Agriculture and the Postwar Period

Broad Shifts in Production and Distribution Expected with Return of Peace-time Conditions

By W. PRESTON THOMAS and GEORGE T. BLANCH

Agricultural Production

The economics of agricultural production is a second problem with which we shall be concerned. American farmers have made an excellent record during the war period in the production of food and fiber. In 1944 agricultural production was one-third above the average of 1935-39. This increase was obtained with 8 to 10 percent less farm labor than was used in 1935-39. The output per worker in 1944 was 93 percent higher than in 1910. This increase was achieved with a very small increase in the area of cropland, and in spite of shortages of many aids to production. Some of the increases were the result of surplus feeds on hand at the beginning of the war and a part of them were the result of favorable weather. On the other hand, American agriculture has adopted a number of technological changes which have materially increased production both per acre and per man. The increase in use of commercial fertilizers, the widespread use of hybrid seed corn and improved seeds of other kinds, and the use of superior livestock, and the mechanization of American farms are some of the factors that have influenced agricultural production during the war period and these same factors will continue to influence production after the war is over.

The present and future technological improvements in agricultural production will likely make changes in the production and marketing of some commodities produced in the west and will also require changes in farm organization and management. The improvement in mechanization and in breeding of crops and livestock will affect the size of the farm, land ownership, and may alter the family size farm program in America. Yields and costs of production may be changed to the extent of requiring the addition or deletion of certain crops from our cropping system. The mechanization of sugar beet production may be the final determinant as to whether the growing of this crop continues in the west. Also the reduced costs of growing dry land wheat by further mechanization of this enterprise will determine whether wheat can be produced on dry farms in the west as cheaply as corn in the corn belt and thereby place its production on a feed rather than a food basis. If this can be realized, then the livestock programs in many areas of the western regions will be changed.

We can expect many other changes in production and farm organization resulting from technological improvements that are now in sight. Likewise, the marketing and distribution of agricultural products will be affected. The kind, quantity, quality, and production and marketing costs of various agricultural products will be influenced by new culture and marketing practices.

On a national basis such changes will no doubt influence programs dealing with production controls, land use, farm tenure, land settlement, land reclamation, farm labor, and many others. It (Continued on page 2)
PRESIDENT FRANKLIN STEWART HARRIS

ON JULY 1, Dr. F. S. Harris returned to the Utah State Agricultural College to become its seventh president, succeeding Dr. E. G. Peterson, president emeritus. Dr. Harris has been well known on the College campus ever seen he first became a member of the faculty as assistant chemist in 1907.

After completing his studies for the doctorate degree at Cornell University in 1911, he returned to the College as professor of agronomy and head of the Agronomy Department. In addition to this position, he served as director of the School of Agricultural Engineering from 1912 to 1916, and from 1916 until 1921 when he became president of Brigham Young University, he was director of the Agricultural Experiment Station.

Under his leadership in agronomy and as director of the Station, extensive investigations were conducted in irrigation, soil management, dry farming, drainage, and reclamation of alkali soils, as well as in other phases of crop production and livestock management. Many discoveries and developments made during that time have had a beneficial effect in making agriculture a more substantial and profitable industry, and also in improving living conditions for those who dwell on the land.

Dr. Harris has taken a leading part in state, community, and church activities. He helped organize the Utah Academy of Science, Arts and Letters and later served as vice-president, and president. He was associate editor of the Utah Farmer from 1913 to 1920, during which time he contributed several hundred articles to its pages. He was a member and secretary of the Utah Dry Farmers Association, and a member and president (1921-22) of the Utah Irrigation and Drainage Congress.

Dr. Harris has not only been an outstanding agricultural leader at the College and in Utah, but in the nation and in other countries of the world. In 1927 he participated in the agricultural section of the Pan-Pacific Science Congress held in Japan, after which he visited many countries of Asia, Europe, and Africa. In 1929 he went to Russia where he served as chairman and agriculturist of the scientific expedition for planning the Jewish colonization of eastern Siberia. In 1939-40 he spent a year and a half in Iran where he served as agricultural adviser to the government in the organization of the Department of Agriculture and in the development of agricultural resources.

He has actively participated in many national and international organizations. For several years he was an active member of the International Dry Farming Congress. He is a member of the American Society of Agronomy and served as its president in 1920; in 1930 this organization elected him as honorary fellow. He also assisted in the organization of the Western Society of Soil Science. He is a member and fellow of the American Association for the Advancement of Science, a member of American Farm Economic Association, fellow of the American Geographical Society, American Asiatic Society, American Oriental Society, American Academy of Political and Social Science, Academy of Political Science of New York, Philosophical Society of Great Britain, National Education Association, and several other national scientific and educational organizations. He has been honored by election to numerous honorary scholarship societies, including the Society of the Sigma Xi, Phi Kappa Phi, Gamma Sigma Delta, Pi Gamma Mu, and Alpha Kappa Psi.

President Harris is the author of a number of books and many bulletins and articles in scientific and literary journals. Among his books are Principles of agronomy, (1915, rev. 1929); The sugar beet in America, (1918); Soil alkali, (1920); and Science and human welfare, (1924).

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no doubt will also lead to a further reduction in the proportion of people employed in agriculture, and the proportion living on farms and in rural areas.

Demand for Agricultural Products

Closely associated with the problems likely to arise from changes in agricultural production are those associated with the demand for agricultural products. Specifically, the problems will probably be those associated with the disposal of the total production. Agriculture is looking hopefully toward increased employment of non-agricultural groups. It has been found that the major factor influencing the consumption of agricultural products in this country is the purchasing power of consumers. It is estimated by the Bureau of Agricultural Economics that with a national income during the postwar period of 150 billion dollars and with employment

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New Insecticides for Control of Alfalfa-Seed Insects
Field Trials Show Superiority of DDT as Insecticide, but Its Affects on Beneficial Insects and Livestock Still Not Tested

By F. V. LIEBERMAN
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Utah's alfalfa-seed farmers have long waited for research to produce a method for the control of the destructive Lygus, which each year deprives them of much precious seed. Now the ill wind of war has blown the seed grower some good. The wartime search for substitute and supplemental insecticides has brought to light both new and rediscovered materials, and some of these are effective against Lygus. Particularly promising is the now famous DDT. This compound is highly toxic to Lygus and, unlike most insecticides that kill by contact, is effective in the field for weeks after it is applied.

