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The Bermudagrass Eriophyid Mite [1]

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During the last four years a new bermudagrass pest, *Aceria neocynodonis* Keifer, commonly known as bermudagrass eriophyid mite, has caused very characteristic damage to bermudagrass lawns. The mite is widely distributed throughout southern California, from along the Coast in the Los Angeles area, to north of Tehachapi in Porterville, and throughout the southern desert valleys. Mite infestations are also present in Nevada, Arizona, New Mexico, Texas, and recently severe infestations were reported in Florida and Georgia. It is very likely this mite will soon be reported from all the bermudagrass growing areas in the United States.

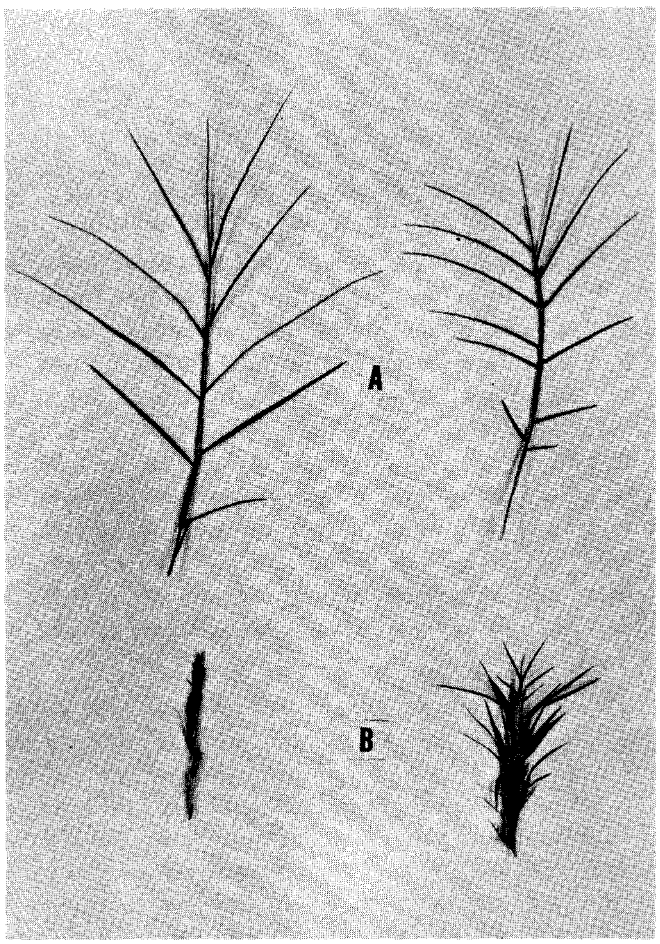

Figure *1. Bermudagrass stems.*
A -normal. B - bermudagrass eriopbyid mite damaged.

Damage by the bermudagrass eriophyid mite may be first noticed early in the spring as bermudagrass breaks dormancy, although injury may become more severe later in the growing season. The injured grass has shortened internodes (Figure 1) which produces a typical rosetting and tufted growth, or a witch's-broom effect. With severe infestations there is almost no green regrowth and the turf is a mass of large knots which often die, leaving brown areas in the lawn. Mite-infested grass is often damaged by summer blight *(Helminthosporium sp.)* which is probably important in causing a loss of stand.

The bermudagrass eriophyid mites are whitish-cream in color and elongate in shape, approximately l/100 of an inch in length so about 50 power magnification is required to see them. The mites remain hidden under the sheaths of the grass. There may be a few to a hundred or more under a single leaf sheath (Figure 2). Detailed observations on the biology of the mites have not been made and this has limited the scope of experimental work on factors affecting their abundance and activity.

Management practices appear to have an important influence upon the severity of mite infestations. Bermudagrass turf that has been "over-seeded" with a winter grass is more severely damaged in the spring and early summer than where not over-seeded. Other factors such as the amount of "thatch", irrigation, soil fertility, summer temperatures, and shade, appear to affect the extent of mite damage at different times during the growing season.

