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BASING EUROPEAN RED MITE CONTROL DECISIONS ON A CENSUS OF MITES CAN SAVE CONTROL COSTS

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European red mites (ERM) are a major concern of many apple orchardists in New York. These pest mites are the most difficult and costly arthropods to control. As its name implies, ERM is a European species which was introduced to North America on nursery stock. The adult females are easily recognized by their deep brick - red color and are approximately the size of a pin head. Another plant feeding mite commonly found in New York orchards is the two spotted spider mite. These mites are buff colored with two distinct black spots on their sides and are slightly larger than ERM. Of the two pests, ERM predominates in abundance and importance. Therefore, attention will be focused on this species.

In this article, we first describe the pest status of ERM and the damage it causes to apple trees. We then discuss how treatment decisions for ERM can be based on a rapid census of mite populations in orchards.

Pest Status of Mites on Apple Trees

The biology of ERM and modern, commercial orchard practices combine to make ERM a formidable pest. European red mites usually go through 6 to 8 generations each growing season. In commercial orchards with healthy, fertilized trees, an average adult female produces 20 eggs. The combination of a large Number of generations and high egg production combine to produce relatively high rates of population growth. It is pesticide use in orchards, though, that usually precipitates severe mite problems. This is because some commonly used pesticides are very toxic to predacious mites that feed on ERM and thereby control this pest. Destruction of these natural enemies allow ERM to realize its full capacity for rapid ^population growth.

European red mites injure apple leaves when they insert their mouthparts into the leaves to feed on plant juices. ERM injury reduces the capacity of the leaf to use sunlight as an energy source (photosynthesis). This in turn may lead to reduced yield and quality of fruit, reduced vegetative growth, reduced flowering, and reduced fruit set. The degree of reduction depends on the severity of the leaf injury and when it occurs. Early season mite injury (before July 1) is much more severe than late season injury.

Moderate ERM injury occurring after July 1 does not damage the tree, the current crop, or the potential crop the following year. This finding is based on four years of recently completed research. During these investigations, mite injury was quantified using a statistic known as a mite day. A mite day is the cumulative measure of mite density through time; one mite on a leaf for ten days yields ten mite days as does ten mites on a leaf for one day. Through our research, we found that mite day values of 750 to 1000 which accumulated after June 15 produced no measurable effect on yield or fruit quality during the year damage occurred or during the following year. Furthermore, no effect of mite injury could be found when this level of mite feeding was sustained for two years on the same trees. It is important to note that the mite injury was induced in this study during the middle and end of the growing season. Trees may be more susceptible to mite injury during the early part of the season. A mite day measure of 750 produces slight but noticeable leaf damage called bronzing. It also corresponds to a peak mite density of approximately 30 per leaf.

Basing Control of ERM on a Census of Mites

Miticides are often used to control ERM in commercial apple orchards. While this is usually an effective control strategy, unnecessary use of miticides is costly and will hasten the development of resistance to miticides by ERM. ERM become resistant to miticides because the increasingly repeated use of these compounds kills susceptible individuals, leaving large numbers of survivors which are immune to the chemical. When resistance occurs, a miticide will no longer effectively control ERM. Resistance by ERM to commonly used miticides occurs in some New York orchards.

When a chemical pesticide is used to control mites, the benefits from using the miticide should outweigh the costs. The benefits of miticide use center on preventing mite injury before it reduces yield or the quality of fruit. The costs of miticide use not only entails the direct cost of the chemical pesticide and its application, but also the increased likelihood of resistance.

A miticide should not be applied unless the number of mites which would occur in the absence of the pesticide is sufficient to cause a reduction in crop yield or quality. Based on the research reported above, a miticide should therefore not be used unless more than 750 mite days would accumulate in the absence of the miticide treatment. In practice, it is very difficult to actually sample mites intensively throughout the season to accurately calculate cumulative mite days. What is needed is a relationship between this mite days threshold value and mite numbers at various times during the growing season. In addition, a rapid method for determining mite numbers is also required. Recent research has provided both of these tools.

Using a mathematical model of mite dynamics and our experience in commercial and research orchards, we have established guidelines for mite densities which require treatment in order to prevent the accumulation of more than 750 mite days. These threshold values vary depending on the date and are shown in the table below.

Table 1.Threshold densities for European red mite in apple orchards. If densities in orchards exceed the threshold, treatment with a miticide is necessary.