The United States Department of Agriculture's experimental use of DDT and another new insecticide, sabadilla, against Lygus in alfalfa grown for seed was begun in the summer of 1944 at Gandy, an isolated ranch settlement in northwestern Millard County. This locality was selected for the initial experiments with the new dusts because the alfalfa flowers is adequately accomplished by large populations of wild bees. Extensive cross-pollination of the alfalfa flowers is essential to high yield. Particularly abundant and highly efficient in tripping alfalfa blossoms at Gandy is a medium-sized species, Nomia melanderi Ckll., commonly called the alkali bee.

This first season's work was limited to small plot trials. Four insecticidal dusts were used, and several fifth-acre plots were treated with each one. The dusts were applied with a tractor-mounted and operated crop duster. The dusting and all other operations in handling, harvesting, and threshing the crops from the plots closely approached actual farm practice.

In untreated acreage of the experimental field, the alfalfa flower buds were so severely damaged by Lygus that, for the most part, the plants failed to bloom. In a typical plot, production of clean seed was equivalent to only 23 pounds per acre. All four dusts helped the plants to achieve at least a general bloom and to set seed pods in distinctly greater quantity than in the untreated areas.

Best protection from Lygus damage was given by a dust containing 10 percent of DDT. The stability of this insecticide enabled the dust to kill Lygus continuously for several weeks, the nymphs as fast as they hatched from eggs already laid in the plants, and the adults as soon as they flew into the plots from the surrounding area. Only one application at the rate of 27.5 pounds of dust per acre was needed to give excellent protection for the entire crop period. Plants in these plots blossomed fully and set pods heavily. The seed yields were much superior to those produced under any of the other treatments, averaging 385 pounds of cleaned seed per acre. The seed from DDT-dusted plots was particularly free from inert matter, partly because there was little Lygus feeding on the pods, and partly because the plants matured somewhat earlier than other dusted growth and escaped the full effect of a severe early frost. This earliness of seed ripening may have been an effect of the DDT, but it might also have been the result of the better protection given these plants.

Two dusts containing sabadilla were tested, one containing 20 percent and the other 10 percent. Both strengths were effective in reducing Lygus populations on the plants at the time of dusting, but after a day or so this material exhibited no further killing power. Within a week nymphs were as numerous on the plants as they were before the dusts were applied. Therefore, a second application of each was made seven days after the first. Again, while the kill of bugs on the plants was excellent, within a week the nymphs were just as abundant as before dusting. The dusts had been applied at 25 to 32.5 pounds per acre, and no further applications were made.

Even though sabadilla was not effective in keeping the plants reasonably free from Lygus, the two applications of both dusts did give sufficient relief from Lygus feeding to allow the plants to bloom and set seed pods. In fact, in the plots treated twice with 20-percent sabadilla dust the pod set appeared to be as good as that in plots dusted once with DDT. These plots, however, yielded only 185 pounds of seed per acre, the feeding of Lygus on the green pods being appreciably responsible for this poor yield. Most of the pods were still green when severe early frost occurred and further lessened the yield of these plots. The plots treated with

Dusting alfalfa for control of Lygus at Gandy, Utah

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of 50 to 60 million people, the per capita food consumption would be increased about 15 percent over prewar. This increased consumption of 15 percent resulting from full employment and the food required for the increase in population would use most of the 25 percent increase over the prewar agricultural production which is predicted for the postwar period, leaving only a small amount to export above the usual amount of agricultural products going to other countries.

The Bureau of Agricultural Economics also estimates that with 60 million people employed, the agricultural income would be about 19 billion dollars, as compared to 8 billion dollars if only 38 million people are employed.

Agriculture, therefore, has a vital interest in full employment and a high total income for non-agricultural groups. On the other hand, a program of high wage scales with but few employed is injurious to agricultural interests.

The goal of a national income of 150 billion dollars and the employment of 60 million people is highly desirable. The problem is in its accomplishment. To transfer over to a strictly civilian production, and productivity, leaving only a small amount of agricultural product of the home market, would indeed be a miracle if accomplished.

Agriculture is hoping that full employment can be realized. If high consumer demand is not maintained, then we are likely to turn in a large way to subsidized consumption programs to increase the demand for agricultural products. The argument in support of such programs is that from one-fourth to one-third of the families of the United States have an income too low to purchase food for an adequate diet. These subsidized consumer programs may take the form of a food stamp plan, a basic food allotment plan, a food price discount plan, and the school lunch programs. The experience with such programs indicates that they have their limitations in increasing consumption of food.

NEW INSECTICIDES

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The fourth dust used contained pyrethrum, one of the best of the older contact insecticides. This was included as a standard for comparison with the new materials. The dust was applied twice seven days apart and quite unintentionally, at only half the dosage (14 to 16 pounds per acre) at which the other materials were applied. Protection against Lygus was inadequate, and the plots so treated yielded only 89 pounds of seed per acre.

In this experiment the only insects actually counted were Lygus. However, large aphid and thrips populations which were present in all plots at the time of dusting, were practically eliminated in the DDT plots and slightly reduced in the other treated plots. DDT was also observed to reduce populations of beneficial insect predators.

