FACTORS AFFECTING RUSSETING OF RUSSET BURBANK POTATOES

N. Holstad

INTRODUCTION

The premium price paid for the Russet Burbank potato is based on many factors, such as its excellent baking and frying qualities, its long shape, and general eye appeal. One of the factors in eye appeal of russets is, of coarse, its russeted shin. This russeting, as well as being attractive, also provides some mechanical protection and helps to mask and retard the development of green pigmentation when the tubers are exposed to light. Each year many russets are grown which lack or partially lack the characteristic russeted skin.

Many terms have been used to describe this lack of russeting. Some of the more common ones are: smooth skins, slick ends, smooth tubers, and netting [or lack of it]. In this report we shall describe the degree of russeting as the percentage of the tuber surface with smooth skin.

Commonly the basal [stem] end of the tuber may be smooth while the apical [bud] end may be well russeted. This, however, is not always the case as I have seen tubers which were well russeted at both ends and smooth in the middle, circular areas of poor russeting, and smooth apical ends, etc.

In order to evaluate the effects of various experimental treatments, a 0-100 scale was established, the scale being based on the percentage of the tuber surface with poor russeting [smooth skin]. When the average reading is 10 or less, it indicates that the tubers are very well russeted. Readings of 15-25 indicate that a lack of russeting would be noticable, with casual observation, but would not seriously affect the eye appeal of the potatoes. When the percentage of smooth skin goes above 25, the problem becomes more evident and a noticable loss in eye appeal may take place.

Briefly let us look at some of the factors which have been reported to influence russeting. Some of these causes of smooth skins are based on only a few observations while others have been extensively studied.

Nitrogen fertilizers: Increasing rates of nitrogen may reduce the amount of russeting.

Phosphorus fertilizers: Increasing rates of phosphorus fertilizers may be beneficial to a limited extent.

Potassium fertilizers: Increasing potassium fertilizers may decrease the amount of russeting and the chloride [muriate] form may be more detrimental than the sulfate form.

Placement effects: The data is inconclusive but banding of nitrogen and potassium may be more detrimental than broadcast applications.

Sources of fertilizer: The formulation of the fertilizer may have an influence on russeting. Acid fertilizers may be more detrimental and phosphate fertilizers high in water solubility may be of more benefit.

Soil temperature: Tubers developing in cold or warmer than normal soil are likely to have poor russeting.

Soil Moisture: Moist soil is more conducive to good russeting than dry soil.

Soil Texture: Well aerated [coarse] soils are more likely to produce well-russeted tubers.

Soluble salts: Observations in Idaho indicate that soils high in soluble salts will produce poorly russeted potatoes.

pH: Wisconsin has reported that when the Russet Burbank potato is grown on strongly acid soils, the type is not good and the tubers are poorly russeted.

EFFECTS OF FERTILIZERS

An experiment conducted in 1963 compared four rates of nitrogen, phosphorus, and potash in all possible combinations. Nitrogen was applied at 100, 200, 300 and 400 pounds of N per acre. Phosphorus and potash were applied at the rates of 0, 133, 267 and 400 pounds of P_2O_5 and K_2O respectively. All of the fertilizer was banded at planting time.

As the level of nitrogen was increased, the degree of russeting decreased. Potash application had a similar depressing effect on russeting. Phosphorus applications apparently were of some benefit. [Fig. 1] These are main effects and do not tell the complete story.

