

# Effects of ReTain, Nitrogen Fertilization, and Mid-summer Trunk Scoring on Fruit Color and Quality of 'Jonagold' Apples

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'Jonagold' is a high quality apple that has steadily increased in popularity since its release by the Cornell/Geneva apple-breeding program in 1968. However, the fruit of most 'Jonagold' strains in many orchards do not develop sufficient red blush - even when firmness, starch index, and other maturity indices suggest the fruit is ready for harvest. To make matters worse, if growers delay harvest waiting for better red color, 'Jonagold' often becomes greasy and vulnerable to rapid breakdown during subsequent cold storage. The success and profitability of 'Jonagold' for the NY apple industry has been limited by these problems. We initiated an experiment to test and develop practical management strategies that improve fruit color, firmness, and storage quality of 'Jonagold' apples in New York.

Our strategy over the last two years examined: 1) The use of ReTain™ (50 g AVG/acre) to slow ethylene synthesis and ripening and delay harvest for better color development; 2) Nitrogen management schemes including, i) elimination of nitrogen applications, ii) a single low nitrogen (N) fertilization (30 lb. N/acre, soil applied in May), and iii) spring and postharvest urea spray applications (two 1% sprays post petal fall, and one 5% spray postharvest); and 3) Mid-summer trunk scoring (first week of August) to decrease N uptake and increase the carbohydrate to N ratio in the tree canopy,

thereby improving fruit color. Fruit were collected and analyzed weekly on four dates, beginning in late September and ending the middle of October during 1998 and 1999. This allowed us to determine the treatment effects on color and maturity over time.

## Results from 1998 and 1999

**ReTain:** Maturity indices showed that ReTain delayed maturity of 'Jonagold' by 7 to 10 days in both years of the study. This was evidenced by lower starch index scores, increased firmness, lower internal ethylene production, reduced red blush, and greener background color when treated fruit were compared to controls on the same harvest date. Harvest of ReTain treated fruit had to be delayed approximately one week to obtain equivalent percent blush color as untreated fruit (Fig. 1A). In the 1998, ReTain reduced blush development more when sprayed on N fertilized trees compared to unfertilized controls (Fig. 3D). ReTain had no direct effect on fruit size, but size increased linearly over the three week harvest period (Fig. 1C). Therefore, delayed harvest of ReTain treated fruit could be expected to increase average fruit weight, just as early harvest of Ethrel treated fruit will result in smaller fruit size. Since 'Jonagold' is a large fruited variety, the increase in fruit size is not an advantage, but small-fruited varieties may benefit

Fruit coloring can be improved in poorly coloring blocks of 'Jonagold' by limiting or eliminating N fertilizer applications on trees with leaf N levels above 2.0% or by mid-summer trunk scoring. Red color intensity can also be improved by trunk scoring.

from delayed harvest with ReTain. ReTain treated fruit were firmer than untreated fruit at harvest and after storage when picked at the same time (Fig. 1B). ReTain also delayed the onset of greasiness at harvest and after storage (Fig. 1D). The delay in firmness loss and greasiness development was a function of delayed maturity since these benefits were lost when ReTain fruit were harvested at similar levels of maturity one week later. After that period of time, ReTain treated fruit had equivalent, but not higher flesh firmness compared to untreated fruit harvested earlier. The same was true for greasiness. Therefore, ReTain appeared to be an effective harvest management tool, maintaining fruit quality for a period of 7 to 10 days beyond that of untreated fruit. Harvest timing of ReTain treated fruit should



Figure 1. Jonagold fruit color following treatment with AVG (ReTain) (top left), trunk scoring (bottom left), 30 lbs/acre N fertilizer (bottom right) or untreated (top right).

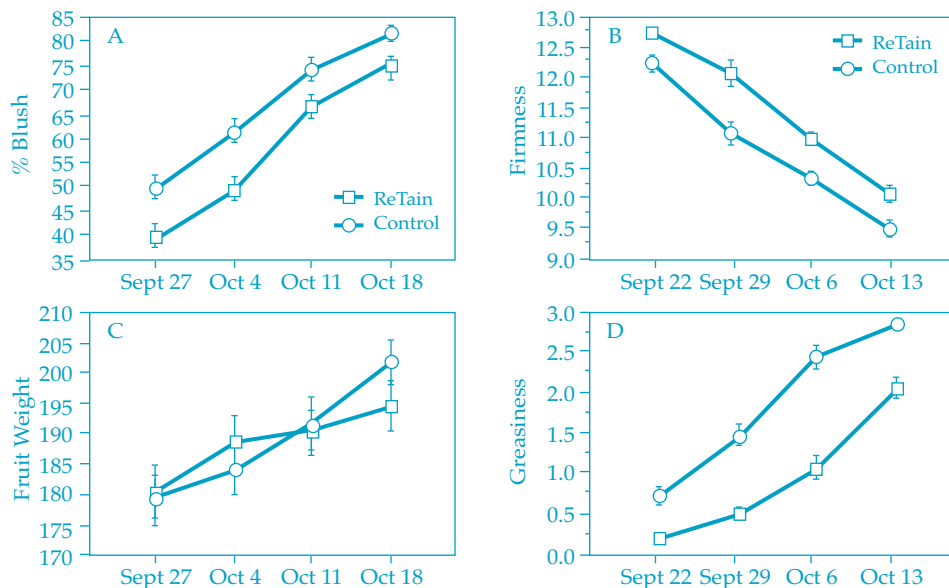


Figure 1. Effect of ReTain on percent blush (A), and average fruit weight (C) at harvest in 1999, and firmness (B) and skin greasiness (D) after two months in cold storage and seven days at room temperature (?) in 1998.

