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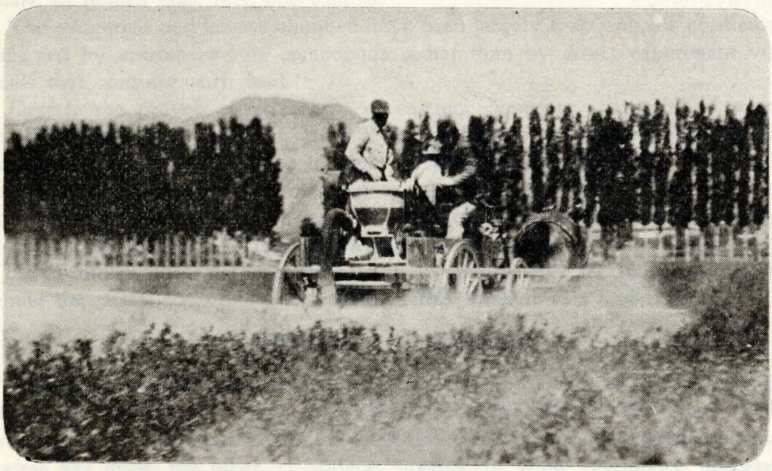

Dusting machine (boom) in operation.

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UTAH STATE AGRICULTURAL COLLEGE
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Feeding Value of Alfalfa Hay Treated With Calcium Arsenate[1]

H. J. Frederick[2]

For a number of years many tons of sprayed or dusted hay have been fed successfully to livestock by stockmen interested in controlling the alfalfa weevil; nevertheless, the supposed cases of poisoning that have been reported naturally have caused concern among feeders.

Further confusion on this question has resulted from reports on studies designed to determine the effect of lead arsenate instead of calcium arsenate.

Whether the lead in lead arsenate has been a more injurious agent than the arsenic, of course, is difficult to state. Most of the experiments performed in the feeding of sprayed or dusted hay have been conducted with small experiment animals, as guinea pigs, rats, and rabbits.

The symptoms and lesions obtained have been largely from animals accidentally affected by arsenic and its compounds rather than by direct experiment with animals that consume such feed.

Despite the proven effectiveness of calcium arsenate in alfalfa weevil control[3],[4], a number of stockmen are still doubtful as to the feeding value of hay from alfalfa thus treated, fearing it might be poisonous to livestock. As a rule, their fears in this respect are traceable to reports of poisoning based upon fallacious reports from different sources. Direct information on this subject is limited and difficult to obtain; especially is this true with calcium arsenate. In order to get direct information on the feeding value of alfalfa hay treated with calcium arsenate the study constituting the basis of this bulletin was undertaken.

PROPERTIES OF ARSENIC

Arsenic (arsenious acid, AS_2O_3) is derived from roasting arsenical ores and purifying by sublimation. It is a heavy solid occurring either as an opaque white powder or in irregular masses of two varieties: One, amorphous, transparent, and colorless like glass; the other, crystalline, opaque, or white resembling porcelain. Both are odorless and tasteless. The glassy variety dissolves slowly in 30 parts of water, the porcelain variety in 80 parts of water. It is soluble in glycerine and slightly soluble in alcohol. When heated to 420° Fahrenheit, arsenious acid is completely volatilized without melting.

ACTION OF ARSENICAL COMPOUNDS

Externally, arsenic acts on raw surfaces or mucous membranes as a caustic causing pain and sloughing; internally, when given in small doses, it improves the

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Note: The work covering this project (110) was planned by and is under the supervision of the Veterinary Science Department of the Experiment Station, cooperating with the Bureau of Entomology U. S. Department of Agriculture (Alfalfa Weevil Investigations, Salt Lake Laboratory, under supervision of George I. Reeves).

[1]Contribution from Veterinary Science Department of the Animal Husbandry Division, Utah Agricultural Experiment Station.

[2]Veterinarian.

[3]Reeves, G. I. The arsenical poisoning of livestock. In Jour. Econ. Ent., 18: 83-89. 1925.