Bermudagrass strains respond very differently to natural infestations of the bermudagrass eriophyid mite. Ratings of mite injury (1 - least to 9 - most) were made on replicated plots of 96 bermudagrass strains at Tucson in 1961 and 1962. The data indicated that some strains showed little or no mite injury, some were moderately injured and others were severely injured. Details were presented in University of Arizona Agri-

1/ Paper No. 798, University of Arizona Agricultural Experiment Station.

culture Experiment Station Report 203 for 1961 and Report 212 for 1962. A Summary of the results from selected strains is given in Table 1. Large differences existed between the "little or no injury" and "severe injury" classes. Strains shown in the "intermediate injury" class exhibited some mite damage at certain periods during the season.

Table 1. Bermudagrass eriophyid mite damage to various bermudagrass strains and varieties. Tucson, Arizona. 1961 and 1962.

LITTLE OR NO DAMAGE	INTERMEDIATE DAMAGE	SEVERE DAMAGE
C. bradleyi	Common selection 6144	Common (Seed Lot)
Common selection 6129, B133, 8134	*C. magennissii* (Sunturf)	Florida 50
8142	*C. transvalensis*	Ormond
Florida 8	Everglades No. 1	Seeds from U-3 stolons
Royal Cape	Texturf 1F	Tex. 8
Selection 8181	Tiffine	
Snyder	Tifgreen	
Tex. 22	Tiflawn	
Texturf 10		
Tifway		
u-3		
Ugandagrass		

Plots were rated by feeling the turf and noting the presence of clumps of mite-injured stems. Plots with no mite injury were rated as 1. When only a few isolated stems had mite injury, the rating was 3. More severe infestations were rated from 5 to 7, and finally the most severe infestations, where the grass was virtually all infested, were rated as 9. In Table 1, varieties listed under "severe damage" had a number of single observations which rated as 9. The "little or no injury" class, in general, had an average rating of 1 for the season.

In the 1961 bermudagrass breeding nursery, individual seedling plants of common bermudagrass showed marked differences in severity of damage from the bermudagrass eriophyid mite. It appears that both seeded and vegetative types of bermudagrass could be developed with a high degree of tolerance or resistance to this mite.

Although injury in 1962 was somewhat less severe on the strains reported in Table 1, the ranking was changed for only a few strains. Also, since the natural infestations were severe, the ratings given may be expected to have predictive value for bermudagrass strains and varieties grown under similar environmental conditions. However, it is not expected that these varieties and strains will respond the same to this mite at the various environments found in the southern part of the United States.

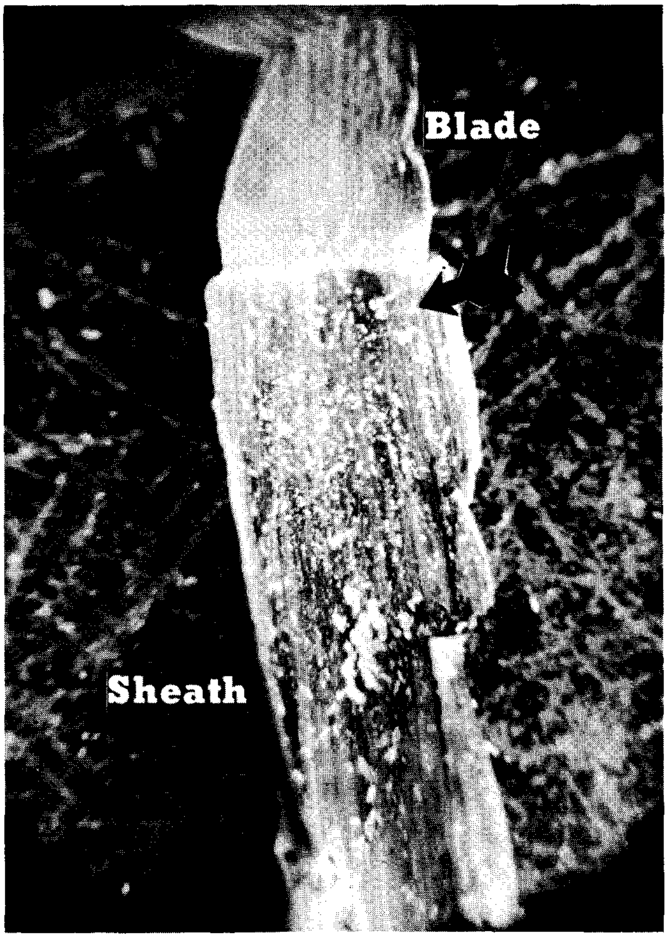

Figure *2. The under side of a bermudagrass leaf sheath with the arrow indicating a betmudagtass eriophyid mite.*