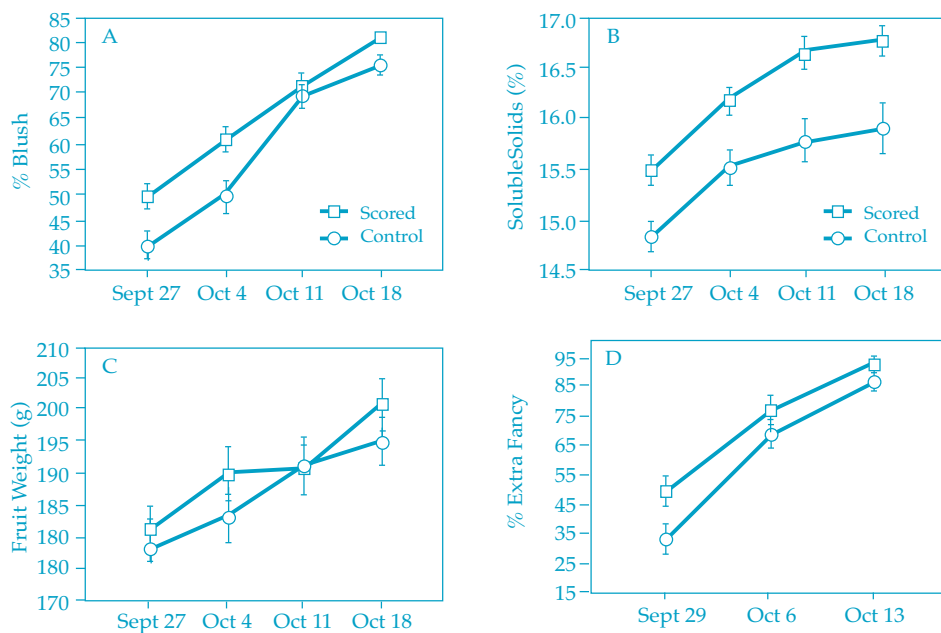


Figure 2. Effect of mid-summer scoring on blush development (A), soluble solids (B), and average fruit weight (C) in 1999, and percent extra fancy fruit (D) in 1998.

be based on the grower's objective. If the grower's goal is to have harder fruit that are not greasy out of storage, treated fruit should be harvested around the same time as untreated fruit, but color will be sacrificed. If the goal is to delay maturity of 'Jonagold' in order to harvest larger crops of earlier ripening varieties, then ReTain can be used to extend the harvest window without substantial loss in fruit quality. Using ReTain to let fruit hang on the tree longer to improve red color does not seem to be a viable strategy for 'Jonagold' since ReTain actually delays

color development. Furthermore, one should consider the potential for ReTain to interact with other orchard factors that may reduce color development such as N fertilization. Color may be further delayed if ReTain is applied to heavily cropped or overly vigorous trees.

**Trunk Scoring:** Mid-summer scoring increased blush development in both years of the study (Fig. 2A). Fruit from scored trees had 7 to 10% more blush than control trees resulting in 10 to 20% more fruit in the extra fancy grade compared to non-scored trees (Fig. 2D). Red color

intensity was brighter and background color was less green on fruit from scored trees. The effect of scoring on fruit color was more pronounced at the earlier harvest dates. This was not attributed to advanced maturity of scored trees since there was no difference in ethylene or starch index. The only observation that indicated advanced maturity of scored trees was the slight increase in skin greasiness at harvest which did not persist after storage. Scoring increased soluble solids concentration of fruit at harvest and after storage, giving fruit a noticeably sweeter taste (Fig. 2B). Scoring had no direct effect on fruit weight (Fig. 2C), but size appeared to be reduced only when low N status trees were scored. Timing of scoring seems to be a significant factor involved in fruit color improvement. In other studies, scoring performed in the spring to reduce vegetative growth or enhance fruit set and flowering advanced fruit maturity without improving fruit color. In contrast, we found that scoring in mid-summer enhanced fruit color development without advancing maturity. Hastening the advent of color development with mid-summer scoring has the benefit of allowing growers to harvest a greater percentage of fruit earlier in the harvest window when storage quality is best.

Mid-summer scoring may be an effective method for improving blush of poorly coloring 'Jonagold' strains, especially since it can be performed at the same time as summer pruning. However, this technique needs further investigation before it can be recommended commercially. Data from this experiment were only collected for two years, and therefore, long term effects on tree health and yield could not be assessed. In any case, growers with poorly coloring blocks of 'Jonagold' may want to consider experimenting with this technique on some of their own trees.

