step. Dipping later, before planting the bulbs in pots for forcing, may be too late. PCNB plus Ferbam, so effective as a dip for field-grown lilies, has generally failed if applied just before forcing. It penetrates very well between the scales, but it stays on the surface of the tissues.

Benlate can follow a pathogen into the tissues, and probably acts on *Fusarium* inside the bulb and roots. With *Pythium*, the problem is less difficult, because *Pythium* lives mainly in the tissues it has already destroyed. Dead tissue is often more easily penetrated by fungicides than living tissue. Reports of successes in controlling *Pythium* with Truban, applied before forcing, may be at least partly explained on this basis.

Root damage

Often the root system of a plant is unbalanced by disease rather than destroyed (see photo 1). Foliage symptoms may result from this lack of balance, because of the arrangement of vessels conducting water from the roots to the foliage. Basal roots are directly connected to the basal leaves. Stem roots arise in clumps from the nodes, and are connected with the leaves and flowers more or less directly above them. The ascending stream of water and nutrients can cross from one channel to another in the stem, but under stress the leaves directly connected with injured roots cannot compete for water and nutrients with the leaves that are linked directly with healthy roots. In consequence, they yellow and die, leaf scorch symptoms may appear on leaves that are less severely affected, and even some buds may abort (blasting). Often a few small basal leaves die, and, as other roots take over from those that were damaged, further symptoms on the foliage are checked.

A grower can control disease in some degree by cultural practices, such as planting bulbs near the bottom of the pot, so that a length of root-forming stem will grow up into soil rather than air. He can provide the plants with adequate nutrition, careful watering, and controlled temperature and light. These are indispensable for growing symptom-free plants, but they are not the ultimate solution for the disease problem. Direct measures, such as dipping, for disease control are also needed.

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Soil conditioning and SEED POTATO HANDLING *are keys to survival of* SUMMER PLANTED PO

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THE RELATIONSHIP between soil physical condition and plant stand vigor was partially revealed in a report of studies 10 years ago. Additional information is now available on seed potato performance and on cultural adaptations that affect plant survival during high temperature planting conditions. The respiratory response of seed potato pieces to conditioning procedures was measured in the laboratory. At the same time the influence of soil conditioning and soil moisture on potato seed piece survival and plant emergence was investigated in the field.

Kennebec potatoes, harvested in late May, were placed into controlled temperature storage of 20°C (68°F) and held there until two weeks before planting. Sufficient time had elapsed for seed to break rest, and sprouting was evident.

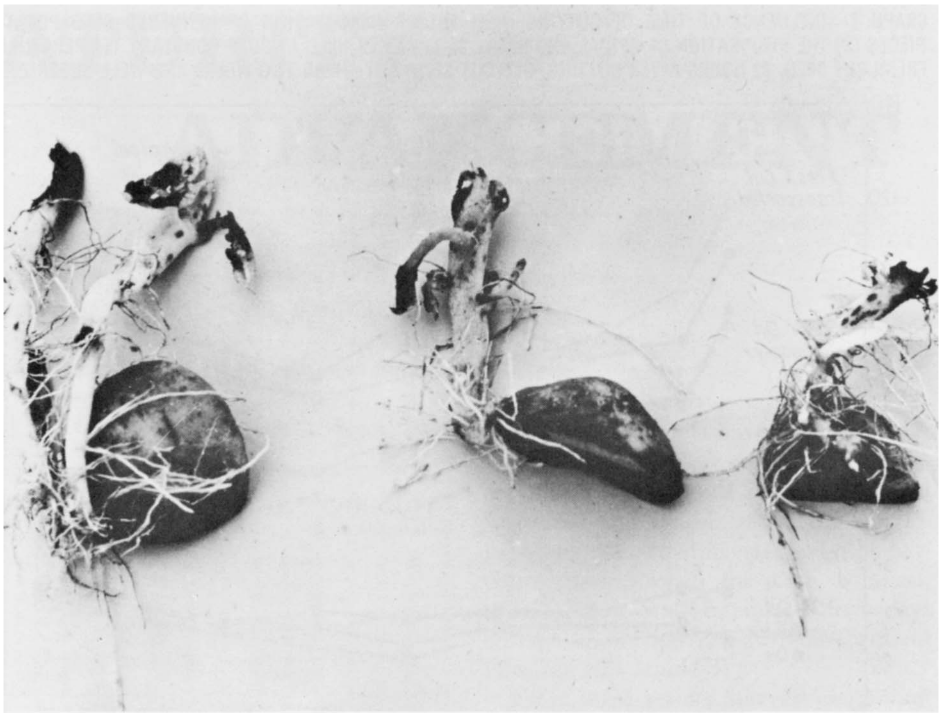
One half of a lot of whole potatoes was cut into 43 to 57 g (1½- to 2-oz) pieces two weeks prior to planting and replaced at 20°C (68°F). These pieces were designated as "old" cut seed. The other half was cut into seed pieces 12 hours before planting, and designated as "fresh" cut seed. Seed pieces from each were planted the following day at the U.S.D.A. Cotton Research Station, Shafter. Sufficient amounts of conditioned seed were set aside for use in a respiration study under controlled temperature conditions in the laboratory. Apical and basal seed pieces were kept separated. While potatoes were being cut it was observed that a number of them were infected at the stem end with dry rot. Infected seed pieces were sorted out. However, it became apparent during the laboratory study that not all seed pieces were free of infection.

