

## Science of Sun Dried Raisins

*Bill Peacock and Pete Christensen*

Raisin drying is mostly an "art" based on observation and experience. Weather conditions and date of harvest have the biggest influence on drying time, but roll type, tray type, and tray filling also have an influence. We quantified the effect of roll type, tray type, and tray filling on the rate of raisin drying at the Kearney Agricultural Center in 1994 and 1995.

Harvest occurred on August 29, 1994 and September 5, 1995 with an average daily high/low temperature during the drying periods of 88 °F / 51 °F in 1994 and 91 °F / 56 °F in 1995. Drying conditions were good both years - no rain occurred. It took 13 days in 1994 and 16 days in 1995 for 20 pounds of fruit on standard wet strength trays to dry to 14% moisture (Figures [1](#) and [2](#)). The later harvest and shorter days slowed drying a few days in 1995 even though average temperatures were higher.

Experimental rows were terraced with a minimum slope (5%). Row orientation was east and west. Experiments were designed as randomized complete blocks with eight replications. Trays were weighed every two days by carefully sliding the trays onto a sheet of wood and then carefully replacing the tray on the terrace after weighing. A dried-fruit moisture meter was used to measure the final raisin moisture, and back calculation determined moisture content of the fruit at each weighing.

### Tray Type

Raisin trays can be purchased in a variety of tray dimensions, coatings and other paper treatments. However, tray type has very little effect on the drying rate of raisins while the trays are open (before rolling). This was demonstrated in the 1995 study comparing the following tray types: (1) standard wet strength (24" x 36"); (2) standard wet strength (26" x 34.5" - extra wide); (3) polycoated; (4) polycoated with venting; and (5) extra wide with surface sizing. The results in Figure 3 show very minor differences in drying rates among the five tray types over 16 days. Raisin moisture in the last four days of drying (open trays) showed raisins on polyvented and extra wide trays were slightly dryer, but the difference was small and amounted to a day or less of drying time.

### Roll Type

The effect of roll type on the drying rate of raisins along with the interaction of roll types with different raisin paper was also evaluated. A cigarette, flop, biscuit roll, and an open tray (unrolled) were compared using standard wet strength, polycoated, and polycoated vented tray types. Trays were rolled when raisin moisture averaged about 20% in 1994 and 18% in 1995. At rolling times there were many uncured raisins ("frog bellies") and a few green berries, particularly in 1994.

Raisins in a biscuit roll dried the slowest and lost about 0.8% moisture each day after rolling. Raisins in a flop and cigarette roll dried at the same rate and lost about 1.2% moisture each day. If the trays were left open (unrolled), they lost about 2% moisture each day (Figures 4 and 5). Growers sometimes do not realize how quickly raisins continue to dry after rolling into a cigarette or flop (under normal drying conditions), and this often leads to excessively dry raisins.

The type of raisin tray (wet strength, polycoated, polyvented) had little effect on the rate raisins dry in a cigarette (Figure 6) or flop roll. However, the drying rate in a biscuit roll was slowed considerably using a polycoated tray (Figure 7). Moisture escapes from the open ends of the cigarette and flop roll. However, in a biscuit roll there are no open ends, and the polycoating keeps moisture inside (the vented polycoated tray did not improve the situation). Polycoated trays, whether vented or not, should not be biscuit rolled until they have dried to the minimum 16% moisture or less.

## Tray Weight

Most growers wish to fill trays with about 20 pounds of fruit as a compromise between maintaining reasonable picking costs and optimum drying. Table 1 represents drying rates of trays filled with different amounts of fruit. Standard, wet strength trays were loaded with 16, 18, 20 and 22 pounds of fresh fruit on August 29, 1994. Fruit on the 16 and 18 pound trays dried the fastest. When more than 18 pounds of fruit was loaded on trays, it took a little longer to make raisins. The 20-pound trays took a day longer to dry and the 22-pound trays took two days longer. Two days doesn't seem like much difference, but the moisture content of raisins on open trays can drop from 15% to 12% in two days with normal drying conditions. Boxing two days earlier could make a big difference in avoiding a weather event, particularly late in the season.

