties vary widely in their resistance to stresses and tuber defects that tend to reduce quality (Figures 3 and 4). For example, compared to Russet Burbank, Ranger Russet is very resistant to hollow heart. Umatilla Russet seldom develops problems with sugar ends. Russet Norkotah, across environments with differing levels of stress, maintains a more constant tuber specific gravity than does Russet Burbank. Under conditions of imposed irrigation deficits, Russet Burbank and Alturas show large stress-induced yield losses, while Gem Star Russet (A9014-2) and Ranger Russet do not.

Recently, a comparison was made of variety performance in three separate years, each with distinct temperature stress levels. The years were 1999, a relatively mild year season-long; 2002, with 2 to 3 weeks of unusually hot temperature during tuber set followed by moderate temperatures during the remainder of the season; and 2003, with moderate temperatures through early tuber development followed by very hot temperatures throughout the remainder of the growing season (Figure 5). The amount of stress to which the crop was exposed was highest in 2003, intermediate in 2002, and lowest in 1999.





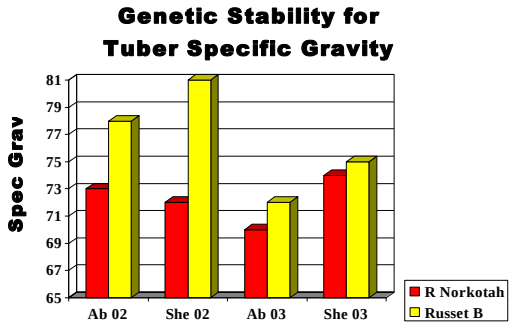
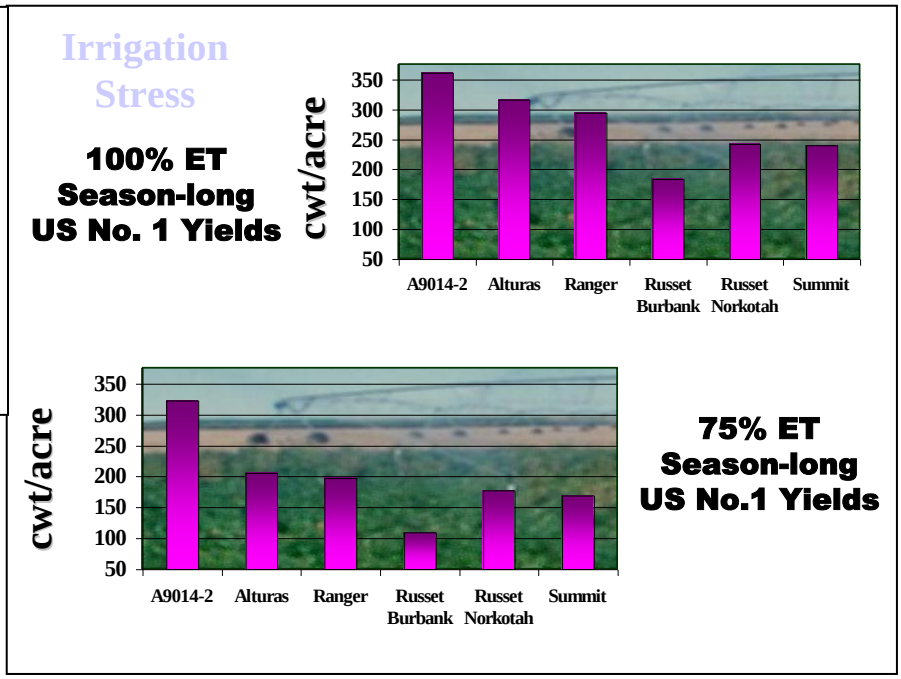


Figure 3. Comparison of Russet Burbank with Ranger Russet, Umatilla Russet, and Russet Norkotah for resistance to hollow heart and sugar ends and stability of tuber specific gravity.

Figure 4. Yield comparison of 6 varieties at full irrigation (100% ET) and under season-long water deficit (75% ET).



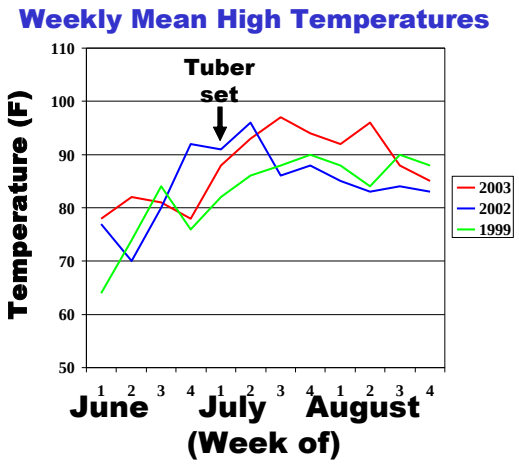


Figure 5. Weekly averages for daily high temperatures during the growing season in 1999, 2002, and 2003.