Several other important questions must be answered before DDT can be released for any but experimental use. The best dosages and mixtures for use against Lygus infesting alfalfa are not yet known. The correct time to apply the dust, particularly in connection with protection of pollinating bees, must be determined. The long-lasting quality of DDT also makes it necessary to study carefully the hazard of livestock poisoning before it is used freely on forage crops. The poisoning hazard of dusted growth that is pastured or cut for hay instead of seed will be greatest.

Admittedly, obtaining normal bloom in alfalfa seed fields by gaining control of Lygus is the first step back to consistent profitable production. Although this important step will be of some benefit to all seed growers, it will not be the end of the alfalfa seed problem. Until methods of obtaining adequate pollination of alfalfa flowers under various present-day conditions are developed, DDT or any other effective insecticide may be of limited value to the average seed grower.

Professor F. M. Coe, head of the Department of Horticulture, has been granted a leave of absence to teach courses for the U.S. Army at Biarritz, France, for the coming year. Professor Coe left the campus on August 18.
RESULTS of investigational work performed by the Utah Agricultural Experiment Station and the United States Department of Agriculture over a period of several years definitely indicate that lygus bugs while feeding inflict serious damage to alfalfa being grown for seed. Young buds are most seriously damaged. Flowers and developing seeds, while in the milk stage, are also injured but apparently to a lesser degree than the buds. In consequence of lygus-bug injury, alfalfa-seed production in Utah and other western states has been reduced during recent years below domestic needs.

Best insecticides on the market prior to 1944 which were adaptable for use against lygus bugs in alfalfa were only partially effective. Early in that year, however, two new insecticides, DDT and sabadilla, became available for experimental testing in the control of these injurious pests.

Procedure and Materials

These insecticides and one older one were tested at the Forage Crops Farm south of Logan, Utah. Trials were made on 64 plots of Ranger alfalfa, 7 x 7 feet, arranged in four groups of 16 plots each, which permitted the testing of the four insecticides in two dosages, two strengths, and in four replications. Plots receiving different treatment were separated by cultivated alleyways 8 feet wide. Each group of 16 plots comprising a replication was in turn separated by alleyways 12 feet wide. The alleyways were intended to lessen the effects of drift when applying the insecticides and to reduce migration of bugs between plots receiving different treatments.

Application of Insecticides

Separate hand dusters of the rotary type were used for each of the four insecticides. Two cloth cages, of a size large enough to cover an entire plot, were placed over the alfalfa during application to reduce drift (see figure). One cage was left in position over a plot for several minutes while application was being made under the second cage in position over another plot. A removable section of the top of each cage, approximately 18 inches wide, facilitated application of the dusts within the cages. Application began on July 18 and continued to September 9.

Dosage Used: Each insecticide was used at the rate of 30 and 50 pounds per acre on respective plots. These amounts, although thought from the outset to be excessive, were used because application of smaller measured quantities on separate plots proved to be impractical.

Frequency of Application: Previous experiments for insecticidal control of Lygus in alfalfa-seed production had shown the lygus population to build up to injurious proportions on small experimental plots through migration from surrounding host plants within four or five days following treatment. It was planned, therefore, to repeat the application of insecticides in 1944, at weekly and semi-weekly intervals. This plan was carried out from July 18 to August 15. From July 18 to August 8, it was shown by frequent counts that the lygus population on the treated plots was being held to a relatively low number in comparison with that on untreated alfalfa. Following the cutting of the second crop on nearby fields on August 6, a heavy influx of adult Lygus to the experimental plots occurred. Application of treatments two days later on August 8 again reduced the bug population on the plots to approximately the same low level that it had been before migration.

Because of the continued low population of Lygus on DDT-treated plots following the application of August 8, further treatment was withheld until August 22, when the population was again approaching damaging numbers. The plots were therefore again given their respective treatments, which in the case of DDT was the last for the season, whereas regular applications of sulfur-Pyrocide and sabadilla were continued to and including September 9. Because of this change in the original plan for frequency of application, the plots which were to have received weekly treatment with DDT received five instead of nine applications, and those which were to have been dusted semi-weekly with DDT received 9 instead of 16 treatments.

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WHAT appeared to be a new virus disease of the sweet cherry was first observed in Davis County, Utah, in the summer of 1943. Subsequent studies have established the fact that this disease is definitely of a virus nature, and have shown that it is identical in many, if not all, respects with rusty mottle of the sweet cherry, a virus disease reported by E. L. Reeves of the U. S. Department of Agriculture, from Washington in 1940, and now known to occur in various areas of the Pacific Northwest.

Preliminary survey studies made during 1944-45 have shown that rusty mottle is firmly established in Utah orchards, that it probably has been present for at least 10 years, and now occurs in destructive proportions in a high percentage of orchards of practically all ages in the cherry-growing areas of the northern part of the state. The widespread occurrence of this disease in Utah orchards constitutes a serious problem for sweet cherry growers. It is therefore important that they should be familiar with the disease in all of its various symptom expressions in order that they may be on the lookout for it and aid in the development of an effective control program.

Nature and Cause of Rusty Mottle

Results from repeated transmission by budding at the Bountiful experimental plot have confirmed what had been established earlier by Reeves in Washington—that rusty mottle of the sweet cherry is a systemic disease induced by a readily transmissible virus. The incidence of transmission by various methods of budding is high, approaching 100 percent. Further evidence of the virus nature of rusty mottle has been obtained by growers who were found to have inadvertently spread the disease in their orchards by the use of buds from diseased trees in introducing pollinizers into their trees. In one case a grower transmitted the disease to practically every third tree in every third row of part of his Lambert plantings. The fact, shown by our survey studies, that the disease in many orchards has been traced back to infected nursery stock further demonstrates that rusty mottle is bud-perpetuated and that the disease results whenever buds from trees with this disease are used for propagation.

