CONTROL OF SHOOT GROWTH AND TUBER DEVELOPMENT IN RUSSET BURBANK POTATO [1,2]

by
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Tuberization in potato is influenced by a number of factors such as temperature, daylength, nitrogen nutrition and growth regulators. High nitrogen fertilization in greenhouse and field experiments are known to delay tuber induction. In greenhouse experiments, tuberization can be prevented by a continuous supply of nitrogen. Tuber induction occurs only when the nitrogen supply is temporarily interrupted. Two to 4 days of nitrogen withdrawal or changes induced in the endogenous hormone balance as a result of growth regulator application are known to promote tuberization.

Nitrogen nutrition influences the internal hormone balance, particularly gibberellins (GA), abscistic acid (ABA) and cytokinins. Tuberization can be prevented or delayed by treating plants with gibberellic acid. The inhibitors of GA biosynthesis such as 2-chloroethyltrimethylammonium chloride (CCC) and paclobutrazol (PP333) and the hormone ABA have been shown to promote tuberization under conditions which normally inhibit it.

In tuber crops there is an inverse relationship between shoot (vine) and tuber growth. Factors which promote shoot growth generally inhibit tuber growth. One phenomenon linked with tuberization which may have a hormonal cause is the so-called "sink-effect" in which the tuber influences the net carbon assimilation in the leaf. One of the reasons behind this explanation is that the net carbon assimilation in leaves drops when tubers are removed. The tuber yield of potato plants depends upon the total production and distribution of the dry matter in different organs of the plant. If the top growth is vigorous, a major portion of the carbohydrates could be used up for the shoot growth. Instead, by applying growth regulators soon after tuber induction, it should be possible to decrease the shoot growth and increase the tuber growth. This could result in increased mobilization of assimilates and nutrients to the tuber.

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During the past few years we have experimented with different combinations of growth regulators and nitrogen levels to study their effects on vine:tuber ratio, mineral composition and accumulation of mass and solids in Russet Burbank potatoes. The efficiency of nitrogen utilization is known to decrease after a threshold level. Therefore, controlling the shoot growth soon after tuber induction seems to be an important factor to be considered in attempting to promote tuber yield. To achieve this, inhibitors of gibberellic acid biosynthesis could be used.

Various application methods such as soil drench, foliar spray and painting on the stem or leaves have been tested to apply growth regulators to potato plants. Paclobutrazol, an inhibitor of GA biosynthesis was effective in inhibiting shoot growth in potato plants. In one of our experiments we used different inhibitors of GA biosynthesis to suppress the shoot growth. We found that the growth regulator-mediated inhibition of shoot growth was associated with a significant increase in the tuber yield. Conversely, promotion of shoot growth by the application of high rates of nitrogen or gibberellic acif resulted in reduced tuber growth. Results of greenhouse tests and field trials showed a good correlation. In one of our greenhouse studies, when paclobutrazol was applied as a ring at the base of the main stem soon after the tuber induction, the shoot growth markedly decreased and there was a significant increase in the tuber yield. Tuber to shoot ratio was increased by 60% as compared to control plants (Table 1).

Table 1. Effect of paclobutrazol treatment on shoot and tuber growth of potato plants. *

Treatment	Average fresh weight per plant (g)		Tuber / Shoot
	Shoot	Tuber	
Control	410.0	328.8	0.8
Paclobutrazol**	360.0	505.5	1.4

*For details see V. Balamani and B.W. Poovaiah. Retardation of shoot growth and promotion of tuber growth of potato plants by paclobutrazol. American Potato Journal (in press).

**Paclobutrazol has a long residual effect in the soil and it is not approved for field use.

Mobilization of sugars from leaves to tubers and the efficiency of their conversion to starch are important factors determining the tuber yield. Our results confirm that it is possible to increase mobilization of assimilates into tubers and thus increase yield.