The effectiveness of chemical control measures upon the bermudagrass eriophyid mite appears to vary according to the time of the year. In some experiments chemical treatments were applied in the fall and the treated plots had a distinct reduction in the amount of mite-infested grass the following spring. In Arizona, the general level of bermudagrass eriophyid mite infestation has decreased since the mites were first found in the summer of 1959. Of the eight mite-infested lawns treated in the fall of 1961, six did not have any mite damage in the untreated portions in the spring of 1962; therefore, the value of preventative fall treatments is unpredictable.

Extensive experimental treatments during the spring indicated that insecticide treatments alone did not appear to give any reduction in the amount of mite damage or any improvement in the greening of the grass. Fertilizers alone also did not reduce the amount of mite damage but did give a modest increase in the green appearance of grass plots low in nitrogen. It required a combination of both insecticide and fertilizer to give both a significant reduction in the injury caused by the

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mites and an increase in the green appearance of the grass following early spring applications.

The recommended treatments for betmudagrass eriophyid mite infestations in the summer include dusting sulfur, or a spray of 1.25 ounces of actual diazinon in 10 gallons of water per 2000 square feet. Other materials that show promise include Eradex, Ethion, Phostex, endosulfan (Thiodan) and Zectran. Formulations of tetradifon (Tedion), malathion and naled (Dibrom) appear to be relatively ineffective against the mites. Spring treatments on lawns which have a low fertility level should combine a fertilizer, such as urea-sulfur, ammonium nitrate or ammonium sulfate with the diazinon spray. Under some conditions, an application of diazinon spray in the fall will reduce mite injury the following spring.

Editorial Note:

Today Agricultural Experiment Stations in many states are conducting research on turfgrass and turf-grass management. To provide readers of California Turfgrass Culture with an opportunity to benefit from this work also, we will from time to time carry papers by turfgrass specialists at these stations. The preceding article is the first of this series.

Mowing Grass With a Reel-Type Machine

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Nature, the best of designers, produced a live "lawn mower" in the grazing animal. The use of tethered or enclosed animals for the purpose of cutting grass predates mechanical or manual means by many centuries. Goats and sheep were most often used for this purpose, probably because they were small and easily handled. And in studying these animals we can learn what are useful and desirable design features for our mowing machines today.

The dental structure of the grazer is so made that it accomplishes two things: clips grass by shearing with the purposely overlapping front teeth (not unlike a scissors or a reel-type lawn mower); and crushes or masticates grass clippings for easier digestion, a function not yet paralleled in contemporary grass-cutting machinery.

The grazing animal normally cuts the grass at a height which permits re-growth. He does not usually pull up roots, thereby helping to preserve his food potential. His lips establish the height of cut; they gather in the grass from the area adjacent to the actual cutting region; and they can bend over the taller plants as well as lift the close-lying blades of grass.

Aren't all of these desirable mowing features? Yes, but to date we have not been able to incorporate all of them into a simple, single machine. Let us, therefore, consider only the clipping portion and its relation to the contemporary reel-type lawn mower.