Evidence obtained through survey studies also indicates that the rusty mottle virus spreads naturally from diseased to healthy trees in some orchards, though there has been little or no evidence of this in others. While the rate of spread under any certain set of conditions has not been determined, it is evident from studies in Utah that it is, in general, comparatively slow. It is possible that the virus of this disease may be spread to some extent by insects, but if so, the apparently slow rate of spread of the disease would indicate that the insect vector is not of frequent occurrence.

Host Range

Reeves states that all varieties of sweet cherries grown in Washington are affected by the rusty mottle virus, although he indicates that Lambert, Napoleon (Royal Ann), Black Republican, and Black Tartarian are less severely affected than the Bing. In Utah rusty mottle has been found principally on Bing, Lambert, and Napoleon, but has also been found on Windsor and an early black cherry said to be Waterhouse. It has been found from budding experiments in Utah that the virus passes from diseased buds into young trees of Bing, Lambert, Mazzard, and Napoleon varieties with equal facility. During August, 1944, buds from rusty mottle trees were grafted into peach, western chokecherry, and sour cherry. To date, symptoms have been produced only in the sour cherry. Some evidence exists which suggests the possibility of symptomless carriers of the rusty mottle virus.

Symptoms of the Disease

Rusty mottle is characterized by an array of dissimilar symptoms that develop in a definite progressive sequence during the growing season. The type, sequence, and degree of severity of symptoms vary with the season, the stage of development of the disease, and the variety of tree affected. On severely affected trees the disease can be observed first in the spring by the retarded development of blossoms and leaves. This feature, combined with the barren limbs resulting from the death of buds induced by the damaging effect of the disease during the previous season or seasons, provides a rather clear diagnostic picture (fig. 2). Aside from this retardation, the flower and leaf development appears normal, except that young leaves and blossom clusters from weakened buds frequently collapse and die, turn brown and remain attached, thus producing another striking feature of the disease.

From 2 to 4 weeks after petal-fall, brown necrotic areas, irregular in shape and varying in size and distribution, appear rather abruptly in both the older and young developing leaves (fig. 1). Such necrotic areas may be few in number and rather inconspicuous or, as is
more frequently the case, so numerous
as to involve and kill much of the leaf.
In some cases, considerable marginal
killing of the leaves also takes place
(fig. 1). Such necrotic areas frequently
result in partial defoliation ranging from
slight to severe. This peculiar necrotic
breakdown may continue to develop in
both the older and the younger leaves
until maturity of the fruit. From then
on it is usually accompanied by a con-
spicuous shot-hole effect, resulting from
the dead areas falling out (fig. 1). Such
leaves often become quite ragged.

From 4 to 6 weeks after blossoming,
many of the leaves showing necrotic
spotting, as well as some of those free
from such injury, take on the appear-
ance of early or premature senescence.
Affected leaves turn conspicuously yel-
low, orange or orange-red in color, with
the chlorophyll degenerating in such a
manner as to produce various relatively
small ring spots and line patterns, usu-
ally associated with a more generalized
mottling of the entire leaf. Leaves show-
ing this peculiar senescence invariably
shed, resulting in a defoliation, which,
by harvest time, may involve from 25
to 83 percent of the leaves on diseased
trees. This defoliation, which is much
more severe on some trees than others
and apparently more severe some years
than others, removes the leaves most
severely affected by necrotic spotting.
As a result of this early defoliation, leaf
symptoms of the disease frequently are
so scarce on many trees after midsum-
mer that the detection of the disease is
rendered much more difficult. The ne-
crotic spots that develop on the remain-
ing leaves, in so far as they have not
fallen out, tend to be smaller and more
circular in outline than those that de-
velop earlier in the season.

After this early defoliation, affected
leaves commonly, but by no means al-
ways, develop yellowish or yellowish-
brown chlorotic spots, which, together
with the reddish-brown necrotic areas,
give many of the leaves a general rusty
appearance. The yellowish chlorotic
spotting frequently accompanying the
necrotic spotting, however, at least in
Utah, is by no means always conspicu-
ously developed and often may not even
be apparent on trees during late sum-
mer and fall. During late summer and
fall the combination of brown necrotic
and yellowish chlorotic spots, or more
frequently, the necrotic spots alone,
provide the only characters by which
the less advanced cases of rusty mottle
can be diagnosed, at least until senescent
patterns develop in the young leaves on
the current year's growth very late in
the season.

It therefore often becomes somewhat
of a problem to diagnose rusty mottle
with certainty in orchard surveys made
after the early senescence and leaf fall
takes place. However, it has been found
that in the absence of well-defined symp-
toms of rusty mottle during the latter
part of the growing season, even the meager occurrence of the necrotic spots
associated with this disease constitutes
an almost infallible means of detecting
it and a diagnosis made on this basis will
er in being too conservative.

Diseased leaves on the current year's
growth seldom show any of the typical
symptoms of rusty mottle until late in
the season. In autumn, senescence in
these leaves develops usually from 10
to 15 days earlier than in leaves on
healthy trees. In this late senescence
the chlorophyll also breaks down in a
manner so as to form distinct ring and
line patterns of deep green with a back-
ground of color ranging from light yel-
low to deep reddish-orange. These pat-
terns are similar to those exhibited dur-
ing the early, or June, senescence but
are larger and more definitely delimited.
It is thought that these distinctive pat-
terns in new leaves on current growth
may serve as a basis for identifying and
roguing rusty mottle plants in nursery
stock (fig. 1, leaves 4, 5, 6, and 7).

While conditions determining the se-
verity of rusty mottle symptoms in Utah
have not been determined, it is evident
from three season's observations, and
from the history of specific orchards,
that great variation occurs in the ex-
pression of the disease in the same vari-
dence and during the same season. In
some trees severe early senescence ac-
companied by heavy leaf fall seldom
occurs. Under such conditions the effect
on the tree appears slight and only the
brown necrotic areas and the yellowish
chlorotic spots in the leaves serve to
identify the disease. From a distance
such trees appear fairly normal, even
though they may have been diseased for
a number of years.