[4]Reeves, G. I. The control of the alfalfa weevil. U. S. D. A. Farmers' Bul. ~~1528~~. 1927

appetite and increases both motion and secretions of the stomach and the lower part of the small intestines; in large doses, it acts as an irritant causing loss of appetite, nausea, and digestive disturbances. Toxic doses cause gastro-enteritis. Arsenic is absorbed into the blood stream and, in some forms of anemia, increases the number of red corpuscles and to some extent the hemoglobin. In small doses arsenic is said to stimulate the pulse rate, while in large doses it has a local, depressing action on the heart, lowering its force and frequency and reducing blood pressure. In small doses arsenic stimulates the respiratory center, whereas in lethal amounts it paralyzes the peripheral respiratory nerves. The nerve trunks are painfully influenced in the higher animals. Medicinal doses of arsenic act as a stimulant to the nervous system generally. Therapeutic doses probably diminish tissue changes and elimination of urea and carbon dioxide. Large doses increase metabolic changes. Arsenic is eliminated slowly by most channels. It is found in urine, feces, milk, sweat, tears, and saliva and can be recovered in toxic amounts from the bodies of animals years after death.

In his evidence in the Riverside dairy case before the United States District Court of Utah, Gardiner[5] of Montana stated that 20 to 30 grains of arsenic (AS_2O_3) could be fed to horses and cattle month in and month out without external evidence of injury or without any alteration discernible on postmortem examination, the fatal dose being 300 grains.

Gardiner further states that in acute arsenical poisoning the most general symptom is depression or coma, increased pulse, uneasiness, etc., with lesions in stomach and intestines. There occurs an over-intoxication resulting in an actual destruction and conversion into microscopic fat of the cells of liver tissue proper; within their framework of connective tissue the liver loses its ability to eliminate poisons; in case the dose of arsenic is sufficient to poison the animal there is always a considerable amount of arsenic found in the liver, from 10 to 15 times as much as in other tissues of the body. The existence of arsenical poisoning in farm animals is determined by the history, the clinical symptoms, and by the existence of an acute nephritis shown by the blood and urine and by the presence of unusual amounts of arsenic in the urine and feces.

The symptoms described by earlier authorities of acute poisoning from arsenic are biliousness, mucous or bloody purging, and colic; thirst is excessive, urine highly colored and albuminous; pulse feeble, weak, and frequent. An affected animal may show abdominal pain by rapid and difficult respirations; the extremities are usually cold and exhibit great weakness; finally the animal collapses with convulsions and coma in from 5 to 20 hours up to three days. In chronic poisoning, similar symptoms, with gradual loss of strength, flesh, paralysis, and coma are manifest. Fatty degeneration of the internal organs is noted on postmortem examination especially in the liver and kidneys. Some of the mucous membranes are swollen, softened, and covered with crimson or deep brown-colored patches. There is generally a widespread degeneration of internal organs and muscles.

Arsenic seems to be of greatest service in the treatment of indigestion of horses associated with malnutrition and staring coat. In foreign countries, especially in Austria, arsenic is given frequently to horses which perform hard labor, especially when it is uphill work. Arsenic is believed to improve the endurance

[5]Gardiner, Henry C., D. V. M. In the District Court of United States and for the District of Utah. No. 3841 (Law); No. 1046, Bill of Exceptions. 1915.

and wind in horses and is often used for this purpose. People in these same sections also consume large quantities of arsenic and appear to be robust and healthy. Arsenic apparently influences favorably the mucous membrane of the respiratory tract, improves nutrition, and hastens absorption and repair of the air passages. It is often used in emphysema (heaves) with beneficial results. It is useful in skin disease as eczema, urticaria, and psoriasis, given in small doses over a long period of time. It is most commonly administered to animals in the form of Fowler's solution or as arsenious acid in feed.

