MODIFICATION OF TUBER SIZE, SHAPE, AND SPECIFIIC GRAVITY DISTRIBUTION OF RUSSET BURBANK POTATO

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In a field crop such as the potato, the economic yield of the crop is a function of the total dry matter produced by the plant and that portion that is passed into and stored by the tuber. Dry matter production is dependent upon the size of the plants photosynthetic system. The canopy developed by a crop can be quantified by the measurement of the area of leaves per given unit area of land. This ratio is called the Leaf Area Index (LAI). It is a dimensionless number that is used as a means to measure the efficiency of the crop. As an example, an LAI of 2 means that for one square acre of land there would be two square acres of leaves.

Each crop has its own optimum LAI based on geographic location and growing conditions. Field work at Sutton, Bonington England has suggested that an LAI of 2.5-3 is optimum for the potato crop in England. Leaf area values in this range appear to be adequate for rapid tuber bulking. When values are lower than 2.5-3, tuber bulking rates tend to be directly proportional to leaf area. When values are higher, bulking rates do not increase. If the potato crop could be grown in such a way as to obtain an optimum LAI early and this LAI be maintained over a longer period, maximum tuber bulking rates should continue for a longer period of time, resulting in higher yields.

In the potato crop, the production of new leaves is the dominant use of dry matter and energy produced by the plant until tuber initiation starts. At tuber initiation, new tubers become the chief use of the photosynthetic products. The Russet Burbank potato, however, has an indeterminate growth habit. This means it continues to initiate new leaves throughout the growing season. Under optimum growing conditions, as occur in the Columbia Basin of Washington State, Russet Burbank vines will grow to be over six feet long. Conflicts arise in partitioning of photosynthates between continued production of new leaves and dry matter production in the tubers. Since the Russet Burbank potato has a vigorous growth habit, the key to successful agronomic management of this crop lies in controlling canopy development and manipulating dry matter partitioning to best advantage.

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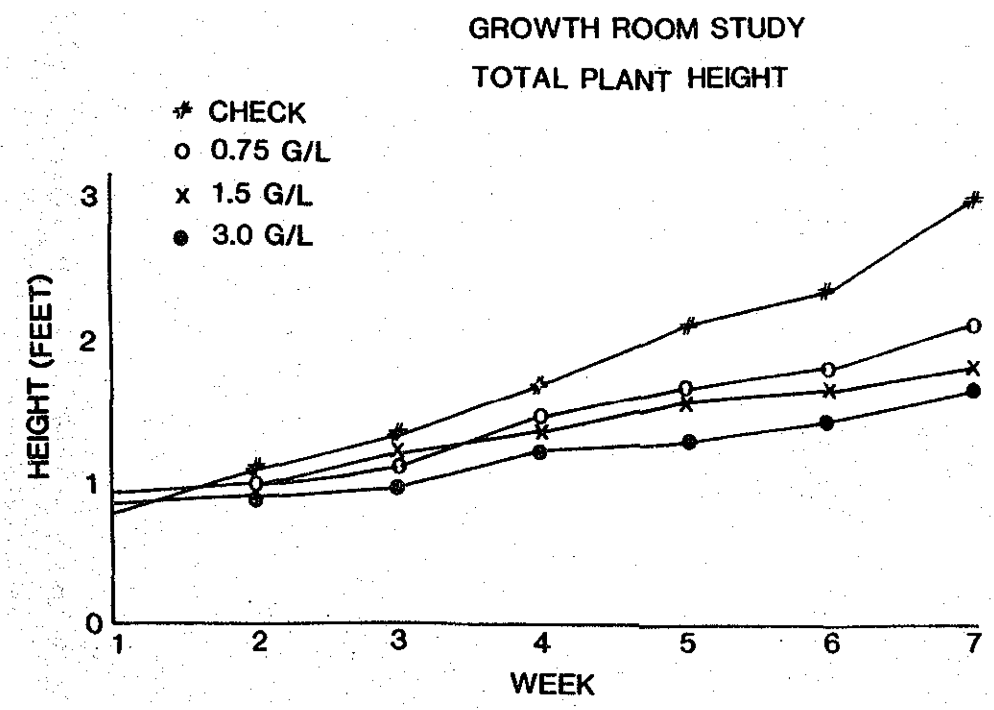
One method that has been examined as a means of manipulating this source-sink relationship is through the use of growth retarding chemicals to control top growth and increase tuber growth by maintaining the LAI nearer some optimal value. For our purpose, we will define growth retardants as a group of chemicals that slow cell division and cell elongation in the stem while the terminal growing point continues to function and produce leaves. These chemicals regulate plant height without deforming the plant.