In the more severe form, which is
characterized by abundant early nec-
rosis, senescence and leaf fall, the buds
and fruit spurs die. As a result, branches
acquire a bare, rangy appearance with
the foliage best preserved, and fre-
quently developed only, on the terminal

Fig. 2. Rusty mottle induced in central one
of three Lambert trees by bud inoculation,
showing retarded development of blossoms
and leaves in the spring and barren limbs
resulting from death of buds during pre-
vious season. Trees on either side are
healthy.

Fig. 3. Row of Lambert trees showing charac-
teristic expression of rusty mottle in all
except the first one, which is normal.

Fig. 4. Advanced stage of rusty mottle in
Lambert tree, showing characteristic bare,
ragy limbs resulting from bud killing, with
foliage limited largely to terminal portions
of living branches and watersprouts.
portions of the limbs (figs. 3 and 4). In the later stages of this severe form of the disease the branches die back gradually, after which the declining trees develop masses of watersprouts from the trunk and lower portions of the main branches. The leaves on these sprouts may or may not show the necrotic and yellowish chlorotic spots characteristic of rusty mottle. A pronounced roughening of the bark frequently, though by no means always, accompanies this more severe form. Observations suggest that this form of the disease may result from a more virulent form of the virus. Strain differences may logically be expected to be present in such a virus that is so well established in Utah orchards.

There exists no definite basis for predicting at what age or how soon after infection a tree may reach a stage where it will become commercially unprofitable. The rate of decline of infected trees appears to vary with the age and variety affected, cultural conditions of the diseased tree and form of the rusty mottle virus involved. After trees have been infected for 2 or 3 years their growth is appreciably less than that of comparable healthy trees. Fruits on rusty mottle trees are not misshapen and appear to be little affected until the disease begins to weaken the trees seriously, after which they tend to be smaller than normal, retarded in maturity, and insipid in flavor. Roots of trees affected by rusty mottle remain living until after the trees have declined well beyond the point where they become worthless commercially. This accounts for the abundant production of watersprouts.

Occurrence and Economic Importance

In preliminary survey studies in Utah during 1944, rusty mottle was found to occur in Weber, Davis, Salt Lake and Utah Counties, but not in Washington County, which is relatively unimportant in cherry production. The incidence and percentage of this disease in the four counties where it occurred is shown in table 1.

Rusty mottle was found to occur in 27, or 20.9 percent, of a total of 129 orchards or blocks of orchards visited in these counties, which, with the exception of Salt Lake County, are all important in cherry production. A total of 576, or 2.4 percent of 24,138 living trees, nearly all bearing, examined in these four counties were found to have rusty mottle.

The average percentage of rusty mottle in the four counties in Utah where this disease was found to occur does not afford a true index of its importance in certain localities. While rusty mottle is of relatively little importance in general in Weber County, it is of considerable importance in the other three counties. It is of interest to note that this disease was found to be particularly destructive in 5 of the 27 orchards where it occurred and that a total of 9, or 33 percent, of the orchards where rusty mottle occurred showed concentrations of the disease ranging above 10 percent.

Striking instances were seen particularly in Utah County, of the high incidence of rusty mottle in a number of orchards where the evidence clearly indicates that the trees involved were diseased when purchased from the nursery. In some cases the disease was found also on several of the older trees in some other part of the same orchard, but in others no evidence of it was found on older trees.

The worst case of obvious dissemination of rusty mottle in nursery stock occurred in an orchard at Mapleton, where 105 trees that had been set out six years ago as replants in an old orchard were found to show striking evidence of the disease and a few others that apparently had died from its effects had been cut down. None of the older trees in this orchard exhibited the disease.

In a 5-year-old planting at Orem, 40 out of 90 living trees remaining showed more or less pronounced cases of rusty mottle. In an orchard on the bench near Orem, consisting merely of a 2-year-old planting, rusty mottle was found to occur in 25 of the 182 living trees remaining.

In a 15-year-old orchard on the bench near Orem a block of Bing trees, comprising 6 rows with 16 trees in each row originally, adjoined a similar block of Lambert trees planted at the same time. Rusty mottle, in severe form, occurred on 59 of the 89 original trees remaining in the Bing block, whereas in the Lambert block this disease occurred on but 2 trees. Since these occurred at one end of the first row next to the Bing trees, it is possible that they may have been of this variety rather than Lamberts. The fact that the disease was confined almost entirely to the Bing block does not necessarily indicate that this variety is more susceptible than Lamberts but suggests that, here again, a lot of diseased trees of the Bing. (Continued on page 11)
Liver Flukes in Cattle and How to Control Them by Medication

By O. Wilford Olsen
U. S. Bureau of Animal Industry

Since Dr. Olsen discovered that liver flukes could be controlled in livestock by the use of hexachlorethane, a new and simpler method has been developed for mixing the suspension:

Hexachlorethane (50-60 mesh) 8 lbs.
Bentonite (pure Wyoming) 12 oz.
White flour 2 teaspoonfuls
Water 200 oz. (1/2 gals.)

The dry ingredients are weighed into a 3-gallon pail and then the measured volume of water is added slowly while stirring with a wooden paddle. This process provides for uniform wetting of the hexachlorethane, bentonite and flour, in preparation for the final mixing. This will make 2 gallons of the suspension and will drench forty 1,000-pound cows.

When the material is thoroughly wet, allow to soak a few minutes. Pour into a 3-gallon bucket whose bottom has been replaced by a brass screen, 20 mesh to the inch. In passing through this screen into another 3-gallon pail, the large lumps of hexachlorethane and bentonite are broken up. By rubbing the screen with a small scrub brush, passage through the screen is hastened without injury to the hands. It is better to pour the mixture through the screen a second time as the last to pass through the screen the first time is usually thick.

