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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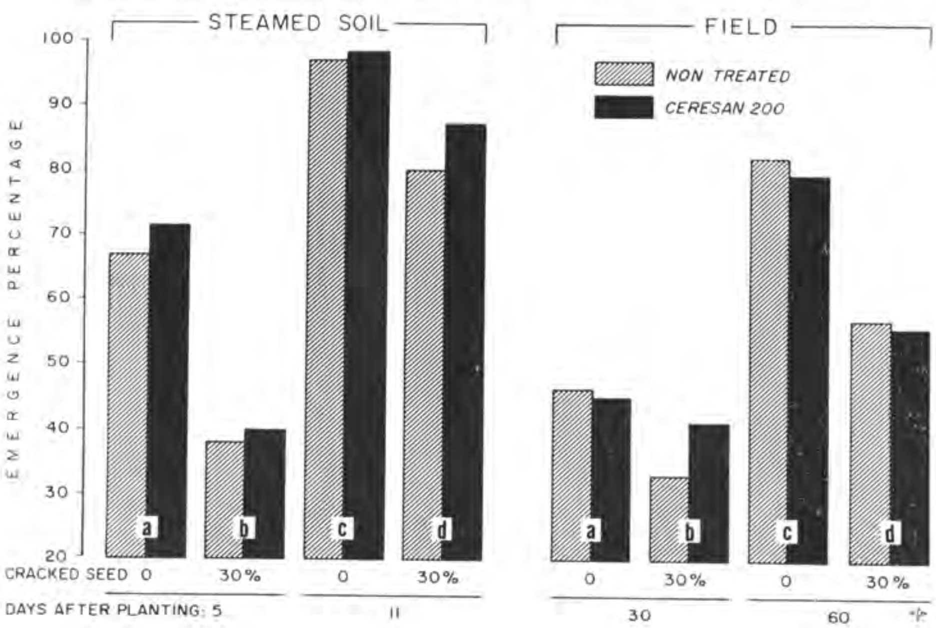
DELAY AND REDUCTION IN EMERGENCE DUE TO CRACKING OF FLAX SEED



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

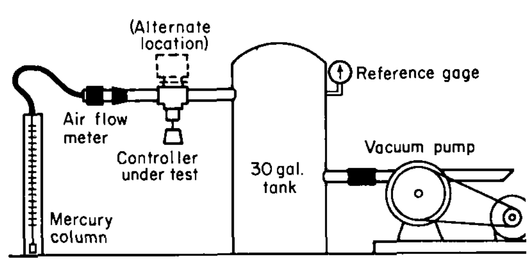


Fig. I

VACUUM CONTROL COMPARISONS

proportional to vacuum level, so are herein considered as self-compensating—a procedure which is within the significance of this study.

Performance curves were plotted for each controller. Ideally, the curve would be a horizontal line which would indicate uniform vacuum level for all load conditions. A simple controller, however, will normally produce an upward sloping curve indicative of proportional control. Level or downward slopes are the result of automatic reset or by a design known as "reaction compensation," whereby the entering air stream is reversed in direction to produce a reaction which alters the net effective force of the controller weight or spring.

Controller Terminology

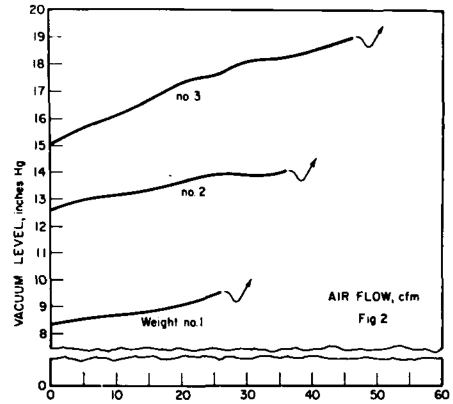
Set-point is the predetermined vacuum level in the system at the controller sensing location and is the vacuum level that is to be maintained. *Sensitivity* is the degree to which the control device will hold the process near the set-point. Quantitatively it is the difference between the highest and lowest vacuum levels maintained by the controller within its practical range of operation and for a given adjustment. A sensitivity of one inch or less within the full operating range should be expected in a good milking machine system. *Proportional control* means that the change of controller valve opening is proportional to the change in vacuum level. A good vacuum controller should operate fully with plus or minus one-half inch or less of vacuum from the set-point. *Lag* is a time delay between the change in valve opening with respect to the change in vacuum level. *Cycling* is the action of a controller opening and closing repeatedly caused usually by excess lag or excess sensitivity. *Dampening* is a resistance against motion of the valve mechanism to prevent cycling. *Neutral zone* is a zone within which there is no control—the valve position being determined by the direction of change of the vacuum level. *Automatic reset* is a controller feature or characteristic which shifts the set-point to compensate for proportional control and thus improves sensitivity.