Respiration

Fresh and old cut seed were each divided into two lots. One lot in burlap bags remained undisturbed in storage at 20°C (68°F) for 12 hours, while the other lot in burlap bags was loaded onto a pick-up truck and transported for 12 hours with air temperature between 20°C and 35°C, while being protected from the sun. After the 12-hour period, seed pieces from 20°C storage and from the truck were redivided again. One lot of seed from each handling treatment was placed at 30°C (86°F) and the other at 35°C (95°F) constant temperature. The evolution of CO_2 from respiring seed was monitored for 144 hours in a continuous ventilated system.

Essentially similar patterns of respiration were obtained at each of the two

Potato growers in the southern San Joaquin Valley encounter wide variations every year in seed potato piece survival and plant stands of the summer planted (July and August) potato crop. Soil temperatures above 32°C (90°F) and air temperatures of 40°C (104°F) or higher are often present at planting time. The death of planted seed potato pieces may occur if soil temperatures above 32°C prevail for longer than a day. Both soil conditioning and seed potato handling were found to be critical factors in these studies of plant survival under high temperature conditions.



Even with healthy seed potato pieces that produce sprouts, plant stems often fail to emerge as indicated in this photo. The terminal tissue of stems shown was severely injured by heat near the soil surface, with temperatures sometimes reaching 38°C to 45°C (100°F to 113°F). Infection by soil organisms rapidly followed.

TATO CROP

temperatures (graph 1), with a slightly higher rate of respiration at 35°C (95°F) than at 30°C (86°F). Respiration was highest the first six hours in the fresh cut seed. The rate of respiration was two to three times higher initially for transported and stationary fresh than old cut seed. Transporting seed resulted in higher respiration rates for fresh than for old seed. Even after 144 hours the respiration of fresh cut seed was nearly double that of old cut seed. The decline in respiration with time was less erratic for fresh cut apical than basal seed pieces. Between 36 and 48 hours the respiration of fresh cut basal seed pieces was higher than apical seed pieces, whereas prior to this time the reverse was true. This change in the pattern of respiration was accompanied by an increase in seed piece deterioration due to dry rot infection of basal seed pieces. At the termination of the study the percentage of infected seed pieces was greater with transported than with stationary handling, and at 35°C (95°F) than 30°C (86°F) holding temperature.

Survival

Fresh and old cut apical and basal seed pieces were planted separately in prepared beds with a machine planter. The entire plot with prepared beds was furrow irrigated ten days prior to planting. After planting and bed conditioning, one half of the plot was again furrow irrigated. Twenty-four hours after planting, the soil moisture content in the center of the bed was between 7% and 9% for the pre-plant irrigation, and between 12% and 13% for the post-plant irrigation (table).