The growth retardant that was used was N-dimethylamino succinamic acid, more commonly known as Alar or B9. It is relatively non-toxic to the plant when applied as a foliar spray and effectively shortens stem length. Although studies have been conducted in Europe on European varieties with this growth retardant little work has been done with it on Russet Burbank potato.

In order to determine how Russet Burbank responds to this growth retardant, a preliminary growth room study was conducted from February to May of 1984. Russet Burbank seed tubers were planted in five gallon pots. When the plants reached an average height of twelve inches, the first spray application was made. A second application was applied three weeks later and the experiment was terminated after seven weeks. The treatments consisted of (1) Control (no Alar applied), (2) Alar applied at 0.75 g/l, (3) Alar applied at 1.50 g/l, and (4) Alar applied at 3.0 g/l. Results showed that as spray concentration was increased from no application to the greatest concentration of 3.0 g/l, total plant height was effectively shortened as spray concentration was increased (Fig. 1).

Figure 1.



A field study was conducted during the 1984 growing season. Two spray rates of 2.5 g/l and 5.0 g/l were used. The plots were sprayed on the three dates of June 26, July 16, and August 6 to coincide with tuber initiation, three weeks later during early tuber bulking phase, and three weeks later during mid-tuber bulking phase (6 weeks following the initial application). All combinations of rates and spray dates were applied to give seven treatment combinations for each rate plus a control. The seven treatment combinations were (1) Alar applied on Spray Date (SD) 1 only, (2) Alar applied on SD2 only, (3) Alar applied on SD3 only, (4) Alar applied on SD1 + SD2 + SD3, (5) Alar applied on SD1 + SD2, (6) Alar applied on SD1 + SD3, and (7) Alar applied on SD2 + SD3.

One effect observed was that flowering was delayed three weeks after the first application. LAI was measured on the plants over the growing season on June 19th, June 26th, July 16th, August 6th, and August 27th. European studies indicated that this parameter was little changed when the plants were treated with the growth retardant.

The results from the plots sprayed at the lower rate of 2.5 g/l (Fig. 2) showed that the LAI on the control plants peaked by July 16 with a value of 6.7 and then fell off. The LAI on the plots sprayed on SD1 also peaked by July 16th at a value of 4.9 and then fell off in the same manner as the Control but at a lower value. The plots sprayed on SD2 followed the same pattern as the control until August 6th and then fell off at a lower value than the control. The plots sprayed on SD3 had a higher LAI value three weeks later (August 27th) than the other two treatments (SD1 and SD2). The plots sprayed at the higher rate of 5.0 g/l on SD3 also had a higher LAI value three weeks later (August 27th) than did the other two treatments (SD1 and SD2).

Figure 2.