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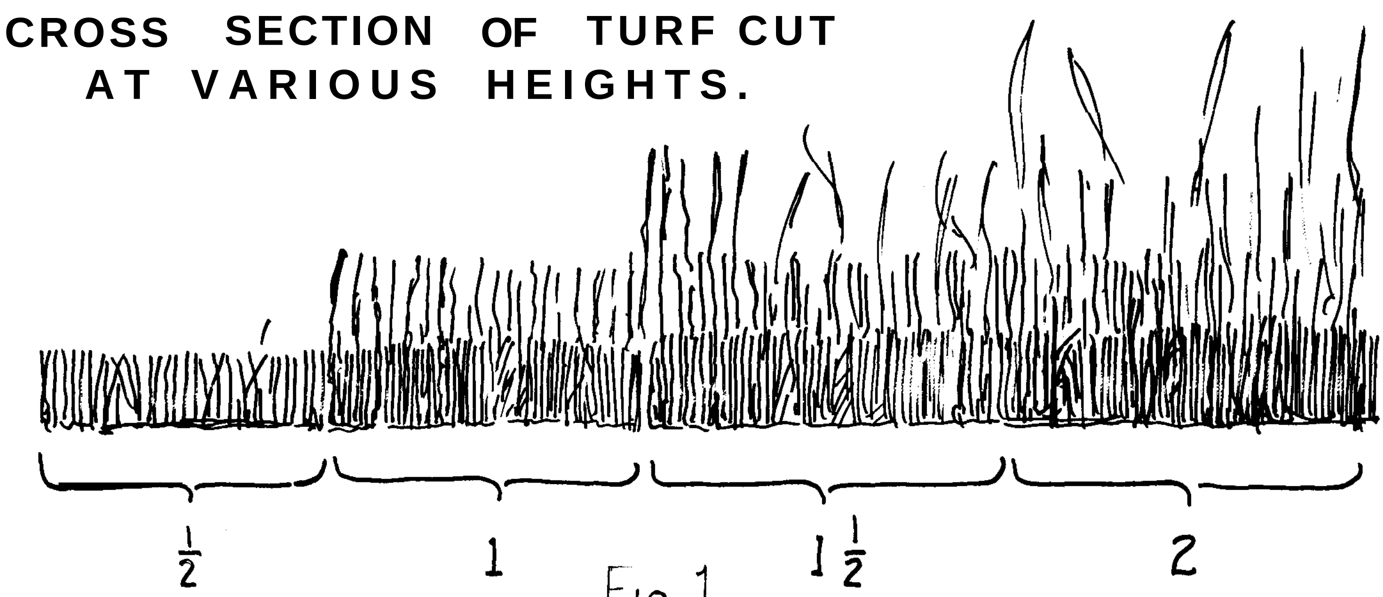

FIG. 1

GRASS

The density of turf has a great influence on turf appearance after mowing. (See Fig. 1 which represents a typical cross-section of cut grass). A conventional reel mower has no means of orienting the blades of grass before cutting and can only cut those blades that become located between a reel blade and a bedknife. A thick turf does provide reasonably good orientation in that adjacent blades of grass are supported by each other. Under these conditions a reel mower will provide a good, clean cut at almost any reasonable height. However, where turf is sparse, scraggly or disoriented, it is not readily possible to obtain clean cutting with a reel mower, at the higher cuts in particular.

Grass has a very definite resilience -- a physical property related, of course, to the type of grass and its state of growth. Young, succulent grass does not “spring back” as does the same grass when it has matured. Because the conventional reel-type lawn mower has no means for picking up the “laid down” blades of grass, it cannot accomplish a smooth result unless the grass has had time to spring back, after being traversed by feet and wheels. To obtain a consistently clean cut, the grass should be mowed before any “laying down” occurs or else sufficient time should be allowed for recovery.

Different species of grass have varied degrees of individual blade stiffness or column strength and these characteristics also vary in accordance with the state of growth as influenced by age, moisture content, and most important probably, by management practices. Most northern grasses are quite soft and succulent in the spring and become wiry and stiff during the summer. Service complaints on quality of cut are usually most predominant during the early growth periods and tend to disappear as the season progresses. This is true of all types of mowers.

We have considered the machine, but what about the grass? How does it react to mowing? We have had time-lapse movies made of blades of grass, both after they have been cut cleanly by a sharp and properly adjusted machine, and also cut raggedly by a dull and poorly adjusted machine.(This may also be considered analogous to a good reel versus an average rotary.) The clean cut begins to grow in a few hours, but the ragged cut is practically dormant for a day or more (as shown in Fig. 2). I can only conclude that physical damage to the plant was less and susceptibility to disease and insect damage will be less after the clean cut.