**Nitrogen Fertilization:** The effect of N fertilization on 'Jonagold' color and quality varied in each year of the study. Under the more normal growing conditions in 1998, both the urea sprays and 30 lb. N/acre caused a 10 to 16% reduction in blush (Fig. 3A). The percentage of fruit graded extra fancy was 11 to 13% lower than control trees. Blush intensity was reduced, and background color was greener with foliar or ground N applications. Fruit size was greater on N fertilized trees, but only if ReTain was not applied (Fig. 3C). For some unknown reason, ReTain appeared to negate the size increase associated with both forms of N application.

Nitrogen treated fruit were softer at harvest (Fig. 3B), but there was no difference in flesh firmness between foliar and ground N treatments when ReTain was also applied. In 1999, N fertilization increased fruit breakdown after storage. We believe that the drought during the summer of 1999 may have interfered with N uptake and utilization.

Nitrogen application had no effect on fruit maturity or yield in either year even with leaf N levels of the control trees averaging 2.0%. Our results showed that N fertilization of mature 'Jonagold' trees had no economic benefit and even the low rate of ground applied N (30 lb./A), or the two spring urea sprays (1%) lowered packout in one year. One important negative consequence of Nitrogen fertilization is that growers may delay harvest due to poor color development in N fertilized trees, during which time fruit quality could decline. Our data indicates that the leaf N status of mature 'Jonagold' trees should be kept close to 2.0% in order to produce a larger quantity of extra fancy grade fruit. Further experimentation is needed to verify this, and also to determine the lower threshold at which point yield or fruit size are reduced, and biennial bearing becomes a concern. Reducing or eliminating N fertilizers on poorly coloring mature blocks of 'Jonagold' may be one of the most simple and effective ways to overcome problems with poor color development. Leaf analysis should be used to determine tree N status so that fertilization programs can be adjusted accordingly.

## Conclusion

Based on results from this study, we conclude that fruit color can be improved in poorly coloring blocks of 'Jonagold' by limiting or eliminating N fertilizer appli-

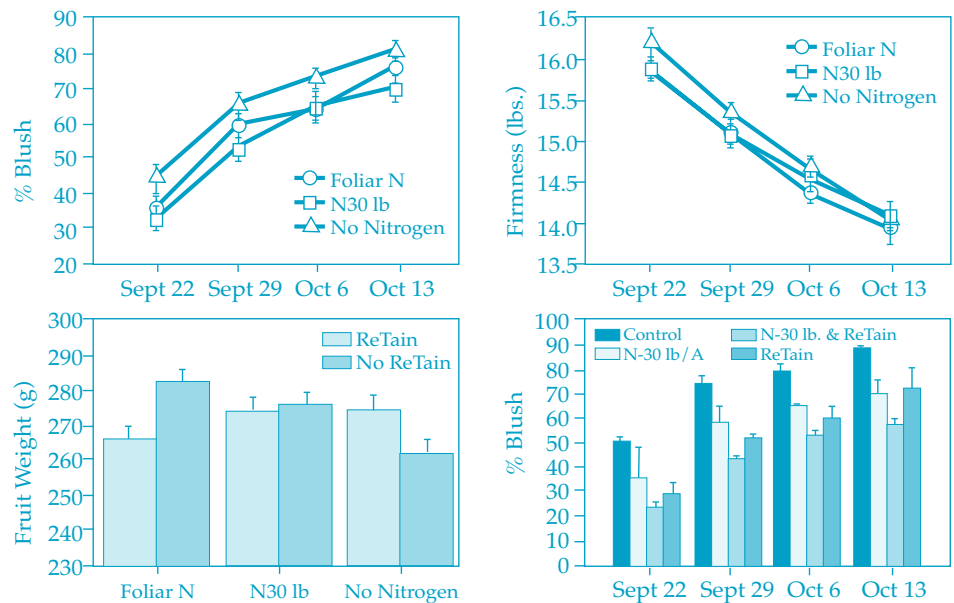


Figure 3. Effect of nitrogen fertilization on blush development (A), and fruit firmness (B) at harvest in 1998. Figure 3-C shows interaction between ReTain and N on fruit weight in 1998, and Figure 3-D shows the effect on N and ReTain alone in combination on blush development in 1998.

cations on trees with leaf N levels above 2.0%. Scoring tree trunks in mid-summer at the time of summer pruning may also be an effective tactic for improving blush intensity and coverage. Since mid-summer scoring is not an established practice, we recommend it only be tried on a limited scale commercially. ReTain can maintain fruit firmness and delay development of greasiness on 'Jonagold' for a period of 7 to 10 days, after which time, fruit quality will be equivalent but not superior to non-treated fruit harvested earlier. We found interactions between ReTain and N on fruit size, firmness, and color development. It is possible that ReTain may interact with other orchard factors to either enhance or reduce its effects on fruit maturity and quality. Growers should be

aware of the potential for such interactions, and apply ReTain only to uniform blocks where color development is generally good, and a 7 to 10 day delay in harvest is desired.

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