By this method practically no equipment is needed and the results are excellent and quickly obtained. Also the drench can be prepared as needed if desired, with no bottling necessary.

Hexachlorethane is now available for purchase in one gallon containers, ready mixed, enough to treat 20 adult animals.

The common liver fluke, Fasciola hepatica, a small, flat, leaflike worm, is one of the most injurious parasites of cattle in certain sections of the United States. In general, this parasite is prevalent in the Gulf Coast area, and parts of the Pacific Coast and Intermountain States, where the moisture and soil conditions are suitable for the development of certain fresh-water snails that serve as the necessary intermediate hosts. The presence, in the bile ducts, of mature flukes or of lesions caused by the migrations of young flukes, renders the liver unfit for human consumption and is cause for its condemnation under competent meat inspection. The result is a great loss of valuable and nourishing food. In addition, the damage to the liver resulting from the activities of the flukes interferes with its proper functioning.

Injuries Caused by Liver Flukes

Flukes cause serious damage to the liver, beginning at the time they enter it as minute, immature forms, and continuing throughout the period of their development and activity. Through their wanderings, the young flukes destroy much of the liver tissue, introduce bacteria from the intestine, some of which find the dead and damaged liver cells ideal for growth and reproduction, and perhaps introduce products from their own bodies, which are more or less toxic to the host.

As a result of repeated infections by the flukes and the damage caused during their migrations, the liver becomes grayish in color and very hard because of the great amount of scar tissue present. Irritation by the flukes to the walls of the bile ducts causes the latter to become greatly thickened and often filled with a stonelike deposit of calcium phosphate. These deposits may become so great as to occlude the ducts and encyst there. Cattle grazing on contaminated pastures swallow the encysted larva with forage and water.

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were condemned on account of liver flukes, according to the records of the federal meat inspection service. The annual average number of infected animals was approximately 128,200 cattle and 5,500 calves. Inasmuch as only about 70 percent of the cattle are slaughtered in federally inspected establishments, the actual losses are doubtless greater than those given.

Allowing 8.24 pounds each for livers from adult cattle and 3.34 pounds for calf livers, which is 1 percent of the live weight ... approximately 1,075,000 pounds of liver were lost annually during the 11-year period as a result of liver flukes.

Loss of flesh due to unthriftiness of cattle harboring liver flukes, resulting from the inability of parasitized animals to digest their feed properly, is estimated to be even greater than the liver losses. Experience has shown that infected adult cattle average about 5 percent and calves about 3 percent lighter in weight than comparable uninfected animals. Allowing an average weight of 824 pounds for cattle and 334 pounds for calves, the annual loss in live weight due to liver flukes is estimated at approximately 2,733,000 pounds, or about 1,366,000 pounds of dressed weight.

In line with the unthrifty condition resulting from liver flukes, it has been shown that parasitized animals gain only about half as much in feedlots as comparable uninfected ones, while consuming about the same quantity of feed. In view of this, the cost of each hundred pounds added to the weight of fluky cattle is twice as great as for nonfluky ones. Moreover, the finish obtained on fluky animals is not so good as on normal cattle.

The average annual loss of food, represented by both beef and livers, in cattle from infected areas is estimated to total approximately 1,220 tons ...

Milk secretion has been observed to decrease as much as 16 percent as the result of heavy infection of dairy herds by liver flukes.

Death may occur as the result of severe liver-fluke infection, especially among range cattle during periods of drought late in the season, or when there is otherwise a shortage of grass.

Reduced breeding activities of cattle also occur as a result of infestations by liver flukes. The extent to which reproduction is curtailed depends on the severity of the infection. Cattle suffering from advanced liver fluke disease, characterized by extreme weakness and emaciation, do not breed at all while in that condition.

How Liver Flukes are Transmitted

The life cycle of the liver fluke is complicated in that the parasite can become infective to cattle only after undergoing a period of development in certain species of fresh-water snails that live on wet pastures (fig. 1).

The adult flukes deposit their eggs, which are microscopic in size, in the bile ducts of the liver. The eggs reach the intestine by way of the common bile duct, and are expelled from the body with the droppings. During warm weather, eggs reaching the pasture hatch in moist or wet places in about 7 to 10 days. Development of the eggs is retarded by low temperatures and completely suspended when the temperature is 50° F. or lower.

The microscopic larva (miracidia) hatching from the eggs, penetrate into the snail's body and pass through certain stages of development before becoming infective to cattle, multiplying several hundred times during this period. After about 7 weeks, small tadpole-like larvae (ceracarias), which are barely visible to the naked eye, issue from the snails. They swim about a short time, coming to rest on blades of grass and on debris in the water, or even on the surface of the water. They then shed their tails and secrete a cyst about themselves which serves both to attach them to the grass or other objects, and to protect them from drying. The encysted stage (metacercaria) is infective to cattle when taken into the digestive tract with feed or water.

Upon entering the body of cattle, the young flukes escape from the cysts in the small intestine. They burrow through the intestinal wall into the body cavity, migrate to the liver, and penetrate the liver capsule. During the next 2 months the young flukes wander in the liver, finally entering the bile ducts where they reach sexual maturity about one month later. Under favorable conditions, it requires, therefore, about 5 months for the liver fluke to complete its life cycle. This period may be divided as follows: (1) hatching of the eggs, about 7 to 10 days; (2) development in the snail, about 7 weeks; (3) development in the liver before reaching sexual maturity, about 3 months.

How to Control Liver Flukes by Medication

In cattle, liver flukes can be destroyed effectively and economically with hexachlorethane, a synthetic drug. The drug should be prepared as an aqueous suspension and administered as a drench. A measured dose of 6 1/2 ounces of the suspension for cattle, and 3 1/4 ounces for calves over 3 months old, is given by means of a metal drench syringe of 4-ounce capacity or greater. Calves under 3 months of age need not be treated because any flukes they might harbor would be too young to be killed by the treatment.