*"Frequency of mowing is also an important consideration in the maintenance program. Infrequent clipping allows the grass to elongate to such a degree that any subsequent clipping removes an excessive amount of leaf surface. At no time should clippings amounts in excess of 1/4 to 1/3 of the total leaf surface be removed at a given mowing. Removal of larger amounts of leaf surface will result in a physiological shock to the plant, cause excessive greying or browning of the leaf tips, and greatly curtail the photosynthetic production of food with a resultant depletion of root reserves. In addition, the accumulation of excessive clippings may smother the grass and provide excellent environmental conditions for disease organisms and insects. The

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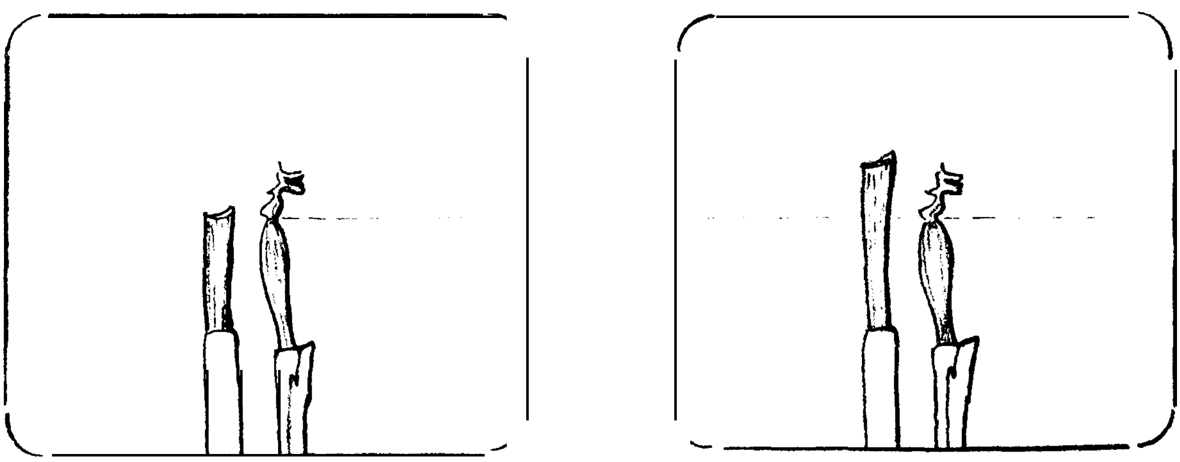

3 HOURS AFTER CUT | **24 HOURS AFTER CUT**

FIG. 2 - EFFECT OF SHARP VERSUS DULL CUT ON GROWTH RATE ON TWO NEARLY IDENTICAL BLADES OF BLUEGRASS. (SKETCHED FROM ACTUAL TIME-LAPSE PHOTOS)

frequency of clipping must be governed by the amount of growth which, in mm, is related to weather conditions, season of the year, soil fertility, moisture conditions and the natural growth rate of the grasses."

It was previously stated that a single blade of grass is a fragile thing. A large quantity of grass blades is not fragile in total and can require a great deal of power to crush. With our "live" machine – the grazing animal-pasture grass is clipped by the front teeth and the rear teeth do the crushing. They were designed much closer to the fulcrum of the jaw and have an appreciably higher mechanical advantage. This is similar to the cutting of wire with a pair of side-cutting pliers – – get the wire as close to the pivot as possible to require the least effort. All this means that we can cleanly cut or shear grass much easier than try to separate a portion by crushing it, and also means a reel mower must have very sharp engaging portions to cut with ease. Rounded edges on either the reel blades or the bedknife would require crushing instead of a clean shear, the power needed would be greatly increased and, also, the effect on the grass leaf would be an unhealthy one. So be very sure that the cutting edges are very sharp.

MOWER

The basic reel-type lawn mower dates back 130 years or more when the first hand-powered units were successfully used. The changes that have occurred since that time have not been functional improvements to any extent; rather, they have been confined to improvements obtained through use of new materials and production techniques. It was not until the end of World War II that the powered mower for the home-owner really came into popular public acceptance and the high production volume category.

