

Published December 1, 2020

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Effect of Harvest Timing on Kernel Quality in Hybrid Hazelnuts

Introduction

Hazelnut plantings in the Upper Midwest are currently populated with open pollinated hybrid seedlings. The diversity of these plantings poses significant harvesting challenges as every plant in a row has a slightly different maturity, and the ripening period across the planting can span more than 30 days from late-August into October. Harvesting too early before nuts have abscised from the husk results in

“stick-ons” or nuts with husk material that stays fused to the nut. Harvesting too late can result in significant nut loss to wildlife, which is particularly noticeable in the smaller plantings in the Upper Midwest that are typically only a few acres in size.

This research bulletin illustrates the importance of waiting for nuts to fully mature before harvesting. In addition to the “stick-on” issue, harvesting too early results in shriveled kernels with little to no market value.

Kernel Development

Hazelnut kernel development is unique among angiosperm plants as fertilization occurs many weeks after pollination. However, once fertilization occurs embryo and kernel development is rapid and full size is attained by mid-August with ripening and nut abscission occurring from late-August to early-October, depending on the genotype. Work with European hazelnut cultivars showed that starch and moisture content decreased steadily during kernel development, while sugars, oil content, and dry matter increased, peaking at abscission (Cristofori et al, 2015). Harvesting too early results in

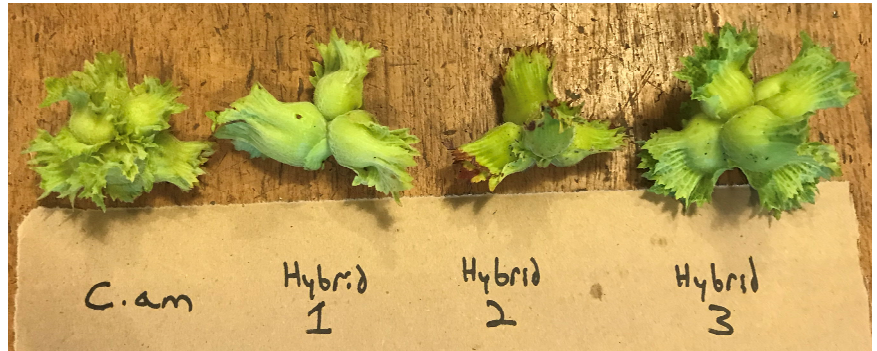


Photo 1. Hazelnut clusters from four different hybrid hazelnut genotypes. Nuts from hybrid hazelnuts don't fall free from the husk, thus knowing when to harvest is not easy. Harvest too early and the nuts won't be mature. Wait too long and the nuts are lost to the critters.



Figure 1 The different kinds of “stick-ons”. Regardless of the cause, stick-ons pose challenges for post-harvest processing and need to be removed from the clean in-shell nuts.

kernels with a high moisture content that, when dried, become shrunken and shriveled. This research bulletin is intended to illustrate the effect of harvest timing on kernel quality in Midwest hybrids, though it was beyond the scope of this project to analyze the chemical composition of the kernels.

The Cause and Problem of “Stick-Ons”

“Stick-ons” is a term used by growers for nuts with husk material still attached. There are two main causes. The first is insufficient de-husking. Hybrid hazelnuts don’t fall free from the husk when mature so the husk must be mechanically removed. If the machines don’t contact the husk material, as is common with single nuts, the material isn’t removed. The second cause is incomplete abscission. One of the last stages in nut ripening is development of an air gap between the cells on the side of the nut and the cells of the husk. This air gap effectively releases the nut from the husk. If it doesn’t form, the two stay fused and the result is a stick-on. Abnormal kernel development caused by weevil or other insect feeding and harvesting too early are the most common cause of stick-ons. Figure 1 shows the four common stick-on types. The most common are the “singles with tails”, where mechanical husking has removed all the husk material except the portion attached to the nut. The “clusters” are two or more nuts in a cluster that haven’t abscised and remain attached to each other. The “bones” are the woody part of a larger cluster that still has an immature nut attached. The main problem with stick-ons is they don’t flow well through processing equipment and plug up the sizing, cracking, and cleaning machines.

Materials and

Methods

One American (*Corylus americana*) and three hybrid (*C. americana* x *C. avellana*) plants



Figure 2. Hazelnut clusters from four different hazelnut genotypes and five harvest dates with most of the husk removed.

