larging crop possibilities presently limited by frost. Research on sprinklers for frost control is being continued by Burton J. Hoyle, station superintendent.

The new crop research program at the station has had to consider consumer acceptance and marketing possibilities as well as crop adaptability for the area. Station research led to the development of a new horseradish variety, "Tulelake No. 1," which is the only specific, named, variety; and when put into production by local growers, it increased yields by more than 50%. The station also participated in the durum wheat development program in cooperation with Kenneth Baghoff, Farm Advisor. Previously, durum was grown only in the Dakotas, but when it was determined that the crop could be grown in the Tulelake basin, grower representatives went to Washington, D.C., and obtained a 10,000-acre allotment. The result was an increase of about $1,000,000 per year in farm income above what the same acreage would have produced in Hannchen barley.

Spinach, broccoli, asparagus, endive, parsley and cabbage have also shown promise on an experimental basis. Tests with cranberries, blueberries and soybeans were not encouraging and were discontinued. Some success was obtained in safflower trials on the sandy rim of the basin. Sugarbeet trials were successful, but contracts were not available for growers. Mint was another possibility, but there was no market for the crop. Winter-hardy fruit and berry rootstocks are being sought in a cooperative effort with USDA researchers.

Extensive trials on seed potato storage proved the value of forced air circulation to inhibit root sprouting. Objectionable sprout and root formation was delayed one month to six weeks by circulating air at a rate in excess of 1¾ cfm/bu at 40°F and 85% humidity. Storage studies in the air-conditioned potato cellars were done with the cooperation of L. W. Neubauer, Professor, Department of Agricultural Engineering, Davis.

As many as 5,000 varieties of barley have been grown in test plots at the station some time during the past 17 years. Two of these—Firlbeck III and Piroline—show promise for replacing Hannchen, the malting barley that has been in production in the area for 20 years. The weak straw of Hannchen, grown on the organic soil of the Tulelake area, has caused lodging problems for the grower; and cloudiness in beer has resulted from the high protein content. Firlbeck III has outyielded Hannchen by 10 to 15%, and the stiffer straw has stood erect under most conditions that would have caused lodging in the other variety. Changes in irrigation, including more critical timing in the early growth stages and curtailment of late water applications, are expected to allow yields to stay high, while protein is kept at a lower level. C. W. Schaller, Professor and Agronomist, and C. A. Suneson, Associate in the Experiment Station, Department of Agronomy, Davis, cooperated in the barley variety studies.

Another development at the station is the complete mechanization of cereal rod-row test plots. Hoyle developed a completely integrated system from planting through harvest, reducing the working time on these test plots to one-tenth of what it had been.

D. C. ERWIN · W. H. ISOM
M. J. GARBER

Harvester Injuries to Seed Reduce Flax Seedling Emergence

Cracking of flax seed caused by improper adjustment of combine threshing equipment has reduced the germination and vigor of seedlings, according to this report of studies conducted at University of California, Riverside, and U. S. Department of Agriculture, Brawley in the Imperial Valley. Seedsmen have often placed the blame on fungicidal treatment and long storage; but although mercurial fungicides have some adverse effects, cracked seed is largely responsible for the reduced seedling emergence.

FLAX SEEDS held over from the previous year have been observed to germinate poorly in southern California. This poor germination was attributed largely to certain fungicidal treatments, but experimental tests had not been made to confirm these hypotheses. Previous reports, however, showed that cracking (visible only under magnification) reduced germination of flax seeds and induced seedling abnormalities. The greenhouse and field experiments reported here showed that cracking—caused by mechanical threshing—reduced germination more than the suspected fungicidal treatments, age of seed, or storage treatment.

Effects of cracking

To determine the effect on seedling emergence, different lots of mechanically cracked (30%) and noncracked seeds of the flax variety Imperial, were stored at air temperature in the Imperial Valley and at 1°C in Riverside. The effect of storage on seedling emergence of another variety, Punjab 47 (noncracked seeds) was also observed. Seeds were not treated with fungicides.

Before storage treatments were started, average emergence from Punjab 47 and Imperial was 90%. Six months later, emergence in steamed soil from the noncracked seed of both varieties stored in Riverside at 1°C and in the Imperial Valley remained high (96 to 99%); but emergence from cracked Imperial seeds had dropped to 83% (significant at the 1% level). No differences in emergence between seed lots stored at low or high temperatures were observed.

In a survey of six fields in the Imperial Valley, the percentage of cracked seeds in combine-threshed flax varied from 10 to 28% (seeds were microscopically observed on one side only) compared with 0 to 3% when seeds from the same areas were hand-threshed. This information indicated that the cracking injury was due to mechanical causes associated with the harvesting process.

To measure the effect of mechanical cracking on germination of seeds, samples from three fields were pooled and examined microscopically on both sides of each seed. The combine-threshed seeds were 30% cracked, whereas the hand-threshed sample was sound. When mechanically harvested and hand-threshed samples were compared in steamed soil and in field trials, emergence from cracked seeds was delayed as well as reduced (see graph). Ceresan 200 did not adversely affect emergence.