A conventional reel mower will not cut many grass blades or weeds that are higher than the horizontal centerline of the reel. A 6-inch diameter reel-set to cut at 1 inch – will, therefore, not cut material 4 inches or more above the ground line, (1/2 the reel diameter or 3 inches plus the height setting of 1 inch.) Some grasses may be bent over and cut but this will not occur consistently. Even to be cut below the 4-inch level, the grasses must have reasonable rigidity.

Reel mowers cut on a line very nearly transverse to the direction of travel rather than over an area as long as it is wide. In this matter a reel mower will cut at a very low height when operated over transverse undulations and will permit mowing at this low height in selective directions, whereas a low-set rotary will scalp, regardless of direction. Even if provided with scalp guards, the rotary will cut at conspicuously varying heights.

This paragraph from Dr. J. R. Watson's paper, "Fundamentals Of Grass Cutting."

The reel mower requires a very close tolerance in the reel cylinder to bedknife distance to perform an acceptable result, This fit must be maintained at all times to produce continually acceptable results. The operator must be most careful to avoid contacting hard objects with the reel or else be prepared for a service repair bill, for it is nearly impossible for the average person to satisfactorily straighten a bent reel of a conventional design.

The spiral structure of a reel causes each reel blade to traverse from one side of the knife to the other, cutting grass all the way. This spiral causes grass to be cut continuously throughout the revolution of the total reel if the succeeding blade engages the bedknife before the first one leaves contact. A straight-bladed reel would be cutting only intermittently and would be jerky and very noisy. The spiral causes the reel blade to contact the knife at a certain angle. There are limits to this angle related to the type and condition of individual grasses, but for critical conditions it should not be greater than about 20 degrees. This angle then has some bearing on the minimum number of blades on a reel, if we want to keep one reel blade on the bedknife at all times.

When a fast rotating reel engages a stone or piece of metal between a blade and the bedknife, the reel would likely be completely ruined. This type of damage is not directly related to the speed of the reel, but to a square of the speed, so chat one reel going twice as fast as another has 2 x 2 or 4 times the energy to absorb. If three times as fast, the ratio becomes 3 x 3 or 9 times the energy value. Conversely a reel going half rhe speed has an energy value of 1/2 x 1/2 or one-fourth.

In the opinion of the writer, more blades are favored on a reel causing a slower tip speed to obtain the desired clip. However, it is often necessary to collect clippings which requires a reasonable tip speed in order to project rhe clippings into a catcher. This is the only justification for faster reels.

CLIP

The "clip" of a reel lawn mower is most readily defined as the distance the machine moves forward between the time that each reel blade engages the bedknife. Most conventional home-owner type reel mowers have a clip of about one inch. For optimum apparent smoothness of cut with respect to ripples or corrugations, a reel-type lawn mower should have a clip approximately equal to the height of cut. Conventional reel mowers with a constant clip can only provide a smooth cut above a quite specific height and will show obvious ripples below that height.

Vertical differences between the peaks and valleys of a reel cut are always present because the valley is the height of the bedknife cutting edge and the peak is

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the height to which the grass springs back after being cut or to which it is restored. The bedknife bends some aft until the "scissors are closed", so to say. The horizontal distance between peaks or between valleys is the clip. When the vertical distance between the peak and the valley is minimal the resulting cut will "appear" to be smooth. Again, this condition exists when the clip is no greater than the height of cut.

For a specific clip a reel mower is dependent upon the number of blades and the rotational speed of the reel and is independent of reel diameter. The tip speed, however, does increase in direct proportion to an increase in the diameter when rotation speed is constant.

If we consider a reel with a certain number of blades, the clip can only vary with the rotational speed of the reel in relation to ground speed. With the same number of blades, the two-times faster reel will produce half the clip length.

Assume we want a l-inch clip on a mower – we can easily obtain that with a 1-bladed reel, so wouldn't that be the logical and cheapest one to make? Of course it would, but it would require balancing and would have to go so fast that required bearings would be expensive. Also, to maintain this blade in constant contact with the bedknife, the angle of shear would exceed 20 degrees unless the diameter was very small.