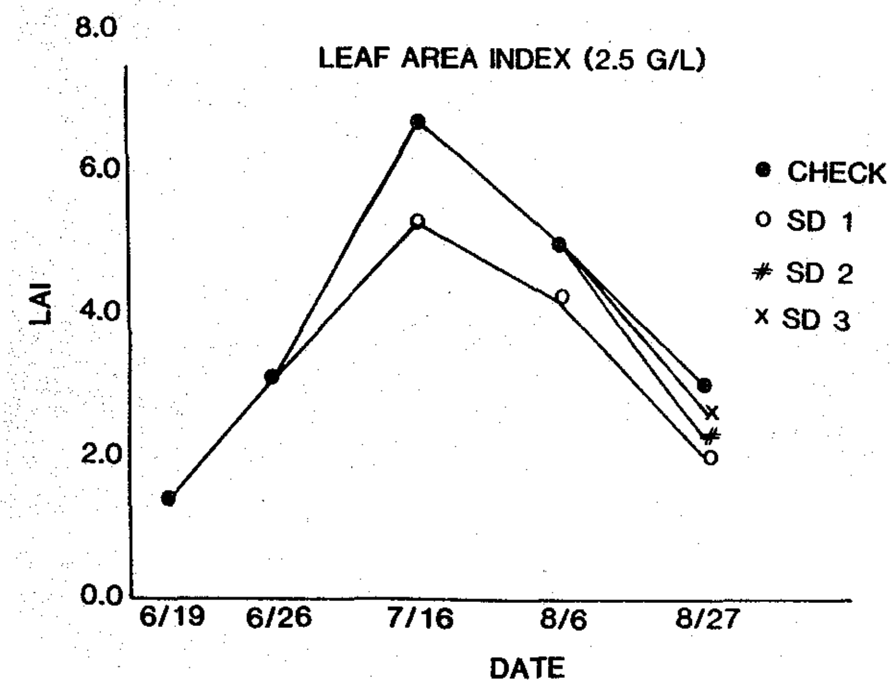
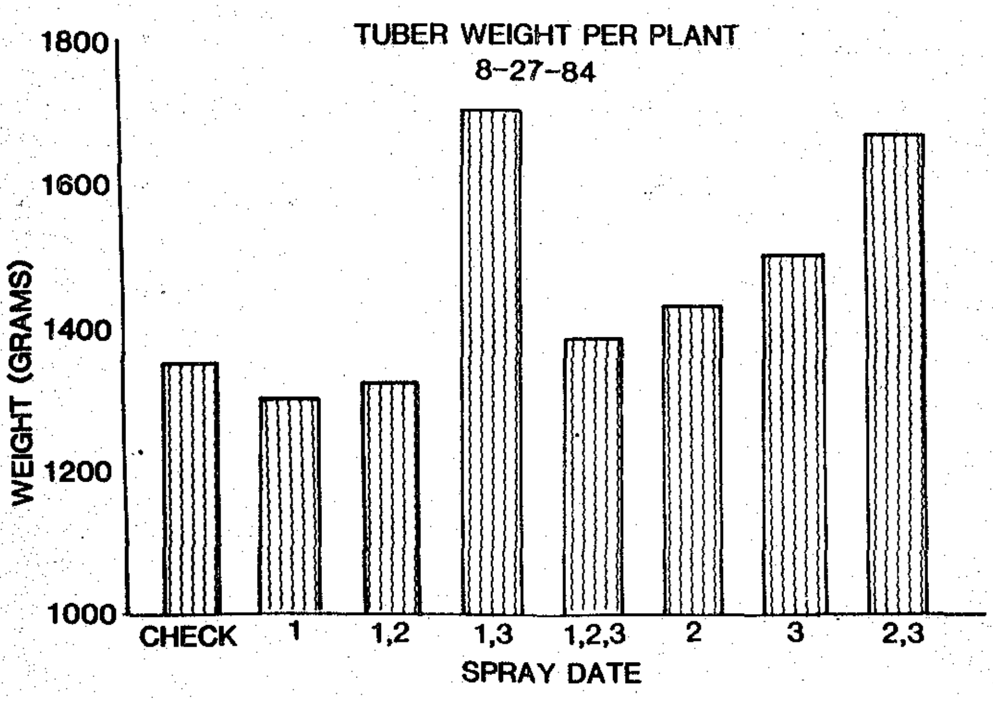