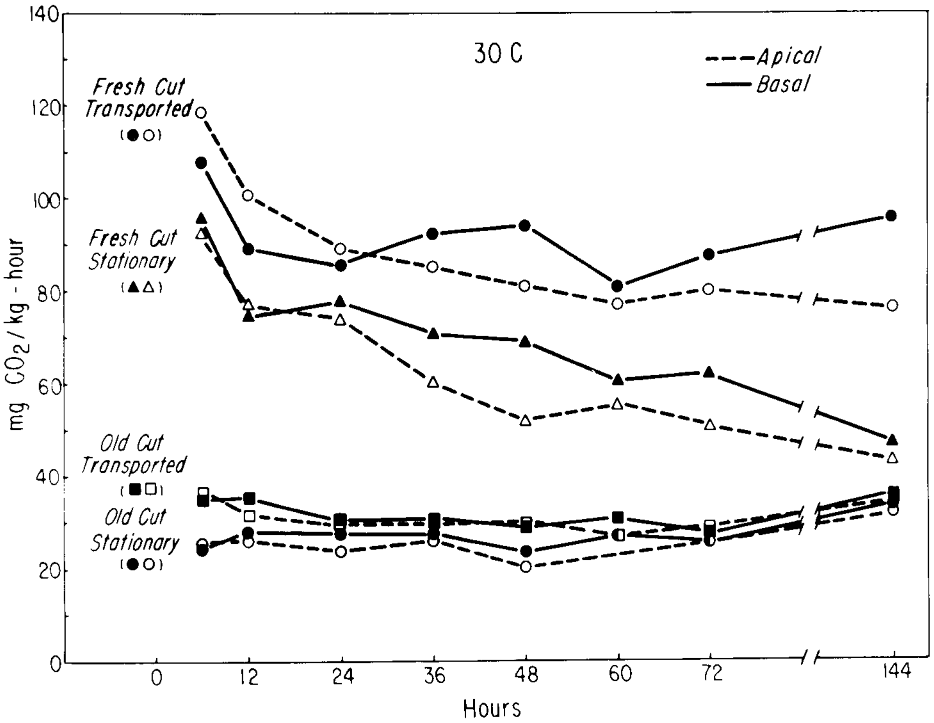
Bed conditioning tests included the control bed which was untouched before or after planting; a bed rototilled four inches deep before planting; a bed undercut below the seed pieces; and a bed

INFLUENCE OF SOIL CONDITIONING AND IRRIGATION ON THE COMPOSITION OF SOIL ATMOSPHERE AND MOISTURE, AND ON KENNEBEC PLANT STAND, PLANTED MID-JULY IN A HESPERIA SANDY LOAM SOIL

No irrigation after planting[2]	Soil atmosphere[1]						% Soil moisture[5]	Plant stand % of control not furrow irrigated
	% CO_2			% O_2				
	24	36	48	24	36	48		
		hours			hours			
Control bed	0.27	0.40	0.23	16.4	15.6	17.8	8.3	100
Rototill bed[3]	0.25	0.37	0.26	16.4	15.3	17.5	—	50
Under-cut bed[4]	0.25	0.30	0.23	16.5	15.6	17.5	—	67
Rolled bed[4]	0.26	0.38	0.26	16.4	15.5	17.7	7.7	54
Furrow irrigation after planting[2]								
Control bed	1.81	4.02	1.46	15.0	13.5	16.9	12.9	8
Rototill bed[3]	2.18	3.23	1.48	15.4	13.6	16.9	—	17
Under-cut bed[4]	2.56	3.62	2.15	15.4	13.8	16.7	—	8
Rolled bed[4]	3.25	4.58	2.27	14.8	12.7	16.5	13.2	8

[1] Soil atmosphere sampled after planting and irrigation—mean of four replicates at 6-inch depth in bed.
[2] Irrigated ten days prior to planting.
[3] Bed conditioned before planting.
[4] Bed conditioned after planting.
[5] 24 hours after furrow irrigation.

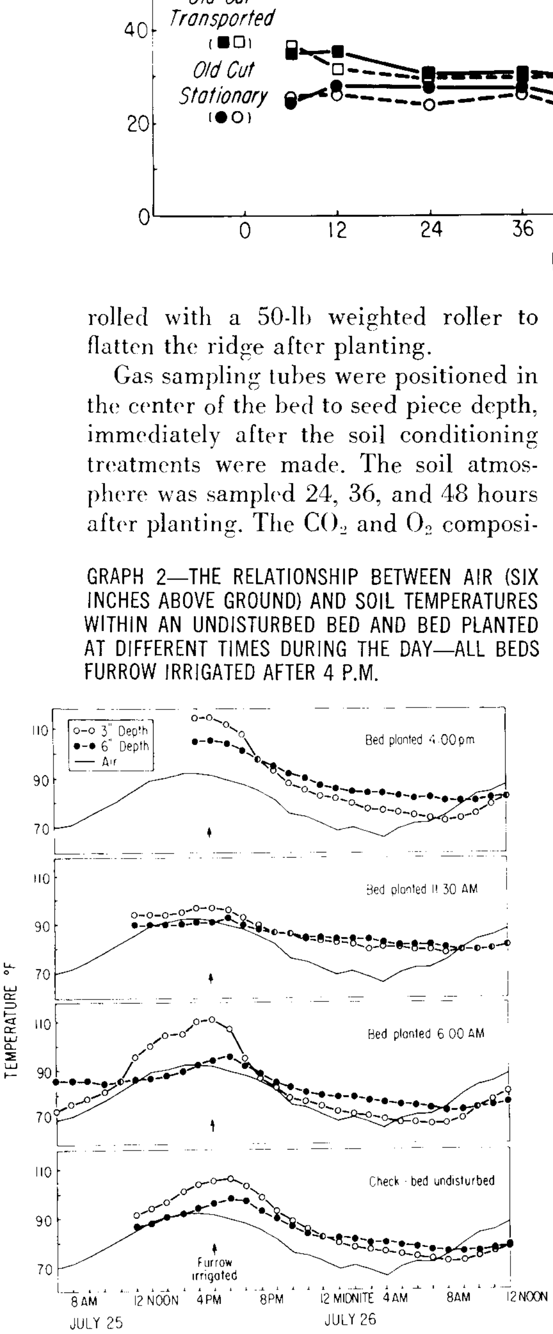
GRAPH 1—INFLUENCE OF TIME OF CUTTING, AND THE TRANSPORTATION OF KENNEBEC SEED POTATO PIECES ON THE RESPIRATION OF APICAL AND BASAL SEED PIECES HELD AT 30°C CONSTANT TEMPERATURE. FRESH CUT SEED, 12 HOURS AFTER CUTTING. OLD CUT SEED, CUT AHEAD TWO WEEKS AND WELL SUBERIZED.