Other effects

To determine the effects of storage temperature on germination, fungicidally treated seeds (30% of which were cracked in the mechanical harvesting process) were stored in the Riverside laboratory at 20, 30, and 40°C. In the Imperial Valley, seeds were stored under natural conditions in a warehouse before planting.

Emergence in steamed soil was recorded at 1½, 4, 5, 8, and 12½ months after initiation of storage. Emergence showed a significant reduction after eight months of storage. After 1½ months of storage, temperature had no effect on emergence; however, all of the fungicidal treatments decreased emergence significantly when compared to the nontreated control. After 12½ months, emergence from both nontreated and treated seeds stored at all laboratory controlled temperatures—as well as under Imperial Valley warehouse conditions—was strikingly reduced. For example, nontreated seed was reduced from 95% to approximately 70%. Differences due to temperatures or to fungicides were only slight. Seeds treated with Ceresan M in the Imperial Valley storage treatment showed reduced emergence more than seeds treated with other fungicides.

In a field experiment the following year, the one-year-old nontreated seeds which had been stored in the Imperial Valley warehouse in the previous experiment were fungicidally treated and compared with new (but noncracked) treated and nontreated seeds. The germination of the "old" seeds was strikingly reduced, as shown in the table. Plants from old seeds were also markedly stunted and reduced in vigor.

Results similar to those in the field were obtained when this experiment was repeated in steamed soil in the greenhouses. Reduction of emergence, as well as a delay of three to four days, was noted for the "old" seeds compared with the new.

In a similar experiment the following year the variables due to seed cracking and storage time were separated by using noncracked seeds (3% or less). A low storage temperature (1°C) was added to reduce the physiological activity of seeds to a minimum. Emergence in steamed soil was then observed at three and eight months after fungicidal treatment. In contrast to the previous experiment in which cracked seeds were used, emergence from nontreated seeds did not decrease with increased time of storage, except at 40°C after storage for eight months. An 8-to-10% depression in emergence from seeds treated with Ceresan M was noted at all temperatures as early as three months after treatment.

"Old" and "new" seeds compared

In another experiment, "old" (18-month-old) and "new" (6-month-old) noncracked seed samples were treated with Panogen, Ceresan M, and Ceresan 200 and stored for different periods under natural conditions in the Imperial Valley. Treated and nontreated old seeds were also stored at 1°C at Riverside.

EFFECT OF FUNGICIDES AND TIME OF STORAGE ON SEEDLING EMERGENCE FROM FLAX SEED OF DIFFERENT AGES IN THE FIELD

Seed lot	Seed condition			Fungicide* Percentage of emergence			
	Age (Months)	Time treated (Months)	Cracked %	None	Panogen	Ceresan M	DuPont 244
A (old)	18	10	30	39	48	46	43
B (old	18	1	30	35	42	48	40
C (new)	6	1	0	68	64	79	59

* Statistical analysis: Seed lot C different from A and B (1% level); among fungicides, in lot A there were no differences; within lot B Ceresan M differed from the other treatments (1% level); in lot C Ceresan M differed from the other treatments (5% level).

Flax seed cracked by harvester injury.

After eight months of storage, emergence of seedlings from seeds treated with Ceresan M was slightly depressed below that of nontreated seeds at both storage sites. Age of seeds or time of storage had no effect on emergence.

Field experiment

In a duplicate experiment in the field, the age of seeds, time of storage, or temperature had no significant effect on the percentage of emergence. Emergence from nontreated 6-month-old seeds was not significantly different (at 60%) from that obtained from the fungicidally treated seed (61 to 65%). However, all fungicidally treated 18-month-old seeds produced seedlings at a slightly (but significantly) increased rate.

None of these experiments indicated that high storage temperatures in the Imperial Valley influenced germination or ultimate seedling emergence from nontreated or treated intact seeds in steamed soil or in the field.

Reduction in emergence of flax seedlings due to cracking of the seed coats was of much greater importance than any other factor studied. However, data shown in the table explains how the cause of reduction in emergence in commercial practice could erroneously be attributed to age of seeds or fungicidal treatments rather than to cracking of the seeds—if adequate controls were lacking. Since cracking induced a marked delay in seedling emergence, it may also reduce vigor and thus increase susceptibility to diseases of seedlings.

Observations during these studies indicated that seeds threshed carefully in small experimental threshing units (Vogel type) were as sound as seeds threshed by hand—indicating that injury may be reduced by proper adjustment of harvesting equipment. Agricultural engineers at Davis suggest that seed cracking of the variety New River can be avoided by reducing the peripheral speed of the cylinder in commercial combines and that the proper adjustment may not be the same for all varieties. Large-seeded varieties with high oil content appear to be more susceptible to mechanical injury than smaller seeded ones—probably a result of thinner seed coats of the former.