When administered as an aqueous suspension, hexachlorethane has a wide margin of safety for the treatment of all classes of range cattle, with the exception of very debilitated ones. Extremely weak animals should be treated with caution since, occasionally, unfavorable effects such as staggering and reeling, sometimes prostration and death, may result from giving a full dose.

One dose of hexachlorethane suspension is usually sufficient to kill the adult flukes in the bile ducts; young flukes are somewhat resistant to the treatment. The dead flukes pass from the liver, by way of the common bile duct, into the intestine, and to the outside with the droppings.

In cases where the poor or unthrifty condition of the cattle is due to liver flukes, there is generally a remarkable improvement in the weight and appearance of animals within a short time after treatment with hexachlorethane. Exceptions occur, however, in instances where the damage to the liver is so extensive that the animals are unable to recover, even though the flukes that they harbored are destroyed.

Time of Treatment

In planning a program for controlling liver flukes, the time of treatment should be chosen so as to take advantage of the weakest point in the life cycle of the fluke. In general, the flukes are most vulnerable in the spring and fall, and it is probably at this time that the treatment may be given most advantageously ...

In regions where cattle are taken off pastures and not subjected to continuous infection during the cold winter months, treatment should be given at the time when the animals are removed from the infested range in the fall and
again in the spring before they are returned to it. The fall treatment kills the flukes that have reached maturity during the grazing season and the spring treatment destroys those flukes that were too small to be killed readily at the time of the first treatment. Animals treated in this manner should be practically free of the parasites when they are returned to the range. Such a program not only kills the greatest number of flukes but also reduces the possibility of infection of more snails on the pasture the next grazing season. A program of drenching cattle twice a year, however, will not eradicate liver flukes, but it will greatly reduce their numbers and improve the health of the cattle.

**RUSTY MOTTELE**

variety happened to be obtained when the planting stock was purchased.

In a 4-year-old block of trees at South Ogden in Weber County, 20 of the 69 living trees remaining showed definite symptoms of rusty mottle and 3 of the others a chlorotic spot. Here again, no evidence of the disease occurred in an adjoining 6-year-old block or in older trees on another part of the property.

These represent but a few of the more striking cases where it is clearly apparent that the trees carried the rusty mottle virus when purchased. Naturally growers who were so unfortunate as to obtain such large percentages of diseased trees have little chance of success. Nursing a lot of cherry trees along for several years, only to find out later that they were infected with the rusty mottle virus to start with, certainly would prove both unremunerative and discouraging business.

Control

Rusty mottle is a systemic virus disease for which there is no known cure. The removal of diseased trees is the only means of eradicating the disease when it once becomes established in an orchard. Specific recommendations for eradication of rusty mottle from an infected orchard can be made only after a detailed study and evaluation of the factors involved. Diseased trees should be watched closely and removed as soon as they become commercially unprofitable and particular consideration should be given to a removal program from the standpoint of preventing spread of the disease to adjacent trees.

Those engaged in propagating trees, or growers desiring to introduce pollinizers into their orchards, should obtain budwood only from trees that are definitely known to be virus-free. Growers should not accept trees from nurserymen who are unable to provide certification that their stock is free from rusty mottle and other virus diseases.

**CONTROL OF LYGUS IN ALFALFA**

(Continued from page 5)

Lygus numbers for each of the 64 plots were determined by the sweep method, taking four strokes of the insect net through the alfalfa, immediately before applying the insecticides and again 24 hours after. In order to study the reactions of Lygus to the effects of the respective insecticides, from 10 to 20 adults or nymphs were collected from nearby untreated alfalfa plots and placed in separate wire-screen, cylindrical cages, 12 x 16 inches. The cages were placed in the alfalfa of the various plots immediately prior to applying the insecticides. Observations on the effects of the treatments on the bugs were made at intervals of 10, 30, 60, and 180 minutes, after application.

Results

Results obtained from application of the insecticides showed that DDT, 10 percent, gave best control of Lygus and the highest average yields of seed. DDT, 3 percent, was second best with sabadilla, 10 percent, third. A high lygus population in alfalfa-seed fields has been found to be consistently correlated with a low yield of seed, whereas high seed yields have generally been associated with a low lygus population or a high degree of freedom from lygus damage.

Semi-weekly application of the insecticides gave slightly better results than at weekly intervals. There was no practical difference between dosages of 30 and 50 pounds per acre. The efficiency of the sulfur-Pyrovicide was low in all combinations of strength and dosage, whereas DDT was relatively efficient.

Biological Relationships

Although no important difference was noted in the effects of the various insecticides upon lygus bugs within the small wire-screen cages, sabadilla dust appeared to be more irritating and killed them quicker than the other insecticides. Nymphal bugs within the cages appeared to be somewhat more resistant to all the insecticides than were adults. One hour after treatment, approximately 33 percent of all bugs were dead and after three hours, usually all bugs were dead.

After treatment of the experimental plots had been started, practically no lygus nymphs were captured on those treated with DDT, indicating that either oviposition had not occurred on them, or if it had, the newly hatched nymphs failed to develop; also, that reinfection by adults resulted from their migration from untreated alfalfa and/or other nearby host plants.

On the DDT-treated plots, it was observed that the thrips population was negligibly low; whereas, on untreated alfalfa, particularly during the blossom period, these insects were exceedingly abundant.

**FIELD DAY AT ALFALFA EXPERIMENTAL PLOTS**

On August 10 and 11, alfalfa and clover experimental plots in northern Utah were visited by college and government officials to observe the progress made in the various phases of the experimental program. Some of this work is reported in two articles in this issue.