METHODS OF EXPERIMENTATION

To carry on the experiment to determine the feeding value of arsenic for

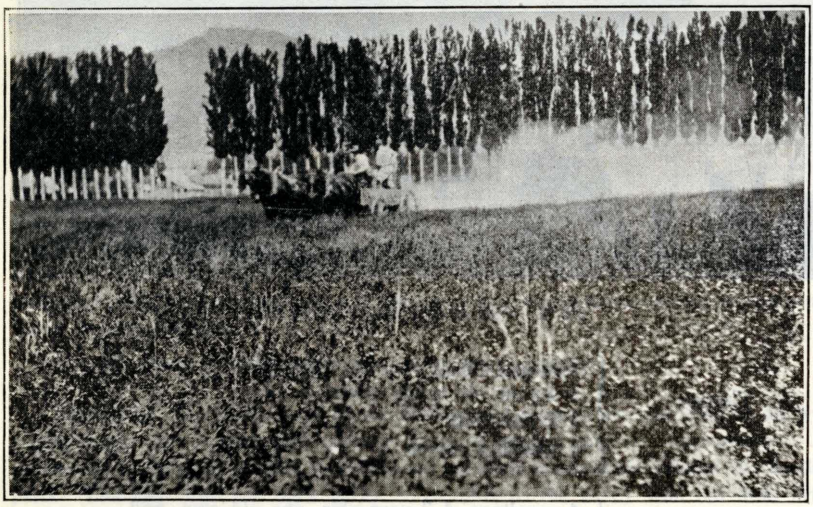

Fig. 1.—Dusting alfalfa field with calcium arsenate.

animals, an 11-acre alfalfa field was secured. One-half of this field was dusted with 3 pounds of calcium arsenate to the acre, the other half with 6 pounds to the acre. The amount of calcium arsenate usually used for destroying injurious insects is about 2 pounds to the acre. The calcium arsenate had been mixed with equal parts of diatomaceous earth and passed through a hopper into a boom 14 feet wide. This was fed by a blower run with a gasoline engine distributing the dust, and was placed on a wagon drawn by a pair of horses. The dust was uniformly distributed over an 18-foot strip. The entire field was covered in this manner and the poison evenly distributed over the field. This trial was made with first-crop alfalfa on June 19, 1929. At the time of application the alfalfa was nearly ready to cut. There was no perceptible atmospheric movement at the time of the dusting, thus insuring a uniform distribution. Ten days later the treated alfalfa hay was cut and harvested as alfalfa is usually harvested. No rain or other unfavorable weather conditions between the time of dusting and stacking was encountered. The alfalfa was stacked in a well-constructed stack containing 44,920 pounds.

FEEDING THE TREATED HAY[6]

The treated hay remained in the stack from July until December. It was then fed to the following groups of animals:

Fig. 2.—Group of cattle used in feeding test.

Cattle—	2 large beef cows, one 6 the other 8 years old 2 3-year old range cows 2 2-year-olds 2 yearling calves
Sheep—	4 yearlings, 4 2-year-olds, one old ewe, and 1 buck, from 83 to 120 pounds each
Horses—	1 2-year old 1 5-year old 1 8-year old 1 about 16 years from 860 to 1480 pounds in weight

It will be observed that the animals were of different ages and sizes and good representatives of their type of livestock. Before placing the animals on this feed they had been on pasture and had been fed but little, if any, hay during that season. They were in three separate lots. Each feedlot was 30 x 80 feet, with a good open shed at one end, and a feed rack in the center and a water trough at the opposite end. These experimental animals were given all the treated alfalfa hay they could eat twice a day. Pure water was before them at all times and they were allowed what block salt they cared to eat. Apparently they liked the hay; when once filled they did not consume as much ' ay in proportion but seemed to

[6]This test should be repeated with dairy cows giving milk to deter ıe the effect, if any, on the milk production. This test should be continued for at least 120 days.