	C. am		Hybrid 1		Hybrid 2		Hybrid 3	
	At-Harvest	Dried	At-Harvest	Dried	At-Harvest	Dried	At-Harvest	Dried
15-Aug	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
20-Aug	0.0%	0.0%	0.0%	0.0%	0.0%	12.5%	0.0%	68.8%
25-Aug	0.0%	52.4%	0.0%	0.0%	0.0%	88.2%	13.3%	69.2%
30-Aug	0.0%	93.3%	0.0%	0.0%	94.4%	91.7%	30.8%	68.8%
4-Sep	83.0%	94.1%	22.7%	42.1%	82.4%	94.4%	95.2%	100.0%

Table 1. Percentage of harvested nuts abscised at harvest and after drying.

were chosen at random from a mature planting near Marengo, WI. Starting on August 15, 2020, ten clusters were harvested at random from each of the four plants every five days. At each harvest date, five of the clusters were immediately de-husked to quantify the percentage of nuts that had abscised. The total number of nuts in a group of five clusters ranged from 12 to 31. The other five clusters from each harvest date were placed in a high-tunnel greenhouse and allowed to air-dry until October 1. At that point, the dried clusters from each plant were de-husked to quantify the percentage of nuts that had abscised for each harvest date. In addition, ten nuts from each harvest date were cracked to determine the percentage of kernels that were fully formed and not shriveled.

	C. am	Hybrid 1	Hybrid 2	Hybrid 3
15-Aug	0.0%	0.0%	0.0%	0.0%
20-Aug	20.0%	0.0%	0.0%	0.0%
25-Aug	70.0%	0.0%	0.0%	0.0%
30-Aug	100.0%	10.0%	100.0%	90.0%
4-Sep	100.0%	90.0%	100.0%	100.0%

Table 2. Percentage of fully-formed (not shriveled) kernels by plant and harvest date after drying.

Results

Figure 2 shows the five clusters that were de-husked (or at least attempted to be de-husked) immediately after harvest for each of the four plants and each of the five harvest dates. Table 1 shows the percentage of the harvested nuts that had abscised from the husk at each harvest date at harvest and after drying. The nuts had abscised by September 4 for three of the plants, but not for Hybrid 1. It wasn't until September 9 that most of the nuts had abscised for Hybrid 1 (data not shown). A significant amount of nut abscission occurred during the drying process especially by the August 25 harvest date, but it varied considerably among the plants.

Table 2 shows the percentage of the kernels that were fully formed and not shriveled at cracking on October 1. Figure 3 shows photos of the kernels. Clearly, the kernels were not yet mature on August 15 and consequently shriveled once dried. The American hazelnut (C. am) had mostly fully formed kernels by August 25, but kernel size was slightly larger at the later picking dates, suggesting there was some shrinkage during drying for the August 25 kernels. Hybrid

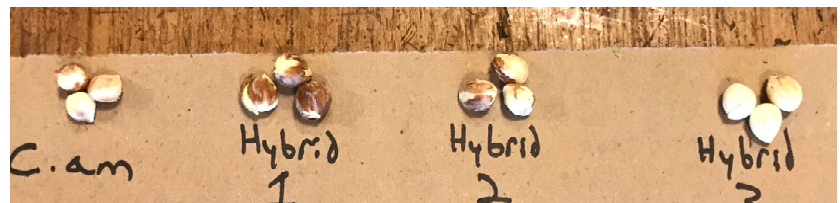


Photo 2. Hazelnut kernels from four different plants on August 15. The kernels are fully formed, but if harvested at this stage they will shrivel when dried.