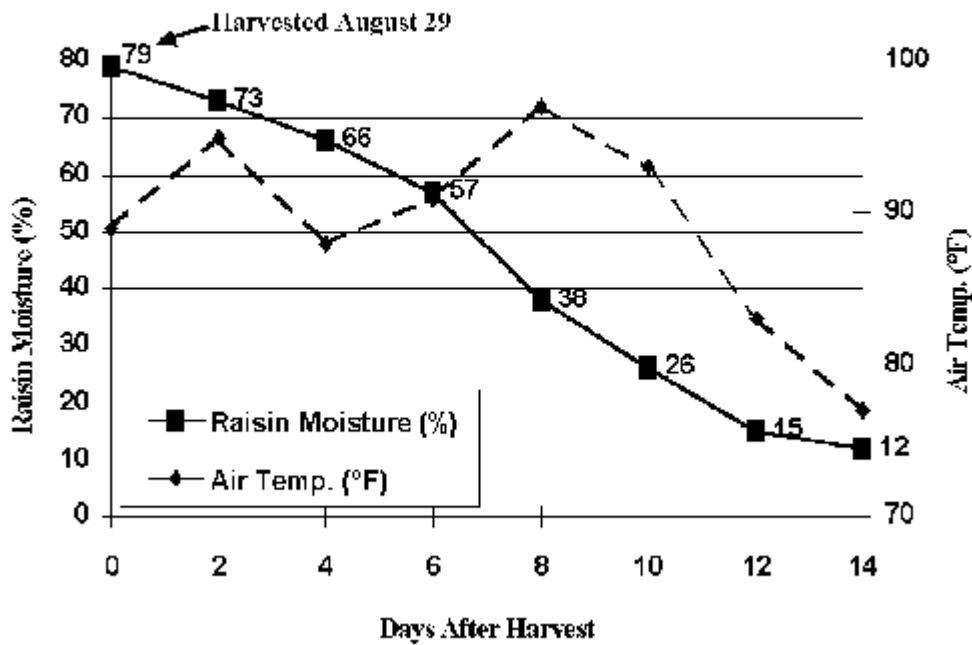
## Summary

Flop and cigarette rolls are very similar and demonstrate rapid continued drying, even with polycoated trays, as moisture is lost out the open ends of the roll. Thus, rolling "on the heavy side," especially during rapid drying weather, can help avoid overdrying and caramelization. The amount of finishing needed should dictate whether a biscuit roll is used. Drying almost stops when raisins are biscuit rolled using polycoated trays. Obviously, polycoated trays should not be biscuit rolled until they have dried to the minimum 16% moisture. Drying rate differences due to tray type are minor. Light trays dry several days faster than heavy trays, and this could be an advantage with a late harvest.

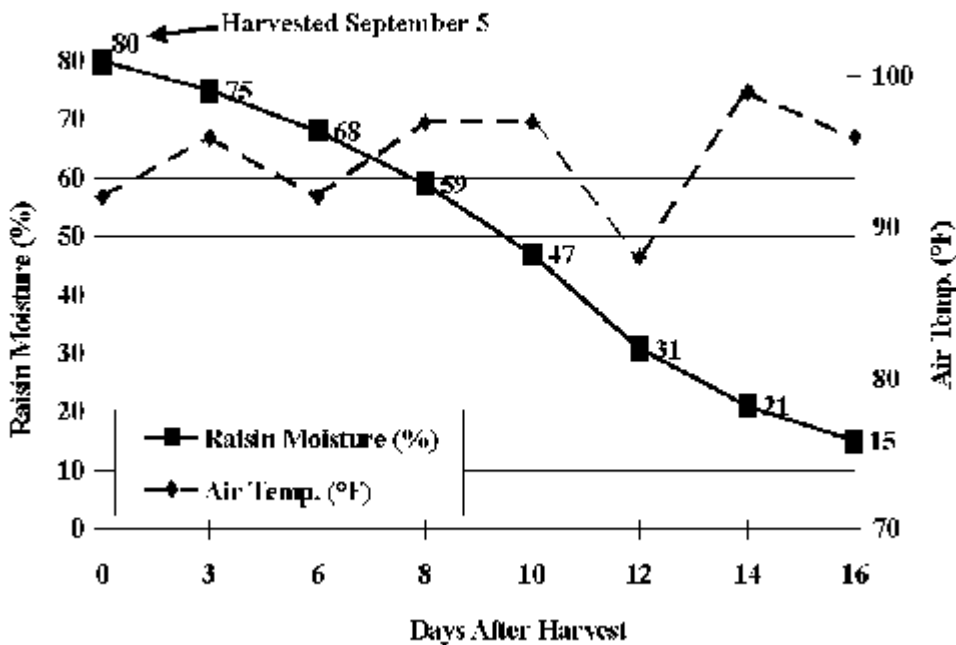
The purpose of this research was not to break new ground but to quantify the effect of tray type, roll type, and tray filling on the rate of raisin drying. This information is intended to help raisin growers fine-tune their judgments calls while sun drying raisins.