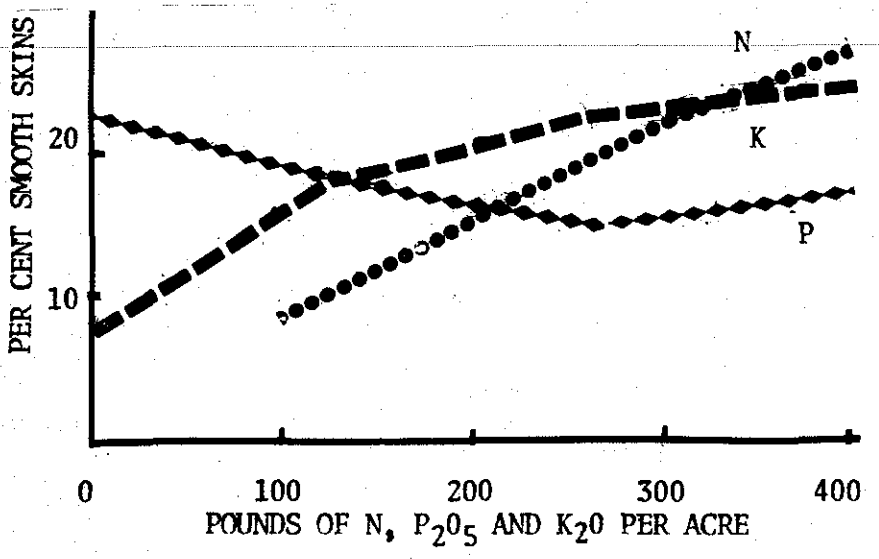

Figure 1. Effect of nitrogen, phosphorus and potassium fertilizers on the percentage of tuber surface with smooth skin. 1963 Fertilizer Factorial experiment.

Looking at some of the individual treatments [Table 1],

Table 1. Effect of various levels of nitrogen, phosphorus and potassium fertilizers on the percentage of tuber surface with smooth skins. Data from 10 of the 64 treatments in the 1963 Fertilizer Factorial experiment.

POUNDS PER ACRE			% SMOOTH SKIN
N	P_2O_5	K_2O	
100	0	0	2.3
100	399	0	.2
100	0	399	16.5
100	399	399	17.3
100	267	399	13.0
400	0	0	24.5
400	399	0	11.0
400	0	399	37.0
400	399	399	28.6
400	267	399	29.0

some further conclusions can be drawn. Let us first look at the column where nitrogen was applied at 100 pounds. As long as the potash level is at zero, the russeting is excellent and adding phosphorus improved on this already excellent russeting. As the potash level was increased to 400 pounds of K_2O per acre the amount of russeting declined substantially, although the russeting would be rated at least as satisfactorily. Here the phosphorus effect is small although 300 pounds of P_2O_5 was a slight benefit, but 400 pounds was no different than zero phosphate.

When only nitrogen was applied at 400 pounds of N per acre, almost 25 per cent of the tuber surface was smooth, an amount high enough to be easily noticed. 400 pounds of P_2O_5 per acre substantially reduced the amount of smooth skins. The poorest russeting among all 64 treatments occured when 400 pounds per acre of both N and K_2O were applied. Additions of phosphate was of some value but did not correct the problem [Table 1].

A similar experiment conducted in 1964 gave results which were almost carbon copies of the 1963 data [Fig. 2].

In an experiment conducted in 1960 it was found that three fertilizer mixtures greatly increased the amount of smooth skin. The following year a comprehensive experiment was put on a farm which had many smooth-skinned tubers in 1959. The treatments included two dates of planting, April 11 and May 2. In this experiment, there was no great effect on russeting regardless of the fertilizer used or the dates on which the potatoes were planted [Table 2].