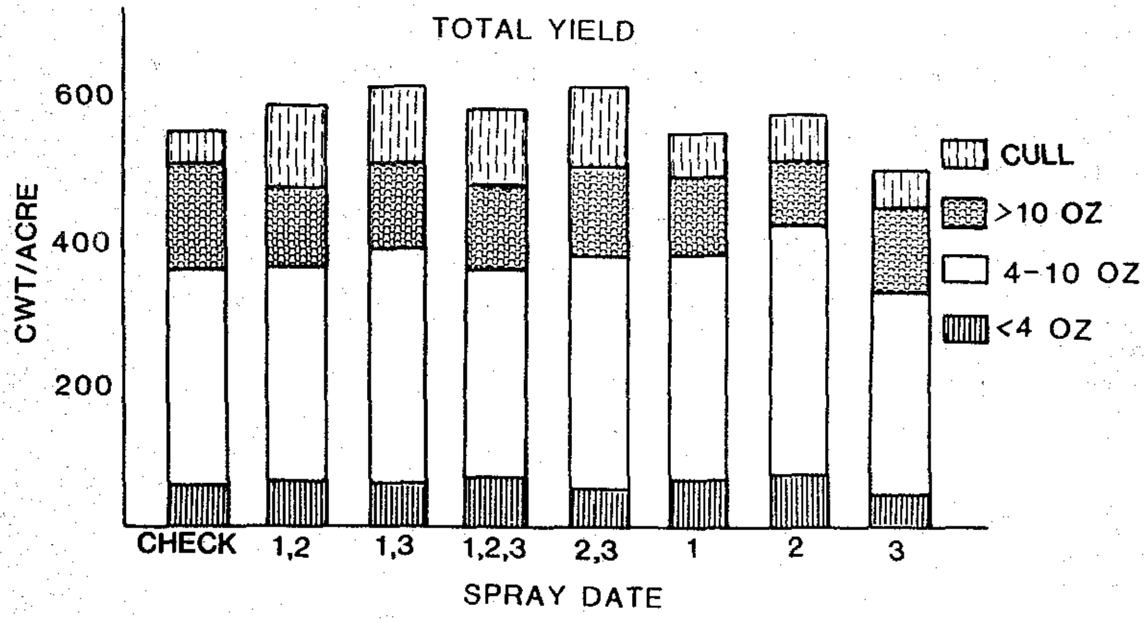
Figure 3.



On August 27th, plots that were sprayed on SD1 + SD2 and SD2 + SD3 had a significantly higher tuber number and tuber weight per plant than did the other treatment combinations (Fig. 3). Final harvest was conducted on October 15th. Two rows from each plot were harvested. Tubers from the first row were separated into two ounce size classes ranging from a <2 oz size up to a >12 oz size. Yield of culls was also determined. Detailed measurements were taken on these tubers. The tubers from the second row were separated into four size classes of <4 oz, 4-10 oz, >10 oz, and culls. Data from the two rows were combined to measure total yield.

Results showed there was no significant difference in total yield among all the treatment combinations (Fig. 4). There was also no difference between the two rates. Data from the August 27th harvest showed a potentially higher yield in plots treated on SD1 + SD3 and SD2 + SD3. This effect did not hold through the final harvest.

Figure 4.



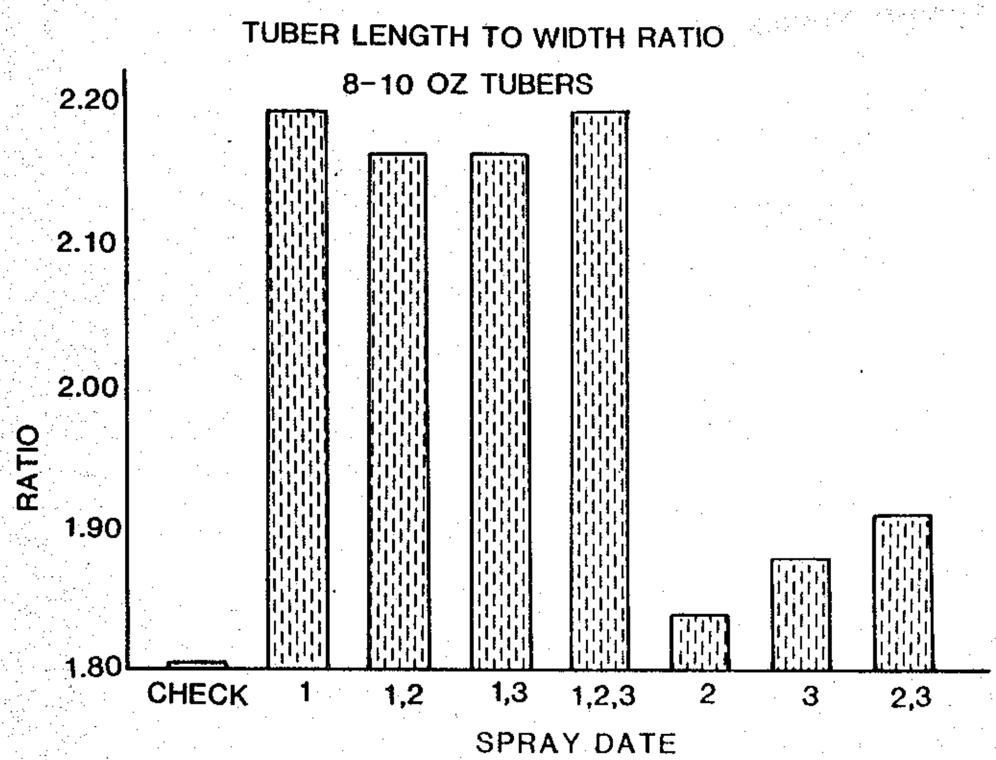
There was no significant difference in yield in the <4 oz 4-10 oz or >10 oz size classes. There was a significant difference in the yield of culls. Culls were defined as misshapen tubers. Results showed that when the plots were sprayed more than once, the yield of culls was significantly increased over the control and plots sprayed on SD1, SD2, and SD3. This may have been due to the fact that when the plots were sprayed on the first date, canopy growth was modified yet tuber development continued. When the plots were sprayed a second time, canopy growth was modified again, but as the plants started outgrowing the effects of the growth retardant, they put on a new flush of growth. This new flush became the dominant sink for energy produced by the plant and slowed tuber growth causing such malformations as pointed end tubers.