Date	Threshold
June 5 to June 25	2.5 mites per leaf
June 26 to July 15	5.0 mites per leaf
July 16 to August 5	7.5 mites per leaf
After August **5**	**10.0** mites **per leaf**

We have also developed a rapid method to determine whether the density of mites in an orchard exceed the threshold values. The procedure is based on a statistical relationship between mite density and the proportion of leaves which contain one or more mites. By inspecting medium aged leaves and recording the proportion of leaves with one or more mites on them, the density of mites in an orchard can be rapidly classified with respect to a threshold value. In most cases, a classification can be made in 10 to 15 minutes.

Use of the mite threshold and sampling procedure can best be explained by using an example.

It is assumed that some form of early season (half inch green to pink) mite control has been used to prevent early season mite injury to the foliage. Early season control is normally done on a prophylactic basis. The best approach is to apply an oil at half inch green or tight cluster. If oil cannot be used, an effective conventional miticide should be applied at pink.

Suppose it is now June 15th and a decision must be made on the need for an additional miticide treatment. Referring to Table 1, the threshold for this date is 2.5 mites per leaf. The values shown in Table 2 will now be used in concert with samples of leaves to determine whether the mite density exceeds this threshold. Medium aged leaves should always be sampled during the summer because these leaves provide the best estimate of the mite density. If old leaves are used, mite density will be overestimated and if very young leaves are used, the density will be underestimated.

Five leaves should be taken from each tree. The cumulative number of leaves with one or more live, motile (not eggs) ERM on it is compared to the two values tabulated beneath the threshold being used and the total number of leaves examined. To start the census, twenty leaves (5 leaves from each of 4 trees) are collected and the number of leaves with mites on them are determined. Suppose there were 8 leaves with mites. This value is compared to the two values under the column headed Threshold = 2.5" and for the row corresponding to "Leaves examined[1] equal to 20 (the values are 7 and 16). If the number of leaves with mites is less than *or equalXo* the smaller value, we stop sampling and conclude that the mite density is lesser than 2.5. Conversely, if the number of leaves with mites is greater than the larger value, we stop sampling and conclude that the mite density is greater than 2.5. If the mite density exceeds the threshold (in this case 2.5), a miticide is recommended to prevent mite damage from reaching the critical level of 750 mite days. If the number of mite infested leaves is at or between the stop limits, an additional ten leaves are examined and the comparisons are made again. In our example (8 leaves with mites), we continue sampling and examine another 10 leaves. Suppose in this sample, we found 1 leaf with a mite. In total, there have now been 9 leaves with mites from a sample of 30 leaves. The appropriate comparison values from Table 2 are now 11 and 23. The total number of leaves we found with mites (9) is less than the smaller value so we stop sampling and conclude that no miticide treatment is currently needed. Note that the maximum number of leaves which can be sampled is 100 and at that point a classification is always made.

The logic behind Table 2 is that if there is strong evidence from the first groups of leaves examined that the mite density is either very low or much higher than the threshold levels; the populations can be classified with relatively fewer samples. On the other hand, if mite population levels are relatively close to threshold values, additional samples should be taken to ensure a precise classification. The value? shown in Table 2 were calculated using a group o. mathematical and statistical models. In addition, research conducted to estimate the accuracy of this sampling procedure has shown the erroneous classifications are rarely made through the use of the sampling protocol. Note that with a threshold of 7.5 and 10 'nd' (no decision) replaces some of the larger numeric values. This means that the mite density cannot be classified as greater than the threshold with the current number of leaves examined and additional samples are necessary. Of course, sampling could be terminated if the number of leaves with mites was less than the lower values.

If the sample shows that a miticide treatment is not required, another sample should be taken in 15 to 20 days. Experience has shown that orchardists can sample mite populations in a particular block in 10 to 15 minutes. When this procedure was tested in 19 commercial blocks of apples in 1987, an average of 1 miticide application/block was saved. We anticipate that growers can save 1 to 2 miticide treatments annually using this procedure. Assuming an average block size of 5 acres, the time invested in censusing mites provides a lucrative return in decreased pest control costs and may reduce the chance of mite resistance developing.

Table 2. Stop limits for use in classifying European red mite populations with respect to a threshold using presence - absence count of mites on leaves.

Leaves examined	Threshold = 2.5		Threshold = 5.0		Threshold = 7.5		Threshold = 10	
20	7	16	11	19	13	nd	15	nd
30	11	23	18	28	21	nd	24	nd
40	16	30	25	36	29	39	32	nd
50	21	36	32	44	37	48	41	nd
60	26	42	39	53	45	57	49	59
70	31	49	46	61	53	66	58	69
80	37	55	53	69	62	75	67	78
90	42	61	60	77	70	84	76	88
100	54	54	73	73	83	83	92	92