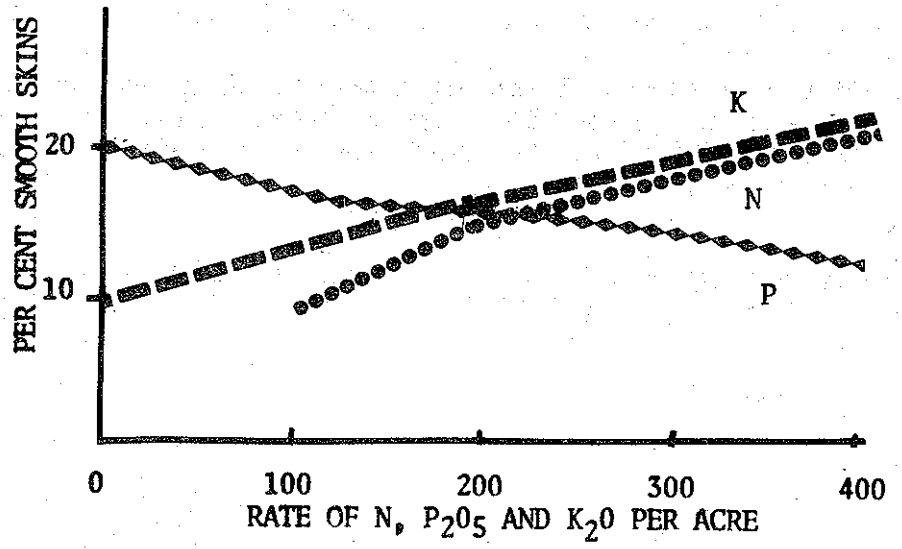

Figure 2. Effect of nitrogen, phosphorus and potassium fertilizers on the percentage of tuber surface with smooth skin. 1964 Fertilizer Factorial experiment.

Table 2. Effect of various fertilizers on the percentage of tuber surface with smooth skins in two different years.

POUNDS PER ACRE			YEAR	
N	P_2O_5	K_2O	1960	1961
128	128	128	38.5	
140	140	140		8.0
128	128	65	32.0	
140	140	70		4.6
128	64	0	24.0	
140	70	0		3.8
128	384	0	3.0	
140	420	0		0.7
128	160	0	5.0	
140	175	0		1.8

In 1965 and 1966 an experiment to determine the effects of potash sources and rates on russeting was conducted near Othello, Washington. The same treatments were planted on the same plots for two consecutive years. Muriate, sulfate, and nitrate of potash were used at 0, 120, 240 and 360 pounds of K_2O per acre. Nitrogen and phosphorus were applied at 300 pounds of N and P_2O_5 respectively. This fertilizer was banded at planting time two inches below and two inches to each side of the seed piece.

The differences in russeting due to sources of potash were small, but generally followed previously established trends. The chloride [muriate] form reduced russeting more than either the sulfate or nitrate form, but it should be emphasized that the differences are so small as to be of only a minor importance [Fig. 3]. The fact that the nitrate form reduced russeting essentially to the same degree as the other two forms indicate that it is the potassium itself and not the chloride or sulfate commonly associated with the potassium in commercial fertilizer, that has the effect on russeting.

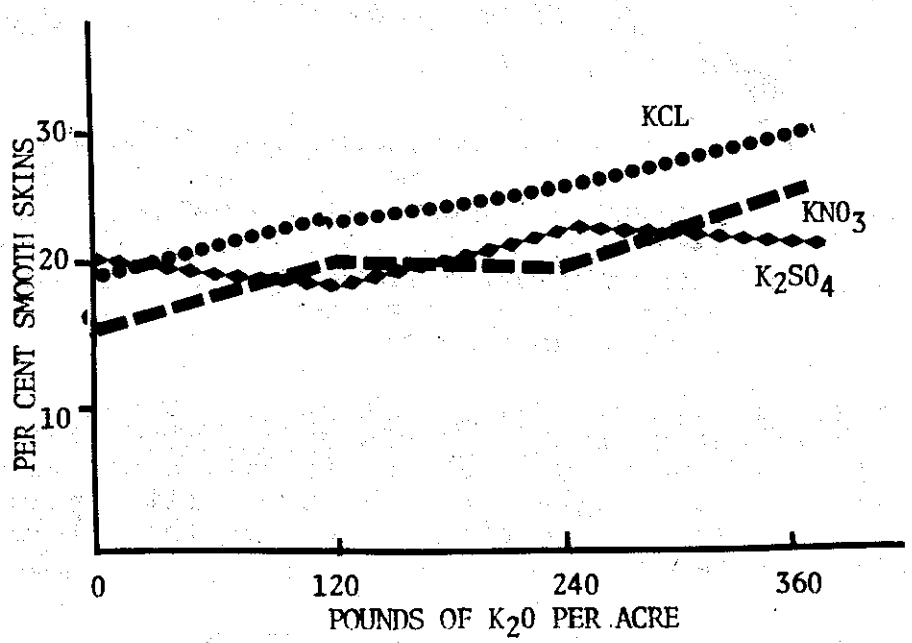

Figure 3. Effect of rates and sources of potash fertilizers on the percentage of tuber surface with smooth skins.