*\*Bill Peacock is a University of California Cooperative Extension Farm Advisor in Tulare County, and Pete Christensen is a Specialist with the Department of Viticulture and Enology, University of California, Davis*

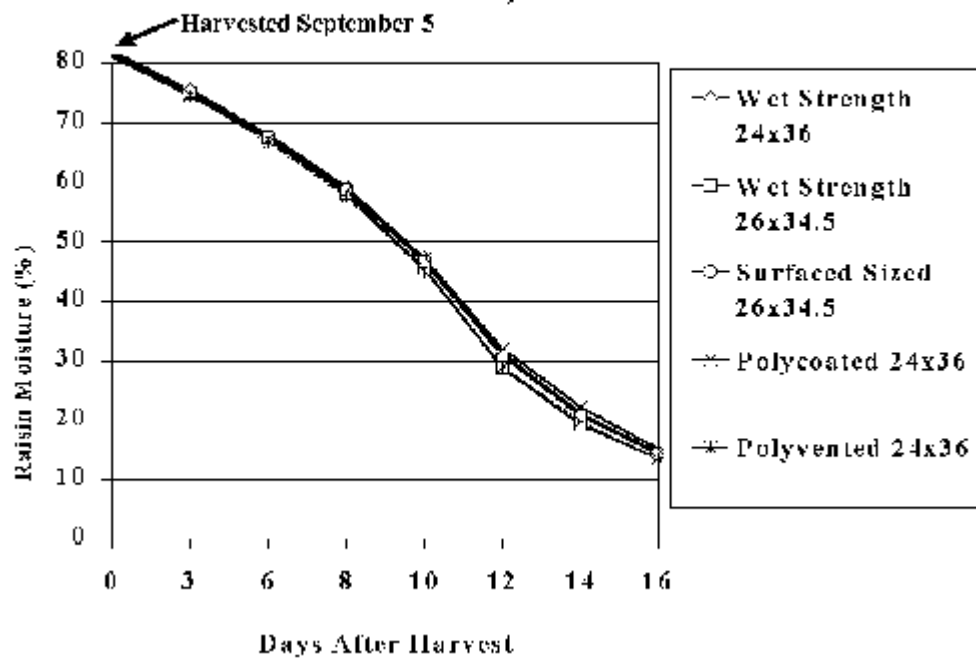
**Fig. 1. Drying rate of raisins with corresponding air temperature, 1994.**



