Evaluation of Metamitron as a Chemical Thinner on Apples

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Chemical thinning remains one of the most onerous tasks a fruit grower is required to do. Adjusting crop load to assure high fruit quality at harvest and allowing adequate return bloom for a crop the following year is extremely difficult since tree factors and unpredictable weather largely determine the success of a chemical thinner application. There are several thinners available that may be beneficial when used at specific times, provided that there are favorable conditions during the critical time after application.

Over 25 years ago, Ross Byers at Virginia Tech identified reduced light available to a tree during the chemical thinning period was a key component that influenced fruit abscission. This observation quickly led to a series of experiments conducted by several researchers that ultimately identified that available photosynthate at the 7 to 15 mm fruit size period determined if a fruit persisted or was signaled to abscise. Alan Lakso over a several-year period developed a computer program that was able to quantify the amount of carbohydrate available in a tree and used this as a tool to predict the ease at which a thinner could reduce crop load. Trees that were subjected to a severe carbon deficit were quite easy to thin; whereas, trees with an excess carbon balance were difficult to thin. The use of artificial shading and photosynthetic inhibitors confirmed the usefulness of the carbon-balance model. However, thinning by the use of artificial shading is not practical and available photosynthesis inhibitors could not be used because of side effects and the difficulty of getting the products registered.

Metamitron is an herbicide used to control weeds in sugar beets in Europe. It is a photosynthetic inhibitor that blocks photosystem II, thus reducing the ability of susceptible plants to produce carbohydrates. Sugar beets are immune to the effects of metamitron since they can quickly metabolize the molecule to a nontoxic breakdown product. Apple can metabolize metamitron as well, but it takes several days. The lag time until apple metabolizes metamitron is sufficiently long to create a carbon deficit in the trees that result in some of the fruit abscising. The most effective time of application of metamitron should be when fruit size is 10-15 mm, when apples are prone to a carbon deficit. During this period of time, there is intense competition between developing fruit and bourse shoot growth for the carbohydrates that are being produced at this time primarily by the spur leaves. The carbon-balance model is most useful in that it indicates an appropriate time of application and aids is selecting the dose of Metamitron to use given the prevailing weather conditions.

Metamitron is used and sold as chemical thinner (Brevis) in some European countries. It has been evaluated in this country for several years now. It is on track to be registered in the United States in as short a time as 3 years. In addition to ongoing research to support the registration of the product here, the focus of research now is to identify the concentration of the product to be used in the East and Midwest and to establish the most appropriate fruit size range to target application. Since metamitron is a photosynthetic inhibitor, the carbon balance model is used and followed closely in all research plots in order to identify environmental conditions and carbon balance that lead to consistent and predictable thinning.

The research conducted in 2018 was intended to evaluate the current formulation of metamitron (ADA 45701), the amount to apply, and the time of application (fruit size) on the thinning effectiveness of metamitron.

Materials & Methods

A block of mature Summerland McIntosh/M.9 was selected for this trial. Sixty uniform trees were selected at the pink stage of flower development. Three limbs per tree were selected, tagged, and the circumference of each was measured at the base. The number of flowering spurs was counted and recorded, and the bloom density was then calculated for each tree. Trees were separated into six groups (replications) of 10 trees each based upon blossom cluster density. Within each replication, trees were randomly assigned to one of ten

Table 1. Influence of metamitron on fruit set of Summerland McIntosh when applied 0n 24 May or 30 May		
Metamitron (lb/acre)	Fruit Set	
	Fruit/cm LCSA	Fruit/100 blossom clusters
	7.5 mm fruit size- applied 24 May	
ADA 46701 0	9.7 a	105 a
ADA 46701 1	8.6 abc	82 bc
ADA 46701 1.5	6.3 de	70 cd
ADA 46701 2.0	5.9 de	44 e
ADA 46701 2.5	7.5 bcd	74 bcd
MaxCel + carbaryl 64 oz 1 qt	9.2 ab	94 ab
Significance	l***q**	l***q**
	13.2 mm fruit size- applied 30 May	
ADA 46701 0	9.7 a	105 a
ADA 46701 1	6.4 bc	55 bc
ADA 46701 1.5	5.2 d	38 c
ADA 46701 2.0	3.9 d	19 d
ADA 46701 2.5	3.6 d	21 d
Significance	l***q*	l***q**