Looking at the rates of potash it appears that increasing the rate has a depressing effect on russeting. Again, however, the total range is not very large and the economic importance of the differences is doubtful.

That the pH [acidity] of the fertilizer used may be a factor is shown in Fig. 4. In the one experiment, dry fertilizer with a pH of 5.4 [acid] depressed russeting more than either dry or liquid fertilizers with a pH of 8.0 [basic]. It should be emphasized that the fertilizer with a pH of 5.4 has at times produced potatoes with excellent russeting.

In some instances the placement of the fertilizer has a pronounced effect on russeting, and the effect is usually accentuated as the total amount of fertilizer is increased.

An experiment to test the effect of method of fertilizer application was conducted on the Othello station in 1962. The fertilizer treatments were applied [1] by banding all of the fertilizer at planting time, [2] by broadcasting and plowing under half of the fertilizer and banding half of the fertilizer at planting time, and [3] by broadcasting and plowing under

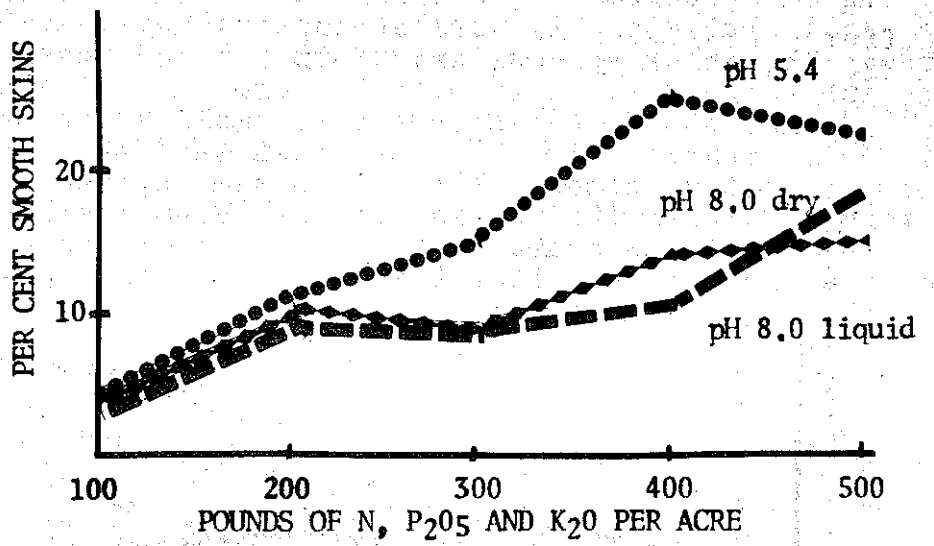

Figure 4. Effect of various rates of fertilizers with different pH's on the percentage of tuber surface with smooth skins.

all of the fertilizer. Rates were up to 240 pounds of N and P_2O_5 per acre and up to 300 pounds of K_2O per acre. In a few cases, the all banded applications significantly reduced russeting to a greater degree than did the split applications which in turn reduced russeting more than the all broadcast applications [Fig. 5].