**Fig. 2. Drying rate of raisins with corresponding air temperature, 1995.**

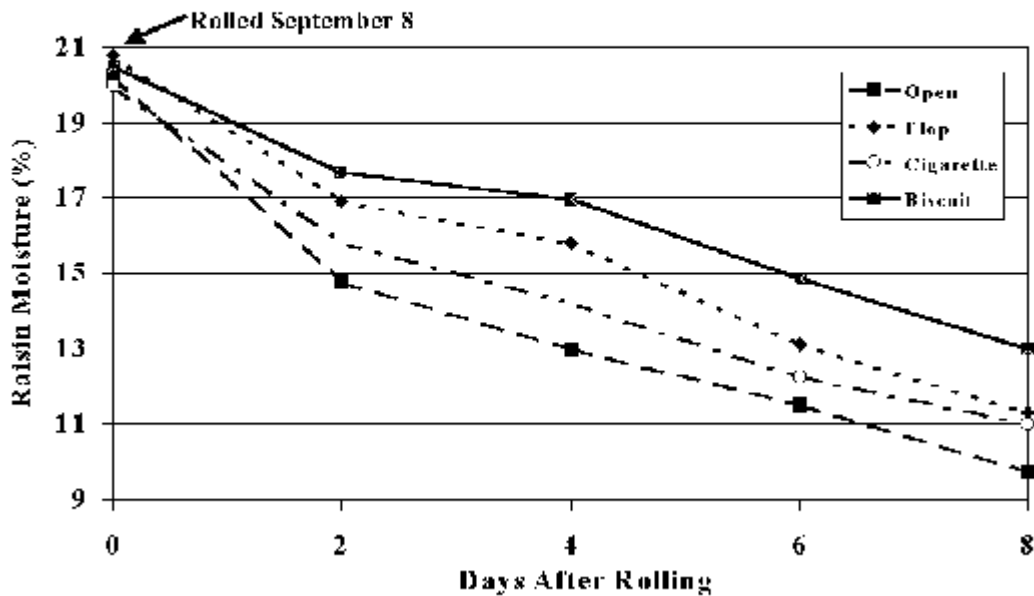


**Fig. 3. The effect of tray type on the drying rate of raisins, 1995.**

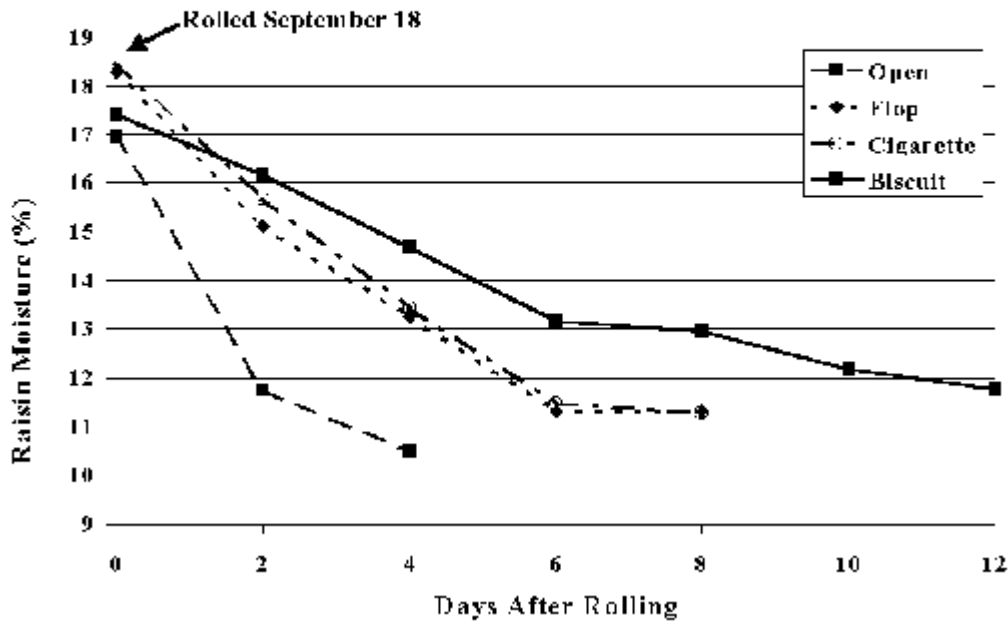


**Fig. 4. Raisin drying as affected by roll type, 1994.**

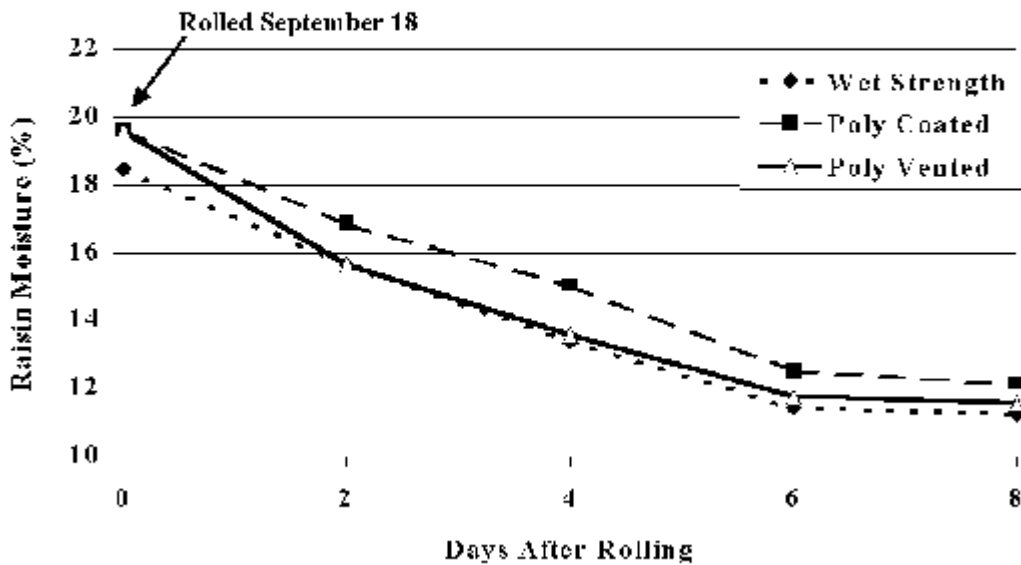
Wet Strength Paper



**Fig. 5. Raisin drying as affected by roll type, 1995.**  
Wet Strength Paper

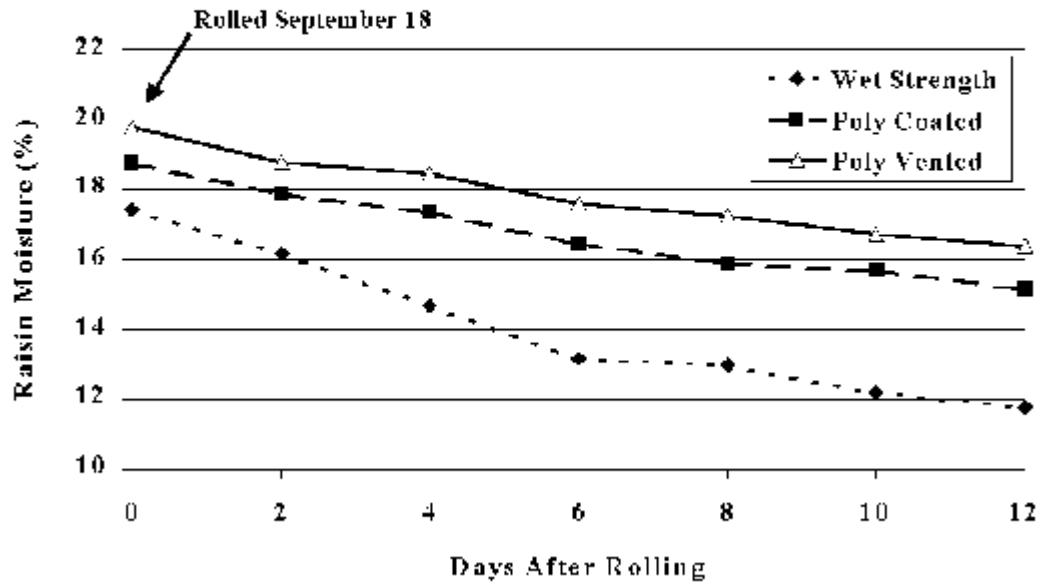


**Fig. 6 Raisin drying as affected by paper type, 1995.**  
Cigarette Roll



**Fig. 7. Raisin drying as affected by paper type, 1995.**

**Biscuit Roll**



**Table 1. Raisin drying as affected by harvest tray weight<sup>1</sup>**

Harvest Tray Wt. (lbs.)	Raisin Moisture (%)							
	Aug 29	Aug 31	Sept 2	Sept 4	Sept 6	Sept 8	Sept 10	Sept 12
16	79.2	73.5	66.0	55.5	34.5	21.8	13.2	10.7
18	79.2	74.0	66.0	57.0	37.4	24.0	13.3	10.9
20	79.0	73.2	66.0	56.8	38.4	25.6	15.3	11.9
22	79.0	74.6	68.3	59.7	43.1	29.9	18.5	13.9

<sup>1</sup> Harvest was on August 29 and raisins boxed on September 12.