The response of four varieties within these growing seasons for yield, %US No. 1 tubers, specific gravity, and sugar ends is shown in Figure 6. Yield responses for Russet Burbank and Ranger Russet were lowest in the worst and mildest stress years. As long as they had good growing conditions during most of the bulking period, these varieties produced well. On the other hand, yields for Summit Russet and Alturas corresponded directly with the amount of stress.

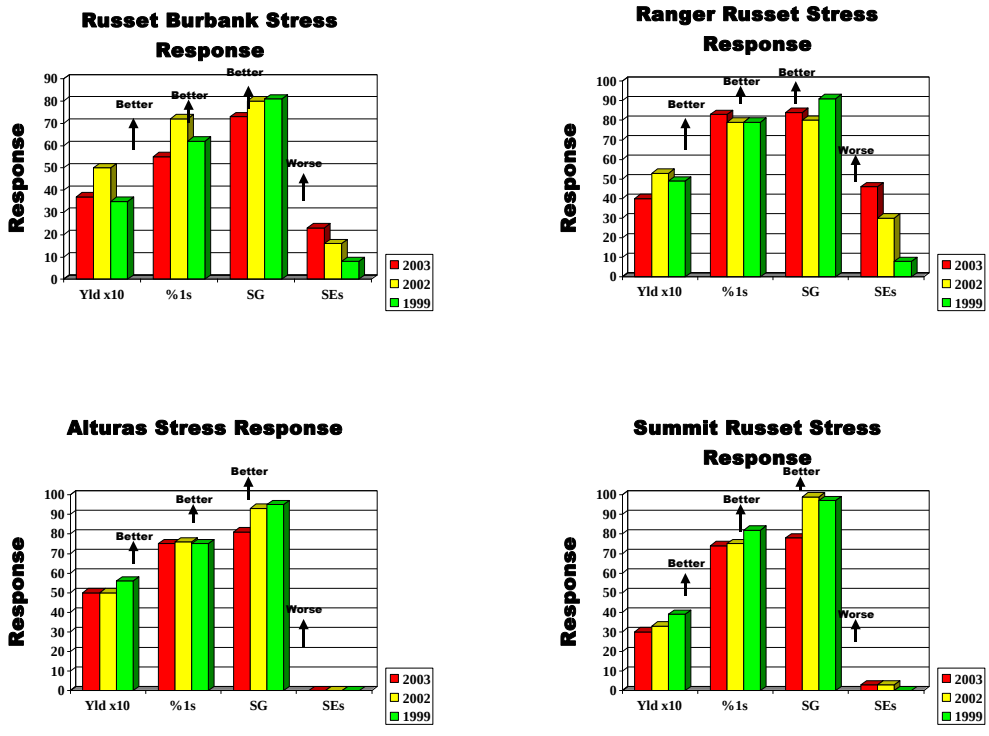


Figure 6. Varietal response to 3 production years, each with differing heat-stress levels.

Three of the four varieties showed a decrease in tuber specific gravity that corresponded with the amount of stress experienced. The exception to this was Ranger Russet, which maintained relatively high specific gravity even in the stressful years. Ranger Russet and Russet Burbank showed markedly higher sugar end incidence in the years with heat stress. Alturas and Summit Russet showed very low sugar end incidences, even under extreme stress. This illustrates even further the differences in varieties and the value of stress resistance.

A list of varieties can be made with respect to resistance or susceptibility to the most common stresses experienced in Idaho. Of the varieties currently available or being produced, the list looks like this:

Varieties with:

Resistance to Heat and Drought Stress

Ranger Russet
Gem Russet
Gem Star Russet (A9014-2)
Russet Norkotah
CalWhite
Umatilla Russet

Resistance to Defoliation Stresses

Ranger Russet
Gem Russet
Gem Star Russet (A9014-2)
Russet Norkotah (affects yield)
CalWhite
Bannock Russet
Alturas
Summit Russet

Resistance to Nutrient Imbalances

Ranger Russet
Umatilla Russet
Gem Russet
CalWhite
Gem Star Russet (A9014-2)

Resistance to Hollow Heart

Ranger Russet
Umatilla Russet
Shepody
Alturas

Resistance to Net Necrosis

Ranger Russet
Russet Norkotah
Gem Russet
Umatilla Russet
Shepody
Alturas
Bannock Russet
Summit Russet
Gem Star Russet (A9014-2)

In summary, each of the common varieties available for production in Idaho has unique characteristics that potentially can make them useful for managing stress-related quality issues. As the Idaho potato market continues to diversify, variety choice will become more important as a management tool.