Should we then consider 8 or even more blades on the reel? An 8-bladed reel would have 1/2 the speed and 1/4 the damage potential of a 4-bladed reel to obtain the same clip.

It is pertinent to point out that the importance of clip to height of cut relationship applies not only to the finished appearance of the cut area, but to the ability of the machine to cut at heights of twice or three times the clip distance. A machine with a l-inch clip will not cut as well at a 2-inch height as a machine with a 2-inch clip. Here, again, the time interval between blade passages doubles and the fewer blades of grass, in most cases at 2 inches and above, require more time to spring back between the reel blades. Furthermore, we do not need a closer clip to realize the desired appearance results.

POWER

In partial recompense for reel maintenance problems and costs, such a mower requires appreciably less power than a rotary to cut an equivalent area of grass. In most reel mowers, the engine has excess power and cutting is accomplished at partial throttle. Also, the reel stirs up less dust than a rotary. These two factors mean improved engine life as well as bearings and other parts.

Let us consider the power requirements by an illustration, bearing in mind that each blade of this grass plant is a quite fragile thing alone. To illustrate, imagine cutting off a l-inch sapling at, say, two feet above the ground. We can cut it with reasonable ease, using a sharp pruning shear and our hand and forearm muscles. To cut it off at the same height with a sharp hatchet or axe requires a home-run swing, using a large percentage of the body's muscle structure. In mechanical terms, a tractor that can readily pull a gang of 9, 30-inch reels for a total swath of some 20 feet would be hard pressed to provide the power to cut a 7-foot swath by rotary impact action over the same grass area.

"Pinching" off the grass increases the cutting power required by greatly increasing the torque reaction – the tendency of the machine to tip over forward. This tendency can cause diving and scalping at very low cuts. The mower will always attempt to rotate about the lip of the bedknife when it is cutting grass and more so if more power is being absorbed at this point.

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The University's Role in the Control of Pests and Diseases Injurious to Agriculture and Public Health

M. *L. Peterson, Director*

University of California Agricultural Experiment Station

By acts of Congress and the California Legislature, the Division of Agricultural Sciences of the University of California has been given the vital responsibility of developing information to aid California agriculture in producing an abundant and wholesome supply of high quality food.

The legislation imposes an added responsibility -- to supply information on pest control materials and procedures which will result in agricultural products that conform to all laws and which will adequately safeguard the public health.

It is the policy of the University of California, Division of Agricultural Sciences, to insure that no recommendations for pesticidal chemicals are released until they are reviewed and approved by the best scientific authorities available at the University.

This procedure assures (a) that the information fully conforms to federal regulations of the U. S. Department of Agriculture and of the U. S. Department of Health, Education and Welfare, the California State Departments of Agriculture and Public Health, and to the policies of the Division of Agricultural Sciences; and also (b) that the pesticidal chemical has been registered for the use intended by U.S.D.A. and the State Department of Agriculture.

University recommendations for use of pesticidal chemicals are based upon information obtained by the Division of Agricultural Sciences under California conditions. Research results from other reliable sources are sometimes used to supplement University data but are not accepted without first being checked. In some cases this has delayed issuance of the University's recommendations but in the public interest this rule must be observed.

Before newly developed chemicals are recommended for application in California, the Division of Agricultural Sciences secures its own information as to residues, pesticidal performance, toxicity to plants, flavor alterations and the effect on other organisms including beneficial predators and parasites, honeybees, fish and other wildlife.

The University is as much interested in avoiding the misuse of toxic chemicals as it is in advocating use of those which, upon approval, may be put to beneficial use in agriculture.

Through research, it seeks the most effective and economically feasible means of controlling insects, weeds, mites, nematodes, plant diseases, and other pests in order that adequate supplies of wholesome food can be produced for the needs of a rapidly growing state and nation.

In the light of present knowledge, we need chemicals to protect crops and livestock from the many species of pests and diseases that affect them. Through long experience and research, we have learned how to use chemical control methods with a high degree of safety. It is true that chemicals can be dangerous and also true that human error may lead to injury from them. The University strongly advocates that no chemical be used except as specifically recommended on the label or in the pest control programs developed by University personnel.