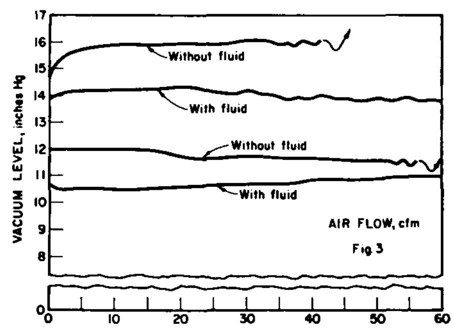
Graph 2 shows performance of a common type of controller with simple beveled valve seat, spherical valve disk and pendulum type adjustable weight. The family of curves was made with three different weights. The pronounced upward slope indicates severe proportional control and resulting lack of sensitivity. Each curve broke at nearly the same valve opening which established the maximum operating capacity. This controller demonstrated excellent shut-off but poor sensitivity and a working capacity of not more than two or three units.

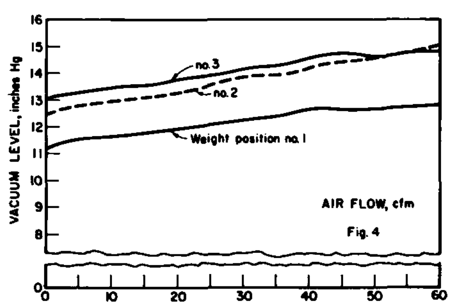
Graph 3 shows performance of a sliding sleeve valve controller with pendulum type adjustable weight, liquid-cushioned to dampen cycling. The general flatness of the curves shows excellent sensitivity due apparently to reaction compensation. The waviness indicates a measurable neutral zone, but it is well within acceptable limits and might tend to prevent the valve from sticking. When the dampening fluid was omitted the valve went into an uncontrollable cycling at high airflows. A reasonable working capacity of four to five units or 50 cfm would be expected.

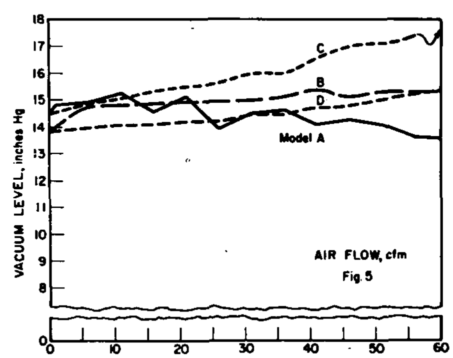
Graph 4 shows performance of a lever-actuated, dead-weight, bevel-seated disk valve, adjustable by sliding the weight along the lever arm. The family of curves was developed from three different positions of the weight. The neutral zone of this controller was narrow, but the proportionality was excessive. The sensitivity of 1.8 inches of Hg in the reasonable operating range suggests a capacity of about three or four units.

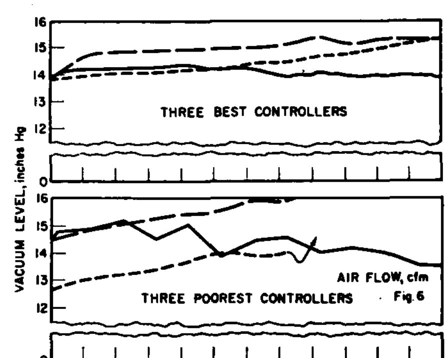
Graph 5 shows performance characteristics of four controllers produced by the same company. Curve A shows performance of a factory-sealed, spring-loaded, nonadjustable controller. The action was unpredictable, showed an extremely wide neutral zone, and showed such a high degree of automatic reset as to produce a reverse sloped action curve. It would be difficult to recommend this controller for any high-performance milking system.











(After these tests were conducted this model was removed from sale in most of California and most units already in use were replaced. The data are included in this report to demonstrate certain undesirable operating characteristics.)