A salt brine solution was used to determine tuber specific gravity classes. No significant differences due to treatment was found. There was also no significant difference in percent of internal tuber disorders e.g., brown center, hollow heart, and internal brown spot, between the control and the treated plants.

European studies indicated that the growth retardant caused the tubers to elongate. In order to measure this parameter, the length of the tuber and the width of the tuber was measured. The length was divided by the width to come up with a ratio. A ratio of two would mean that the tuber was twice as long as it was wide.

The tuber length to width ratio was significantly increased in every tuber size class except those in the less than 2 oz size and those in the greater than 12 oz size (Fig. 5). In all plots sprayed on SD1, tuber length to width ratio was significantly increased over the plots sprayed on SD2, SD3, and SD2 + SD3. This trend was found to occur in all size classes. This may have been due to the fact that SD1 occurred during tuber initiation when tubers were rapidly expanding and elongating. The growth retardant may have altered this growth process.

Figure 5.



In order to determine if the growth retardant affected the number of eyes formed on a tuber, eyes were counted on treated and untreated tubers. It was found that the number of eyes increased when plants were treated with the growth retardant (Fig. 6). Plots treated with the higher rate (5/0 g/l) had significantly more eyes per tuber than plots treated with the lower rate (2.5 g/l). Also, plots treated on the first date had more eyes than plots treated on SD2, SD3, or SD2 + SD3. In addition, more eyes were formed on the stem end of the tuber in treated plants compared to the control (Fig. 7). Again, stem end number of eyes was significantly higher in plots treated at the higher rate of 5.0 g/l than at the lower rate and in plots treated on SD1.

Figure 6.