treatments which are shown in Table 1. Briefly, one tree in each group received ADA 46701 at 1, 1.5, 2, or 2.5 pounds per acre applied when fruit size averaged either 7.5 or 13.2 mm in diameter. One tree in each group was sprayed with 64 oz of MaxCel plus 1 quart of carbaryl at the 7.5 mm timing and one tree was not sprayed and served as the untreated control. Final fruit set was taken at the end of June drop in early July. Two weeks after application, all trees were rated for phytotoxicity symptoms on a scale of 1 no phytotoxicity to 9 extensive leaf injury and necrosis. At the normal commercial time of ripening during the third week in September, a 25-apple sample was harvested randomly from each tree. Fruit were taken to the laboratory where they were weighted, red color was estimated to the nearest 10%, and then flesh firmness, soluble solids and residual starch were rated using the Cornell generic starch chart on 10 representative apples.

Results & Discussion

Final fruit set data shows that metamitron thinned effectively in 2018, although there were differences in severity of thinning which can be attributed to fruit size at the time of application (Table 1). There was primarily

Table 2. Calculated carbon balance in McIntosh trees on the day of and the 5 days following metamitron application.		
Days after application	Date applied	
	May 24[1,2]	May 30
0	-22.5	- 5.2
1	-21.0	8.5
2	-21.4	4.2
3	- 7.0	22.2
4	11.0	35.1
5	- 3.0	23.3

[1]Suggestion on NEWA was to reduce thinning spray by 15% on 24 May and to apply the standard thinning rate on May 30.
[2]Averge fruit size was 7.5 mm on May 24 and 13.2 mm on May 30.

a linear reduction in crop load as the rate of metamitron increased that was recorded for both times of application. However, application when fruit size averaged 13.2 mm resulted in a greater thinning response. The use of higher rates at this fruit size resulted in over thinning. In general, a final set of 6 fruit per cm limb cross-section area is considered an appropriate final fruit set. When application was made at 7.5 mm the highest rates were required to achieve adequate thinning. The carbon balance in trees at the time of application differed (Table 2). The carbon balance in trees sprayed on May 24 was generally negative and the suggestion on the NEWA site was to reduce thinning severity sprays by 15%. The carbon balance in trees sprayed on May 30 when fruit size averaged 13.2 mm was neutral to slightly positive and the suggestion on the NEWA site was to apply the chemical thinners at the standard thinning rate. Fruit size at the time of metamitron application appears to be as important as the rate that is used. (In the 2019 thinning trial, metamitron application was made when fruit sized averaged 14 mm using a wide range of metamitron rates.)

Fruit quality parameters were evaluated on all fruit harvested in this trial. In general, metamitron had no direct effect on fruit red color, flesh firmness, or time of ripening as assessed by fruit starch rating, regardless of time of application (data not shown). Metamitron treatments increased fruit size and increased fruit soluble solids. We consider these responses to be secondary effects since metamitron reduced crop load which resulted in larger fruit sizes. Trees with a reduced crop load usually have higher sugar content due to a more favorable leaf-to-fruit ratio.

Under some circumstances metamitron can cause some leaf damage. This damage generally appears as a slight chlorosis or yellowing of the leaves. In this investigation, phytotoxicity was rated very low even at the highest rates used (data not shown). One had to look very hard to even detect it. We do not think orchardists will consider phytotoxicity to be a problem. In the past, when phytotoxicity was a concern, it was attributed to problems with previous product formulations and the use of surfactants in the spray. The formulations have been adjusted and improved, and surfactants are not recommended to be used in the East.

Conclusions

Metamitron is a chemical thinner that is registered and used in several countries in Europe. It is on track to receive regulatory approval in the United States within 3 years. The availability of metamitron will provide a unique tool for orchardists to thin apples. Its ability to inhibit photosynthesis will give orchards the ability to regulate the carbon balance in a tree, thus having more control over the thinning process. Once available, metamitron can be used alone or in conjunction with other chemical thinners thus providing orchardists more options and better control of the thinning process.