THE PHYSIOLOGY OF POTATO TUBER DEHYDRATION

R. Kunkel
Horticulturist, Wash. State University, Pullman, Wash.

Most people realize that plants must absorb water from the soil to live. Few people are aware of the fact that most of the water absorbed by roots is given off through the leaves in the form of water vapor by a process called transpiration. Most of the water lost from a plant passes through microscopic openings called stomata, in the leaves. The opening and closing of the stomata is controlled by light. Normally they are closed during darkness and open when it is light. In other words, there is little or no water lost during the night hours. The roots however, are continuously absorbing water, and therefore, if a deficit of water occurs in the plant during the day, it is generally replenished during the night.

The status of the water pressure in a plant is referred to as turgor pressure. The water pressure in a cell gives it its mechanical strength. When turgor pressure in the cells is low the tissue is limp and the plant wilts. It is not uncommon on hot days to see leaves which are wilted even when water is flowing in the furrows.

When leaves are wilted the stomata close, even in the daytime. This reduces the rate of water loss but stops the entrance of carbon dioxide from the air into the leaf, and hence, food manufacture in the leaf stops. Among other things, the maintenance of a high turgor pressure in the cells is absolutely essential for cell division and growth. The association between turgor pressure and blackspot and tugor pressure and tuber type should be no great surprise.

Factors affecting water absorption by the roots:

The most important factors determining the amount and rate of water absorbed by a plant are the size and condition of the root system, the amount of readily available water in the soil, the rate of transpiration, soil temperature, soil aeration and type of soil. The interrelationships are obvious. The roots can be healthy, but if there is no available water or the water is too slowly available, the plant suffers. If the amount of transpired water exceeds the amount of absorbed water the plant wilts, growth processes are altered, and if continued too long, parts of the plant and even the whole plant will die.

Factors affecting the rate of transpiration:

The most important factors controlling the loss of water through the leaves are light, water content of the plant tissue, temperature, relative humidity, wind and potash.

The conditions prevailing during the growing season in the Columbia Basin are conducive to the loss of large quantities of water through transpiration. The days are long, the temperatures are high, relative humidity is low, there is constant breeze, the water-holding capacity of the soil is low, and potato

plants growing on soil spots which were low in potash become wilted and scorched on hot days. Plants growing on soil well supplied with potash showed no detrimental effects from the high temperatures.

Experimental results:

Potato plants were tied firmly to stakes, and the soil was carefully removed from the tubers. This made it possible to attach balances to the tubers and to determine the changes in weight for an extended period of time. A black plastic canopy was used to keep the tubers in the dark.

It was found that tubers growing in the same hill do not grow at the same rate. It was found that tubers do not increase in size at a uniform rate, that the weight usually increased from 7:00 a.m. until noon and decreased from noon until evening (Table 1).

Table 1. Change in weight of a ten-ounce potato tuber.

Date	Time	Gain or loss in weight
Sept. 3	6:15 p.m.	314 grams
" 4	8:30 a.m.	316
" 4	12:00 noon	317
" 4	8:00 p.m.	316
" 5	8:00 a.m.	317
" 5	11:30 a.m.	319
" 5	7:15 p.m.	317
" 6	7:30 a.m.	319

That the foliage can actually withdraw water from the tubers was illustrated by cutting off part of the root system. The results are shown in Table 2.

Table 2. Changes in weight of a ten-ounce potato tuber after some of the roots are cut off.

Date	Time	Gain or loss in weight
Sept. 13	11:00 a.m.	324 grams
" 13	4:00 p.m.	321
" 13	7:00 p.m.	318
" 14	9:00 a.m.	321
" 14	12:00 noon	320
" 14	6:00 p.m.	317

When part of the roots were removed, the plant no longer received adequate water, and the foliage drew water from the tubers. Most of the water came from tissue close to the point where the stolon was attached to the tuber. The stem end of the tuber became soft, but the blossom end remained firm. If the tubers were removed from the plant at this time, an internal moisture equilibrium would take place within the tuber, and both ends would feel firm to the touch. It is while the stem end is in the low turgor condition that it is most susceptible to blackspot. If the turgor pressure after equilibrium is sufficiently low, the tuber may be equally susceptible to blackspot at

both ends. However, if the turgor pressure is high, the tuber might be susceptible immediately after being detached from the vine and resistant after equilibrium has occurred.

The loss in tuber weight occurred because transpiration through the leaves exceeded water absorption by the roots. To reverse the process to the extent that water absorption by the roots exceed water loss through the leaves by transpiration, the tops were cut off. Only a six to eight inch long stub was left attached to the roots and tubers. The results are shown in Table 3. The increase in weight must have been due to the water absorbed by the roots and pumped into the tubers, since the stems and foliage had been removed. Removing the tops in the manner described would be similar to beating off the vines with a Roto-beater. The rehydration no doubt would have been faster if none of the roots had been cut off previously and if the soil were moist.

Table 3. Increase in weight of a ten-ounce potato tuber after the tops were removed.

Date	Time	Gain in weight	
		grams	per cent
Sept. 15	1:00 p.m.	318	0.0
" 17	7:00 p.m.	326	2.5
" 25	10:30 a.m.	340	6.9

Beating off the vines with a vine beater several days ahead of digging would bring about maximum hydration and even increased tonnage. The greatest increase in weight after the tops were removed was eight per cent. If this increase were applied on an acre basis and the yield per acre were 400 CWT at the time of beating off the vines, a few days later it would be 432 CWT, due to the absorption of water by the roots and their pumping the water into the tubers. In addition to the increased tonnage, the tubers would be less susceptible to blackspot and have a lower specific gravity which would make them a better all-purpose potato for the fresh market.