Curve B, graph 5, is of an early-design controller using a reaction compensated valve with pedestal mounted weight. The controller tested was used, but reconditioned. The curve indicates that the valve did not shut off well at no flow (probably due to wear), but showed excellent performance throughout its entire normal working range—adequate for four to six units or a pump capacity above 50 cfm.

Curve C, graph 5, is of a more recent, yet obsolete, unadjustable controller of sleeve valve design with pedestal mounted weight. Proportionality is severe, safe usable capacity about 35 cfm, and absolute capacity is near 55 cfm.

Curve D, graph 5, is of a poppet-type valve with the weight suspended on a hollow sliding stem through which the admitted air is drawn. It is adjustable. Uniformity is good, the neutral zone is narrow, sensitivity is good at low flow rates. Proportionality is not excessive. Expected capacity is about 50 cfm.

Graph 6 is a composite of the three best and the three poorest test curves, plotted for comparison. (When several different weight adjustments were tested the setting nearest the common 14- to 15-inch vacuum level was plotted.) The three best controllers all gave high sensitivity from 5 to 60 cfm. The three poorest demonstrated excessive proportionality resulting in poor sensitivity, limited capacity, or excessively wide neutral zone.

Many of the milking machine vacuum controllers supplied through normal dairy equipment outlets were found to be rather crude proportional response air valves. Some showed evidence of deliberate design, but others were fabricated from common pipe fittings, apparently to remain price competitive. The several suppliers of the units tested made no particular reference to capacity. With high-capacity milking systems becoming standard, the need for adequate controllers is increasing. Udder health and operating efficiency must not be jeopardized by a poorly functioning controller. Capacity of each model of controller needs to be recognized, and the need of better engineering for this service is indicated.

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Control of

NAVEL ORANGEWORM

F. M. SUMMERS · D. W. PRICE

Recent experiments indicate that chemical sprays applied to kill navel orangeworm moths in the spring may provide a practical way to control this pest.

Unlike other common fruitworms which attack stonefruits and nuts, the navel orangeworm has not previously responded to test sprays designed to protect maturing fruits against attack. Over the past eight years, a variety of pesticides have been sprayed in almond orchards once, twice and even three times during the period between early hull split and harvest date. None of these test sprays produced any material change in the amount of crop damage.

Failure to find a suitable remedy by this approach required that research be directed especially to analyzing the habits of the pest in all of its stages. The basis for a different approach to the problem resulted from some of these studies, as reported here.

Infestations in almonds appear to be self-sustaining. Almond orchards in isolated places—well away from fruit or nut orchards—may be severely affected by this pest. Black-light traps have shown that hulling sheds and machinery will not hold infestations over from one season to another—providing that they are reasonably clean and free of neglected piles of trash nuts. Trash nuts or mummies left on trees after harvest sustain the pest populations throughout most of the year. Unharvested nuts provide food and shelter for populations of overwintering larvae.

The reproductive periods of the navel orangeworm are not rhythmic; there are no clear cut "broods" or cycles during the growing season. However, during spring months, the populations of moths build up to a low-level maximum during the first half of May. These moths come from overwintered larvae maturing in the old nuts. During the growing season, the immature, green nuts of the new crop are not molested. Before the new crop ripens, the pest continues to breed on the few holdover trash nuts. After mid-May and before harvest date, light traps capture fairly small numbers of moths. There is a very sharp upswing in the population density during the harvest period, when new nuts come under attack.

A study of the relations between the moisture content of almond kernels and their susceptibility to attack by hatching larvae indicates that normal drying of nuts on the trees does not afford any appreciable protection. However, kernels artificially dried to less than 4% extractable free water show partial resistance to the entry of hatchling larvae. Perhaps the weakest link in attempts to protect ripening nuts with spray chemicals is the tendency of moths to deposit some of their eggs under the lips of splitting hulls. The hidden eggs and the tiny hatchling larvae are therefore not exposed to chemical residues deposited on the outer surfaces of the hull. Previous attempts to utilize dormant types of sprays to kill larvae established within old or new nuts have not been successful. An insecticidal bacterium, *Bacillus thuringiensis*, used to contaminate mummy nuts to make them unsuitable as food for orangeworm larvae was also ineffective.

Since navel orangeworm larvae established in either old or new nuts do not respond to conventional spray treatments, an attempt was made to control the pest

Navel orangeworm pupae in an overwintered, sticktight almond.