Fungicidal treatment

It did not appear that the fungicidal seed treatments would account for serious reduction in the percentage of emergence from seeds stored a year before planting. Low germination as caused by Ceresan M can be compensated for by increasing seeding rates, but the certification specifications in California require a minimum of 85% germination of registered or certified seeds. For this reason, use of a fungicide with less phytotoxicity would be suggested.

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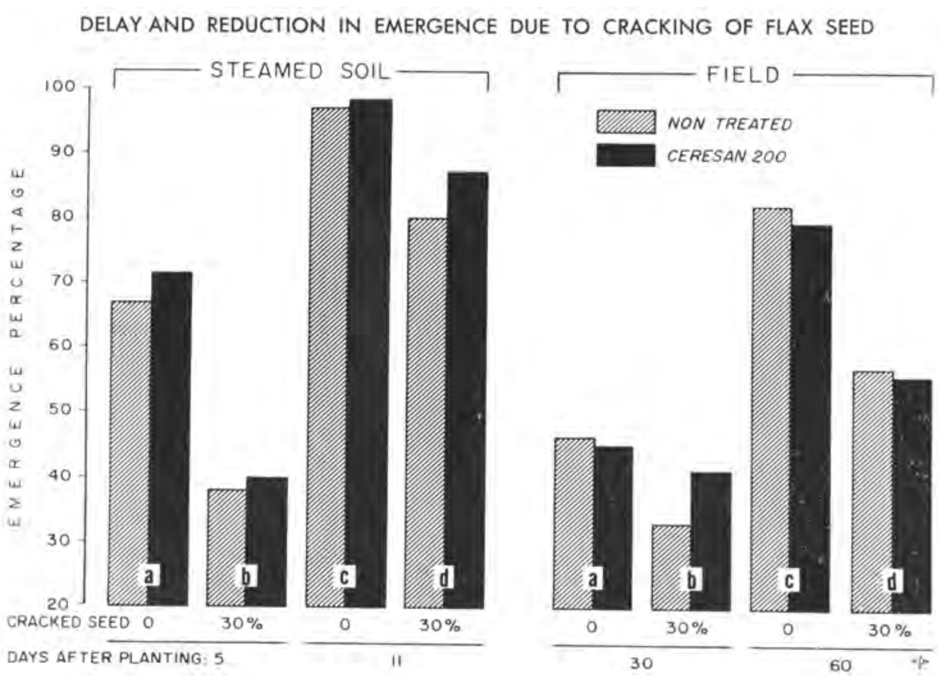

Letters "a" and "b" on bars indicate that the data differed statistically (at the 0.1% level for steamed soil and 1.0% for field soil). Differences due to treatment with Ceresan 200 were not significant.

MILKING MACHINE TEST

W. C. FAIRBANK • R. N. EIDE

A properly functioning milking machine system requires a vacuum controller that maintains a nearly uniform vacuum level from no-load to full-load operation. Experiences with commercially available equipment on California dairies indicate that some types of controllers perform markedly better than other types. In this analysis of vacuum controller performance, controller terminology is redefined, a method for field testing controller performance is described, and six vacuum controllers in common use are rated as to how they meet the operating requirements of a good milking machine installation. Performance tests showed considerable variation in their sensitivity, and the need for better engineered controllers is suggested.

THIS EXPERIMENT was set up to: (1) compare several of the commonly used controllers to establish their acceptability or limitations; and (2) determine a simple method for measuring controller performance. It was not a purpose of this study to evaluate individual controller designs or to make modifications which might improve operating characteristics.

It is difficult to measure airflow through a controller under varying load and vacuum level conditions. An in-line meter such as a rotameter can be used, but this method is cumbersome, could not be repeated by fieldmen or installers, nor would the results be more meaningful for field application. The indirect method of measuring the complementary amount of air necessary to balance a known pump volume was used in these tests.

The test equipment was arranged as shown in the sketch. Airflow measurements were made with a Bou-Matic airflow meter of established accuracy but with the dial-type vacuum gage replaced with a mercury column. (The Bou-Matic airflow meter is calibrated in "15-inch air" and does not indicate true flow at any other level.)

The outlet of the 1½-inch pipe tee into which each of the seven controllers was placed for testing was closed off, and the pump was determined to have a capacity of 61 cfm at 15″ of mercury (Hg). The controller was then mounted and a set of readings was taken from the airflow meter at vacuum levels and corresponding airflows covering the full operating range of the controller. (Pump capacity and airflow meter readings are inversely

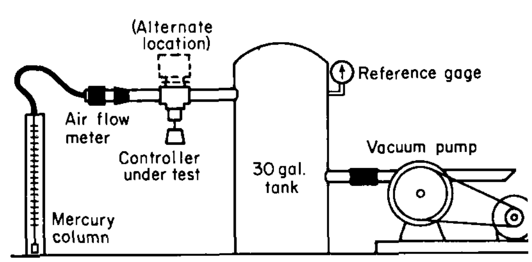

Fig. I