rolled with a 50-lb weighted roller to flatten the ridge after planting.

Gas sampling tubes were positioned in the center of the bed to seed piece depth, immediately after the soil conditioning treatments were made. The soil atmosphere was sampled 24, 36, and 48 hours after planting. The CO_2 and O_2 composition of the atmosphere was determined with the use of a gas chromatograph.

GRAPH 2—THE RELATIONSHIP BETWEEN AIR (SIX INCHES ABOVE GROUND) AND SOIL TEMPERATURES WITHIN AN UNDISTURBED BED AND BED PLANTED AT DIFFERENT TIMES DURING THE DAY—ALL BEDS FURROW IRRIGATED AFTER 4 P.M.



Plant stand counts were made three weeks after planting. Since the laboratory study revealed that some seed was likely to be diseased, only the results from old cut apical seed pieces were used in the data on plant stands. The control bed of the pre-plant furrow irrigation had the highest plant stand. All other treatments were rated against this treatment to evaluate plant stand response between bed preparation and soil moisture condition (table). Plant stands from fresh cut seed were less than 20% under any soil conditioning.

Furrow irrigation after planting resulted in the poorest plant survival. Rototilling, undercutting or rolling bed ridges flat did not improve survival of seed pieces or the aeration of the soil. Respiration of potato seed pieces and microorganisms in the wetter soil caused a marked increase in CO_2, whereas O_2 diminished in the soil atmosphere, between the span of 24 and 48 hours. In comparison, these changes in the composition of the soil atmosphere were minimal with the drier soil, and seed piece survival was higher.

Irrigating the soil after planting impeded rapid gas exchange. Seed potato planting was made between 11 a.m. and 3 p.m. at a time when air temperatures were rising (graph 2), and the soil was irrigated at 4 p.m. The demand for O_2 was high for the rapidly respiring seed pieces, because of conditioning procedures (graph 1) and high soil temperature. The exchange of O_2 between the soil and atmosphere was reduced because of the high moisture content of the soil (table). Breakdown of potato seed pieces was apparently encouraged under these soil environmental conditions.

Improvement

Present research results suggest that seed potatoes need to be cut well in advance of planting to allow for suberization (healing) to take place, and seed should be stored in a shaded, ventilated area that provides temperatures between 25°C and 30°C (77°F and 86°F). These conditions are likely to promote healthy, sound seed pieces that have attained a uniform rate of respiration. Seed pieces should always be handled and transported carefully to reduce bruising and to minimize tissue respiration.

The soil needs to be pre-irrigated far enough in advance of planting so the soil mositure content will not materially interfere with gas exchange but will still provide necessary moisture for sprout and root development. Even though seed pieces may be sound 48 to 72 hours after planting, this does not necessarily imply that developing plant stems will survive (see photo). Under furrow irrigation it was found that soil temperatures at seed depth were not constant nor readily alterable to reduce temperature to below 30°C (90°F) when air temperature reached 38°C (100°F) or higher.

Stem growth in the soil is conditioned by the soil temperature which can vary between the seed and the soil surface (graph 2). Depending upon length of exposure, plant growth may be interrupted at temperatures above 30°C, while death of young terminal tissue can result at temperatures above 38°C (photo).

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