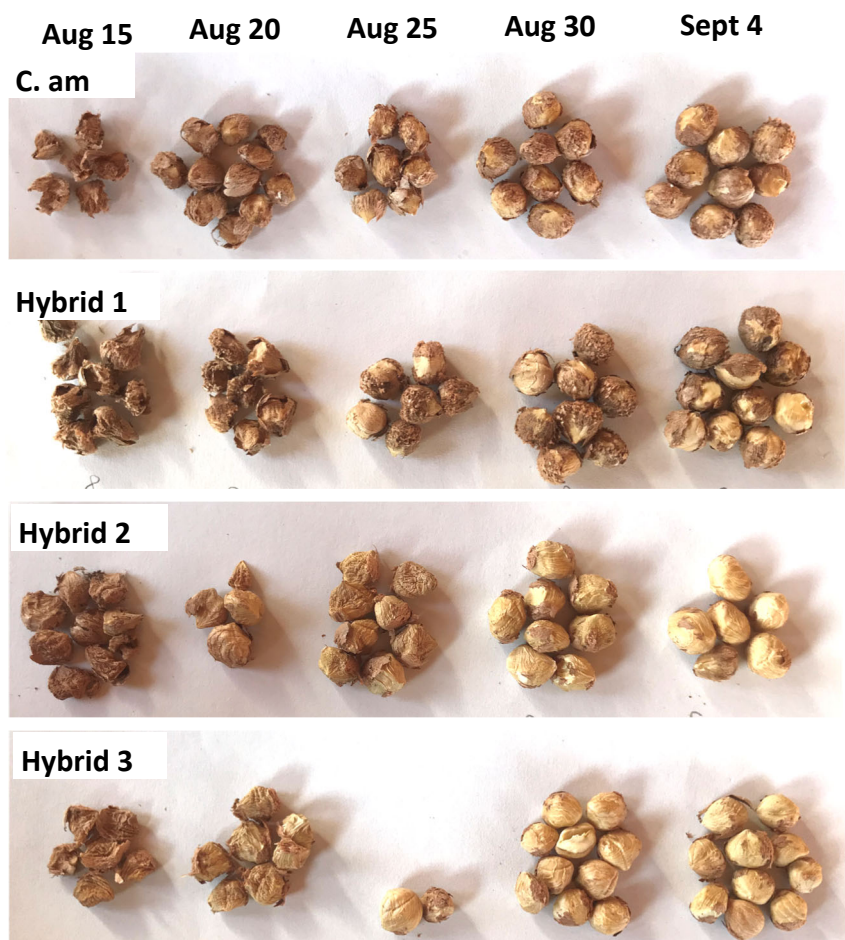


Figure 3. Hazelnut kernels after drying from four different plants harvested at five different dates.

2 and 3 stayed fully formed after drying by Aug 30, but interestingly, the Hybrid 2 nuts had not fully abscised by the August 30 date either at harvest or after drying.

Discussion

Although the kernels had reached full size in the shell by mid-August and appeared fully formed and mature (Photo 2), looks can be deceiving. It can take another 3 weeks or more for the starch and moisture to be replaced by sugars and oil such that the kernels stay fully formed upon drying. If harvested too early, the kernels shrivel and aren't saleable. The general recommendation for hybrid hazelnuts grown in the Upper Midwest is to wait for the nuts to abscise and be loose in the husk before harvesting. Understandably, this recommendation is hard to follow while watching blue jays and squirrels make off with the clusters.

As growers have observed, some abscission will occur after harvest as the clusters air-dry, but post-harvest abscission doesn't mean the kernels will be mature. For example, nearly 90% of the Hybrid 2 nuts harvested on August 25 abscised during drying, but 100% of the kernels from that harvest date shriveled during the drying process. It's just too much of a risk to harvest too early. A much more reliable indicator of nut maturity is abscission prior to harvest.

Though this small study is not comprehensive, there does appear to be variation among genotypes for the abscission-maturity correlation. For example, the American hazelnut plant had fully formed kernels at the August 30 harvest date even though no abscission had occurred at harvest and 93% abscised during the drying process. This suggests some genotypes could be harvested maybe up to a week before abscission in the field, but it's hard to know what's early without knowing the abscission date, especially because it can vary from year-to-year. Further, each genotype would have to be evaluated individually before knowing whether it could be harvested early. This would be something that could be practical for clonal plantings, but not for seedling plantings where every plant is different.

It's easy to know when to harvest nuts from European varieties—just wait for them to fall out of the tree. It's not so easy for the hybrids. A better understanding of the abscission-maturity correlation is needed in order to maximize the harvesting window to prevent nut loss to predators and “stick-ons” while ensuring maximum kernel quality. Incomplete and uneven maturity is a problem in many crops and growth regulators, such as ethephon, have been used successfully to better control maturity. It has never been studied with Midwest-grown hybrid hazelnuts, but might be an option for the industry.

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The **Upper Midwest Hazelnut Development Initiative** is a collaboration of the University of Wisconsin, University of Minnesota, and early adopter growers in the Upper Midwest working to develop a hazelnut industry in the Upper Midwest based on American hazelnut and hybrids. More information about the UMHDI can be found at www.midwesthazelnuts.org.

**Upper Midwest
Hazelnut
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