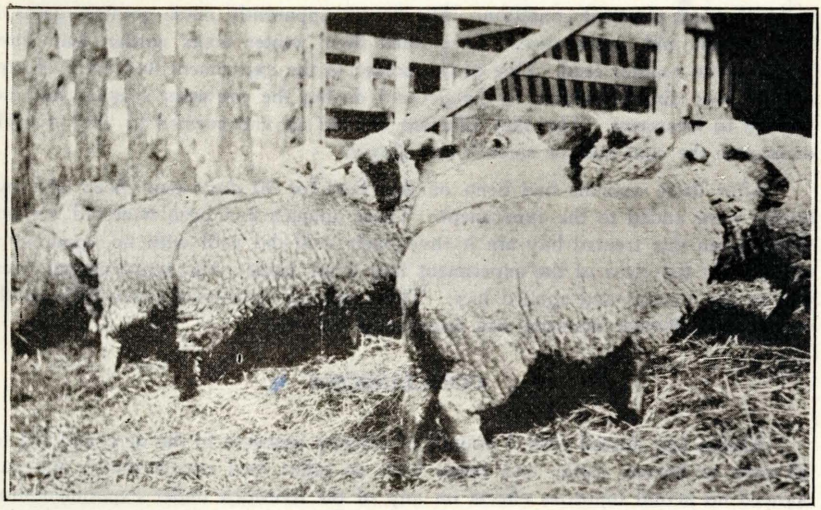

Fig. 3.—Group of sheep used in feeding test.

do well as far as general appearance was concerned. These animals did not consume as much hay as did similar animals fed untreated hay. They drank more water on this ration than did animals fed normal hay. They were closely observed daily for symptoms of any affection that might arise—pulse, temperature, facial expression, etc.

RESULTS OF EXPERIMENT

During the first thirty days of the feeding test all animals appeared to do well, eating freely the rations and making gains in weight and in appearance. All seemed to be in good spirits, as evidenced by their movements around the feeding pens. The hay with the light spray (3 pounds to the acre) was fed first; little, if any, difference could be noticed, unless possibly there was less daily consumption of the heavily sprayed hay (6 pounds to the acre). These animals were fed for 80 days under the same conditions.

With the exception of two cows and two heifers, all seemed to be making normal gains. The bodily condition of these four animals appeared to be at a standstill, although their general appearance was much the same as was that of the other animals. It is impossible to state definitely whether this condition was due to the feed consumed or to the conditions arising from certain feeds. Regardless of the ration, animals on experimental feed frequently do not do well for a certain length of time. If it had been possible to feed these animals for 30 or 40 days longer, possibly it might have been determined whether or not this condition described above was due to the feed. However, at the end of the 80-day period the hay had been consumed and the trial, therefore, closed. Later these animals were put on hay and pasture and when last observed seemed to be improving.

All animals in this trial made gains and did well except the cattle. During the experiment each horse gained more than 100 pounds. The ten sheep gained 130 pounds. The cattle alone did not gain in weight. No special symptoms were noticed with any of them. Their coats looked sleek and glossy and all appeared

to be in good physical condition. The horses apparently made greatest gains in both weight and appearance. They shed their winter coats earlier than those horses given regular feed. One of the horses in the experiment had been affected with a skin disease similar to mange and during the previous seasons had not yielded to treatment. The skin affection cleared up and seemed to be entirely overcome; the coat became smooth and glossy.

After these animals had been on this feed for 40 days one sheep and two horses were added to the experiment. These animals had been wintered out and when given this treated hay ate it ravenously and did well with no apparent ill effects. At the close of the experiment four other horses, also wintered out, were put on the wasted and spoiled hay. These animals consumed practically all the waste and left-over material and apparently did well.

CONCLUSIONS

Alfalfa hay dusted with 3 pounds of calcium arsenate to the acre and fed for 40 days to horses, cattle, and sheep with no other feed except water and salt, showed no actual injurious effects on any of the livestock under experimentation.

Alfalfa hay dusted with 6 pounds of calcium arsenate to the acre fed to the same livestock for a 40-day period showed no detrimental effects; however, some of the cattle did not gain in weight. The horses gained during the entire feeding period, each of them increasing over 100 pounds in weight and presenting a sleek, glossy appearance. The sheep gained during the entire experimental period and weighed 130 pounds more at the close of the test than before; their fleece appeared as good, if not better, than did the fleece of sheep fed on untreated hay.

Alfalfa dusted with 2 pounds of calcium arsenate to the acre, the amount commonly used for destroying alfalfa weevil, may be fed to livestock with impunity for at least one feeding season—four to six months.

Where treated alfalfa hay was fed, more water but not so much hay was consumed, the arsenic in the treated hay seemingly acting as a stimulant or tonic for the animals.

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