Since the early 1930's and continuing to the present time, the study of chemical residues in foods has been carried out on the Berkeley and Riverside campuses of the University. The University staff is always concerned with potential residue problems. In addition to this, a Pesticide Residue Research Laboratory was established on the Davis campus in 1955 to amplify the research begun earlier at Riverside and Berkeley. The University is seeking additional funds to increase its research in this field.

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Since World War II, thousands of' chemicals have been tested by the University for possible agricultural use. Only a few of these have survived the rigorous testing and have been recommended for use under specified conditions. These facts indicate the thoroughness of University investigations to safeguard our food supply and public health. Methods of analysis of toxic compounds are now in use by which the most minute traces of a chemical can be detected – less than one part per billion in some instances.

The University has taken a leading role in pointing out the value and importance of biological control of pests. It was the first university in the United States to have a Department of Biological Control. It was in California that the Vedalia beetle was introduced many years ago to control the cottony cushion scale, a very damaging pest of citrus. More recently, the spotted alfalfa aphid was ultimately controlled by using native and imported insects as well as a pathogen to prey upon this very costly pest. Control of the Klamath weed by use of imported beetles was developed by U.C. and U.S.D.A. scientists just when it threatened to destroy northern California cattle ranges. Use of insect pathogens ("diseases of insects") for pest control was developed by U.C. research men.

Natural or biological control is recommended when practical but it is not always effective. We must use chemicals to produce marketable crops in most cases. It is University policy, long in force, that all possibilities for better pest control be investigated and only those adopted which are proven by exhaustive tests to be safe as well as effective.

At present, departments at Riverside, Berkeley, and Davis work on problems of "integrated" pest control. This concept of combining chemical and biological methods was developed by members of the entomology and biological control staffs and is used successfully against several important crop pests.

Chemicals are an integral part of American agriculture. Actually, some chemicals have been used since Biblical times to control pests. The newer pesticides have made it possible for this nation to produce an adequate quantity of food for our increasing population. It appears that they will continue to be even more important in food production in the future.

The American public itself has made this decision. Consumers expect the variety and quality of food that can be produced in commercial quantities only with the use of positive pest control measures. They refuse to accept the poor quality produced in orchards and fields where such measures are not taken, and the farmer who fails to use chemical pest controls cannot long survive economically.

The fact that United States consumers spend a smaller percentage of their disposable income for food than do people of other nations may be traced in large part to the abundance of food we enjoy.

Recognized authorities agree that this abundance of wholesome food at reasonable cost is possible only if we protect our crops and livestock against the pests that in nature would take a severe toll. Estimates of the damage caused annually by agricultural pests range from eight to fifteen billion dollars despite our considerable knowledge of how to control them.

Discovering that most effective and economical methods of pest control while at the same time safeguarding the health of consumers is a major activity of the Division of Agricultural Sciences. All scientists admit that there are gaps in the information on many important questions concerning the agricultural use of chemicals. In the absence of this information, every precaution is taken by the federal, state and county governments as well as by the University to avoid making recommendations which might be dangerous.

The University also carries out research on pests of public health importance. The study of flies that may carry intestinal diseases, mosquitoes which can transmit encephalitis, gnats which are implicated in infective conjunctivitis (pink eye), and arthropods which may transmit bubonic plague; and a constant search for possible vectors of other human diseases is still another responsibility of the research workers of the University.

Control studies in this field commence only after a thorough investigation of the insect vector and its relationship to man and the surrounding environment. Because treatment of large areas often may be required to suppress these vector species, it is a responsibility of the research workers to evaluate the effect of control measures on all of the exposed flora and fauna and to develop methods that will adequately control the pest but not seriously disrupt the rest of the environment. If chemicals are to be used, special studies are made upon the effect of these materials on beneficial insects, fish, amphibians and other wildlife in the area. Biological and cultural control procedures are also investigated, and frequently the final method to be selected is a composite of the best of all of these.

Much more research is needed in all of these fields. Public support of such scientific work is the most direct and beneficial method of securing the answers to these questions which are so important to California and the nation.