Out-of-state visitors on the inspection trip included Dr. H. M. Tysdal, senior agronomist, Division of Forage Crops and Diseases, U. S. Bureau of Plant Industry, Soils and Agricultural Engineering, Beltsville, Maryland; Dr. E. A. Hollowell, senior agronomist with the same division; C. S. Garrison, extension agronomist, New Jersey College of Agriculture, New Brunswick; Dr. K. H. Klages, agronomist, and Dr. W. E. Shull, entomologist, of the Idaho Agricultural Experiment Station at Moscow; John L. Toews, superintendent of the Idaho Branch Experiment Station at Aberdeen; Frank E. Todd, apiculturist with the Division of Bee Culture, U. S. Bureau of Entomology and Plant Quarantine, Washington; and George H. Vansell, apiculturist with the same bureau stationed at Davis, California.

Dr. L. L. Madsen, new head of the Animal Husbandry Department, has arrived on the campus from Beltsville, Maryland, to take over his duties. Dr. Madsen is a graduate of Utah State and Cornell University. He has been connected with the U. S. Bureau of Animal Industry since 1937 doing research in animal nutrition.

Golden L. Stoker has been appointed re- search assistant professor of agronomy. He will have charge of the program of crop improvement and seed certification which is being conducted cooperatively by the Experiment Station, the Utah Crop Improvement Association, and the State Department of Agriculture. Mr. Stoker received both his B.S. and M.S. degrees from Utah State; he has been both a teacher of vocational agriculture and a county agent. At the time of his appointment he was agronomist for a commercial beet seed company in Oregon.
GROWING LIVESTOCK AND BIG GAME ON THE RANGE

By L. A. STODDART and D. I. RASMUSSEN

UTAH's big game population has reached peak numbers within the past decade. This high game population has not been supported without some sacrifice. Although we greatly enjoy hunting, and the meat, especially now, is a welcome addition to our table, still we must remember that these animals get feed from our livestock ranges and we weight basis, to about 40 thousand cattle or 300 thousand sheep. Stockmen sometimes insist that they alone are the "rightful" users of the public land. Some stockmen have made the mistake of demanding virtual removal of big game from public range so the livestock can have it all. Most stockmen and farmers tolerate reason-able use of their land by game, but when numbers are unreasonable and the animals do real damage, then the sports-men and game commission have a distinct responsibility to do something about it. This means game herd reduction. Occasionally purchase of private land, fencing deer away from private land, or paying for damage to private land will work, but all these are only local answers. Nine times out of ten, herd reduction is the most feasible for sportsmen as well as landowners. On public lands, the problem is more complex, but usually severe misuse of land results from either deer or livestock; seldom from both. Range inspection will show which animal is over-using the range, and that animal should be reduced in numbers until forage and numbers balance. On the few localized areas of public land where serious com-petition between deer and livestock does exist and where, as a result, public lands are being damaged, it should be remem-bered that livestock can be moved or artificially fed. Practically, deer cannot. This does not mean that livestock should always yield to deer, for in every in-stance, intelligent and scientific consid-eration of the problem must precede action. It is entirely possible to produce both deer and livestock on the same range. First of all, competition is far less than generally supposed, although it has re-ceived unfortunate emphasis from agi-tators. It is wrong to assume that no competition exists, but still the maxi-mum productivity of land comes from multiple use. Deer can use parts of a range not grazed by livestock, such as heavily timbered areas and steep and rocky slopes. Without game, these areas might not be grazed. Probably on steep forested range, such as Utah's mountain land, half of the area grazed by deer would not be used by cattle if the deer were not there, and about a fourth would not be used by sheep. In addition to grazing in somewhat different areas, deer have notably differ-ent forage-plant preferences from cattle, and somewhat different from sheep. Detailed studies of the grazing habits of deer have shown that many important deer feeds are not eaten by live-stock, and many others are grazed only occasionally. On the other hand, many plants, such as the grasses, are eaten in large quantity by livestock but are not grazed by deer. Therefore, good live-stock range may be unsatisfactory deer range; satisfactory deer range may be very poor livestock range. Other plants, of course, are relished by both livestock and deer. For exam-ple, on the summer range, many plants are palatable to deer and are also con-sumed by livestock. Many species of weeds and brush eaten by sheep are readily eaten by deer, and really serious deer-sheep competition may exist for these plants. Especially is this true when sheep range is overgrazed, because then the sheep are forced to change their eating habits and eat what deer normally eat. Since livestock and game graze differ-ent areas and different plants, the com-petition is not direct, and the overlap in range use is small. It has been cal-culated that, on an average range, it would be necessary to remove about 30 deer to make room for 1 cow and about 2 deer to make room for 1 sheep. In re-verse, 1 cow would have to be removed to make room for 1 deer and 3 sheep would be equivalent to 1 deer. It is important that both stockmen and sportsmen appreciate that over-use of the range by livestock or deer is bad for everyone. In Utah there are local areas with too many livestock and others with too many deer on the ranges for maximum production. Many livestock ranges have been overstocked and many are still overstocked. There are more deer in many areas than the land can support regardless of livestock numbers, and the best interest of the sportsman is served by reducing deer numbers on such areas. In the same reasoning, some areas support less deer than are desir-able. Too much emphasis has been placed upon game numbers in the past. Actu-ally, condition of the range is the most reliable index to proper management. Even if the exact number of big game were known, still we would have to look at the land to determine whether that number was too many or too few for the feed available. Scientific range ex-amination is the most accurate basis for big game management.

We need a give-and-take compromise between sportsman and stockman in which game and livestock share the range in reasonable numbers and rea-sonable ratio. This "multiple" use gives the highest production from the land. Good deer and good livestock result from good land management, and every sportsman and stockman should work for a better understanding of what a good range consists of and how that range must be managed and protected if the deer herds and livestock herds are to continue to thrive.

This article is a summary of Circular 121, Deer management and range live-stock production, written by the same authors. Anyone wishing further infor-mation on this subject should write for a copy of the circular.

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