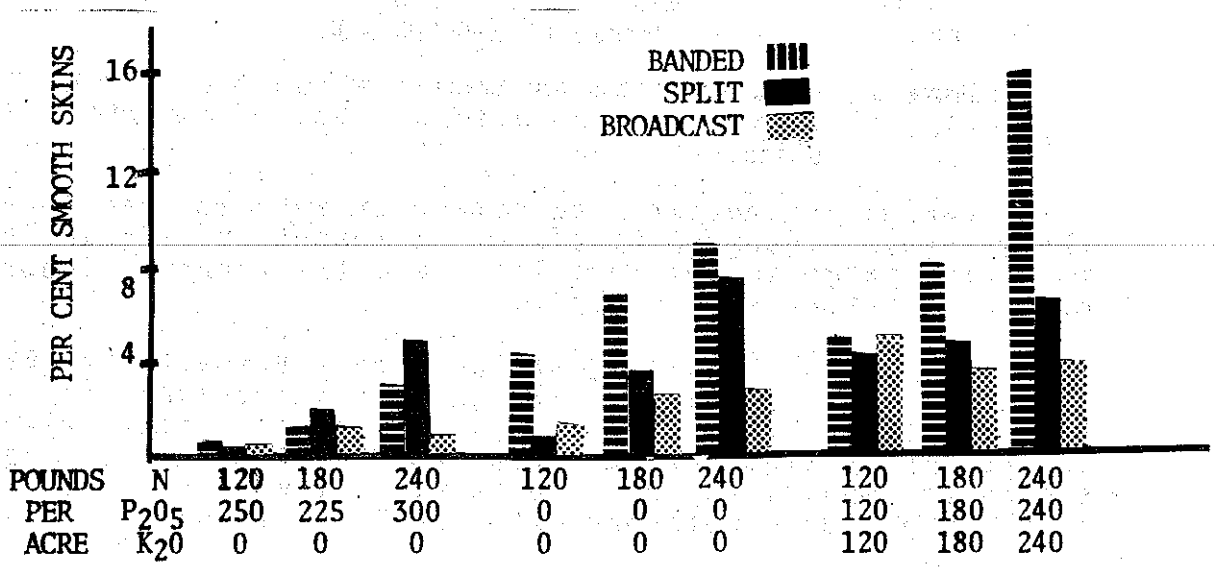

Figure 5. Effect of 3 different fertilizer mixes with 3 different rates and 3 methods of application on the percentage of tuber surface with smooth skin.

It should be noticed here that in only one treatment, the high rate of fertilizer, all banded, did the per cent of smooth skins go above 12 per cent, thus in general the russeting was very good in this experiment.

In another experiment where much higher rates were used, a difference between methods of application did not occur until 320 pounds of N, P_2O_5 and K_2O per acre had been applied [Fig. 6].

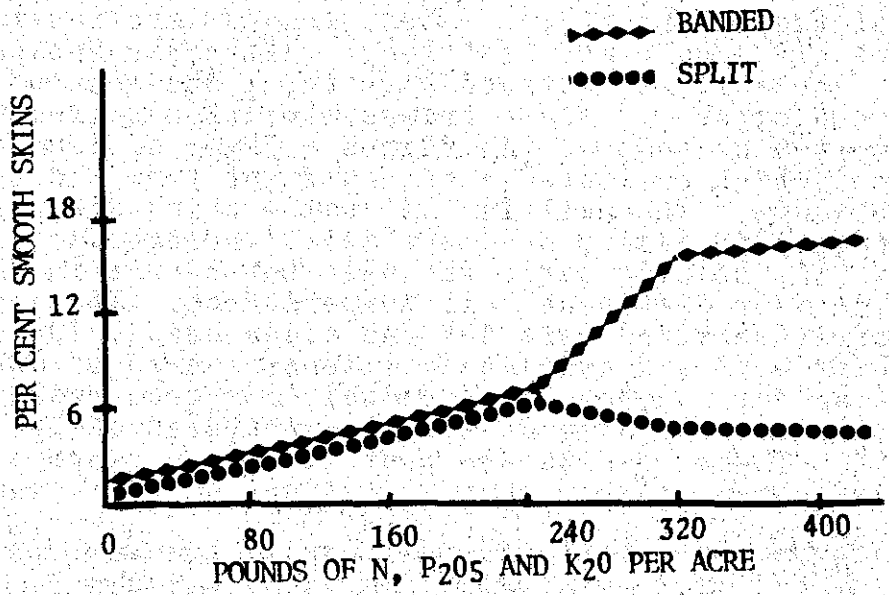

Figure 6. Effect of 2 methods of application and 6 different rates of fertilizers on the percentage of tuber surface with smooth skin.