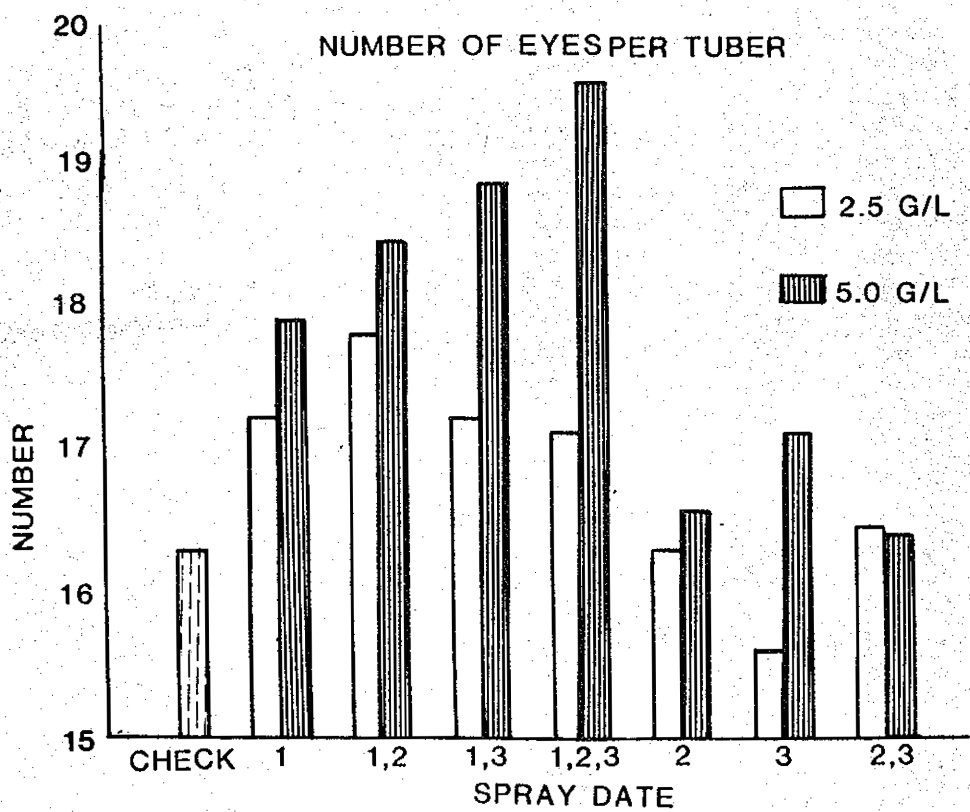
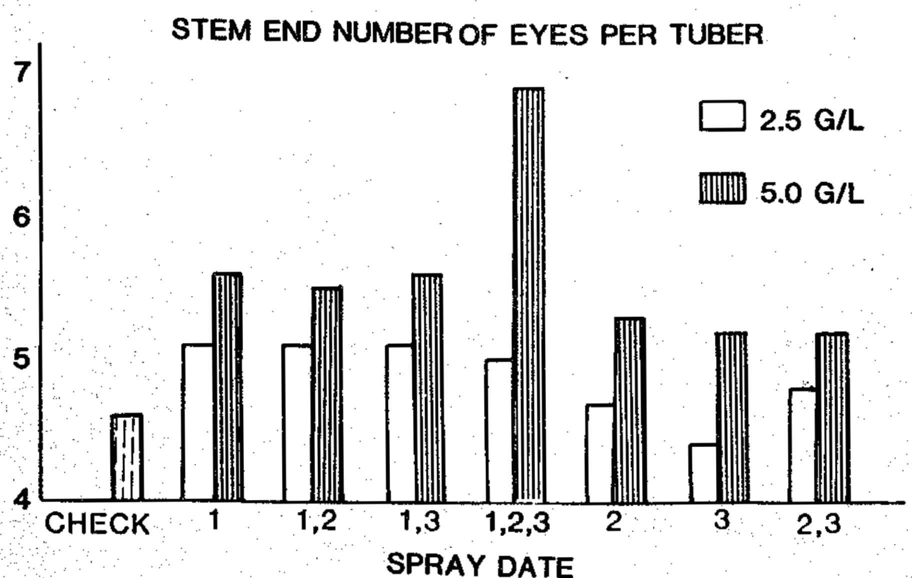


Figure 7.



The Russet Burbank variety has a vigorous growth habit. The treatments used in this study are trying to put more of the energy and nutrients into tuber growth rather than vine growth through the use of growth retardants. This study was only conducted over one growing season, but the data suggest that we were able to alter the LAI by maintaining it nearer some optimal value suggested by researchers in Europe. The LAI was maintained at a higher value for a longer duration when the plots were sprayed on SD3. This has the potential to maintain a longer tuber bulking period and thus potentially increase the yield.

The tuber number and weight per plant were increased by August 27th in plots treated on SD1 + SD3 and SD2 + SD3. This effect disappeared by final harvest. More work needs to be done to try to maintain this increase through to the final harvest. Producing more tubers per plant may also be beneficial in seed potato production.

Tuber length to width ratio and tuber number per plant were increased when plants were sprayed on SD1. Although there is no problem with the number of eyes on Russet Burbank potato, particularly on the stem end of the tuber, some of the newer varieties such as Nooksack are known to have this problem. Increasing the number of eyes on the stem end may be a benefit by decreasing the number of blind seed pieces when planted in the field.