The increase in russeting at rates of over 240 pounds, with the split method is unusual.

Despite the data which seems to be indictive of N and K as a detriment to good russeting, there are many reasons to believe the fertility does not control russeting. On single stem plants with one root system, it is not unusual to find both very well russeted and poorly russeted tubers. This type of variation is difficult to explain from a nutritional standpoint.

From the rate and source of potassium experiment, tubers with very good russeting and with poor russeting were chemically analyzed for nitrogen, phosphorus, potassium, calcium, and magnesium. No differences in chemical makeup of well and poorly russeted potatoes were found [Table 3].

Table 3. Chemical analysis, expressed as per cent dry weight, of well and poorly russeted potatoes.

	N	P	K	Ca	Mg
Well Russeted	1.2	.12	1.5	.70	.93
Poorly Russeted	1.2	.11	1.6	.70	.90

EFFECTS OF SOIL MOISTURE AND TEMPERATURE

A soil moisture and temperature experiment was conducted to evaluate the effect of temperature and moisture on tuber russeting. Special frames were constructed to define the limits of the potato ridge. These frames were six inches high, 17 inches wide and eight feet long. After the potatoes were planted, the soil was scraped away until the tops of the seed pieces were exposed. These frames were then filled with soil. At the bottom of some of the frames a layer of vermiculite was placed which prevented water movement from the furrow up into the ridge. The soil in the frames which did not have this vermiculite layer, was kept moist throughout the growing season. Soil heating cable was also buried within these frames to provide four different soil temperatures. The average soil temperatures obtained were 65F [no added heat], 70F, 74F, and 80F. Moist soil and average soil temperatures of 65F and 70F provided an environment more conducive to good russeting than did the dry soil or average soil temperatures of 74F or 80F [Table 4]. These results are most likely an expression of tuber environment rather than any effect on plant nutrition.

Table 4. Percentage of tuber surface with smooth skin as influenced by soil moisture and temperature within the tuber environment.

	65 F	70 F	74 F	80 F
Moist Soil	16	13	25	21
Dry Soil	21	24	37	34

It should also be mentioned that at the lowest soil temperature, the percentage of number one potatoes was greater than 70 per cent, while at the two high temperatures this figure dropped to below 30 per cent.

When potatoes are grown under furrow irrigation, the movement of water up and into the ridge is often erractic. A "U" shaped area in the center of the ridge often remains dry the entire season. This variation in soil moisture within the potato ridge also affects soil temperature. Both of these factors influence russeting. We now have a situation where one tuber may develop in dry soil and another in moist soil, or different parts of the same tuber in dry and/or moist soil. These conditions can account for many of the slick end type potatoes, and can explain the variations in russeting found on tubers from the same plant.

Many other soil conditions can vary within the tuber zone, but none have been studied in respect to their possible influence on tuber russeting. It is possible that factors such as soil gases, total moisture tension, microbe population, etc., around the tuber may influence tuber growth in general, and russeting in particular.

CONCLUSION

While the kind, rates and method of placement of fertilizer often shows a marked influence on russeting, other factors such as the temperature and moisture status of soil around the tuber may be more of a controlling factor.

If russeting were the major problem, fertilizer recommendations could be made that would be of value. These recommendations would call for little, if any, applications of nitrogen and potash, however, this would mean very small yields and an increase in susceptibility to blackspot, and these ARE THE major problems. Applications of phosphate fertilizers may be of some value, but the effect is small.

In order to avoid smooth skins about the only cultural practice available is to avoid extremely high ridges and other practices which make it difficult for the water to move up into the ridge. Keeping the soil around the tubers both moist and cool, is likely to improve both russeting and the percentage of number one potatoes, particularly in a hot year.