Shaded Windrow Curing for Peanuts in Virginia[1]

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ABSTRACT

At digging, peanut (*Arachis hypogaea* L.) plants were placed in shaded and conventional (inverted) windrows to determine if peanut quality could be improved. Florigiant and NC 6 cultivars were dug and placed in the two windrow types on days when freezing temperatures or frost were predicted. All peanuts were dug with a conventional digger-inverter. The shaded windrows were hand formed by placing a layer of peanuts on the inverted windrow so that the peanuts were protected from direct exposure to the sky. The peanut temperature in the conventional windrow reached the lowest temperature in the nighttime and highest temperature in the daytime and fluctuated from the lowest to highest level compared to the shaded windrow and the ambient temperature. Peanut temperatures in the conventional and shaded windrows were approximately 0 C or below for a short duration during the windrow curing period. The average "maximum" peanut temperature from 12 to 5 p.m. was 3.7 C higher for the conventional than the shaded windrows for all tests. From 2 to 7 a.m., the average "minimum" peanut temperature was 1.1 C lower for the conventional than the shaded windrow. The peanut moisture content in the shaded windrow averaged 7.3% higher at combining than peanuts in the conventional windrow. In a test where the ambient temperature dropped below freezing for two nights following digging, the alcohol headspace meter readings were above the rejection level for freeze damage in the conventional windrow. The shaded windrow provided minimal freeze protection over the conventional windrow and shading is not recommended in the Virginia-Carolina production area.

Key Words: *Arachis hypogaea* L., freeze damage, moisture content, temperature.

With the conventional method of harvesting, peanuts (*Arachis hypogaea* L.) are separated from the soil mechanically and placed into inverted windrows. These peanuts decrease in moisture content more uniformly and at a faster rate when compared to the previous random windrow method (Steele *et al.*, 1969).

A more uniform reduction of moisture content in the inverted peanuts reduces the wide distributions in peanut moisture content due to the indeterminant growth habit of the peanut plant. The faster rate of moisture reduction in inverted windrowed peanuts reduces the risk of weather damage during window curing. A faster drying rate is an advantage during harvesting, but may adversely affect the flavor of the peanut (Beasley and Dickens, 1963).

An early frost may occur in the Virginia-Carolina production area and peanuts exposed to the sky have a greater possibility of being damaged due to radiation. High temperatures are not a problem because individual peanut temperatures do not go high enough to reduce quality during the harvesting season. In the southeastern production area, individual peanut temperatures may exceed the maximum desirable curing and drying temperature of 35 C (Pearman and Butler, 1968). In regions of high temperatures and low humidities, the rate of moisture removal may be high enough to reduce quality (Mixon and Mott, 1969). The quality factors most severely affected are flavor, skin slippage, and split kernels (Young *et al.*, 1982).

Preliminary tests have shown that windrows can be constructed to protect the peanuts from direct exposure to the sky (Wright *et al.*, 1989). The technique used was to hand place one windrow on top of an inverted windrow. The peanuts in the protected windrow would be between the mass of vines or in a shaded position and held off the soil surface by the inverted windrow. The purpose of this study was to monitor the environmental parameters and individual peanut temperatures for shaded and conventional windrows and to determine if the shading method was more desirable than the conventional method.

Materials and Methods

The virginia-type peanut cultivars Florigiant and NC 6 were planted on the Tidewater Agric. Res. and Ext. Farm, Suffolk, VA, where corn had been grown the previous year. The soil type was a Kenansville loamy sand (loamy, siliceous, thermic Areninc Hapludults) with a 0 to 4% slope (Reber *et al.*, 1981). Standard practices recommended for peanut production in Virginia were followed. Plots included four rows 15.2 m long spaced 0.91 m apart and the test had four replications. The two center rows of each plot were dug and used as the test rows.

Peanuts were planted with an inclined-plate planter during the first 2 wk of May. Plants were dug four times in 1988 and two times in 1989 (Table 1). Diggings one and three in 1988 were the cv. Florigiant and all other diggings were the cv. NC 6. A conventional digger-inverter was used to dig all peanuts for the shaded and conventional windrows. Shaded windrows were hand formed by placing a mass of peanuts on top of the conventional windrow so the peanut pods were between the inverted vine mass and the vine mass exposed to the sky. The hand procedure was used because no mechanical means was available to form the shaded windrow.

For each digging, a Campbell Scientific environmental/temperature monitoring system, set up in the middle of the plot area, was used to monitor the peanut temperature and environmental conditions. Four peanut temperatures (ther-

[1]Mention of firm names or trade products in this paper does not constitute a recommendation by the USDA nor does it imply registration under FIFRA.

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Table 1. Time in the windrow and moisture content at harvest for the conventional and shaded windrows in 1988 and 1989.

Test no.	Test year	Time in windrow		Moisture content		
				Conv.	Shaded	Diff.
		d	hr	------% wb------		
1	1988	4.2	100	38.2	47.0	8.8
2	1988	4.8	116	21.7	29.8	8.1
3	1988	5.8	140	22.2	30.9	8.7
4	1988	6.1	146	30.1	37.0	6.9
5	1989	6.8	164	19.9	25.7	5.8
6	1989	10.8	260	21.4	28.8	7.4

mocouple inserted through pod) were monitored in each of four conventional and shaded windrow plots for a total of 16 temperature readings per windrow type. In addition, air temperature, relative humidity, rainfall, and solar radiation were recorded. All sensors were scanned at 60-sec intervals, and the data were recorded every 15 min. The 15-min temperature readings were averaged to obtain hourly data for presentation and analyses.

Because the temperature readings were cyclical with the ambient conditions, the peanut temperature readings from 2 to 7 a.m. each day were averaged to provide a "minimum" temperature reading. Likewise, temperature readings for the time period from 12 to 5 p.m. were averaged to provide a "maximum" peanut temperature reading.

After 6- to 7-d period of windrow curing and drying, the peanuts were harvested with a commercial combine. The peanuts were cured in a forced-air dryer to a moisture content of 9 to 10%. Following a 6- to 8-wk period in storage at ambient conditions, the samples were shelled and sized into no.1, medium, and jumbo. These shelled peanuts were shipped to the ARS South. Reg. Res. Ctr., New Orleans, LA for sensory and gas chromatograph analyses. Only the field data and temperature readings will be presented.

Results and Discussion

The time peanuts were left in the windrow ranged from 100 to 260 hr (Table 1). Differences in field drying times were because of weather and scheduling for official work days. The peanut moisture content (whole pods placed in oven at 84 C for 60-72 hr) at combining ranged from 21.4 to 38.2% for the conventional windrows and 28.8 to 47.0% for the shaded windrows. The moisture content for peanuts from the shaded windrows averaged 7.3% higher than the peanuts from the conventional windrow. This higher moisture level is significant because of higher curing costs needed to lower the moisture content of these peanuts for safe storage. If the peanuts are left in the windrow for a longer period to complete drying, then the risk of weather damage is increased. The slower windrow drying for the peanuts in the shaded windrow would make this windrow method unacceptable to growers in humid or cooler growing regions.

Peanuts in these studies were dug late in the normal harvesting seasons when the forecast was for frost or freeze damage. The air and individual peanut temperatures were plotted for each of the six tests. Tests 4, 5, and 6 (not shown) experienced air temperatures between the extremes of the tests 1, 2, and 3 (Fig. 1). These air temperatures were for short durations and did not adversely affect quality. Studies in 1967-1969 (USDA, 1969) indicated peanut temperatures in conventional (inverted) windrows for the normal harvest season never exceeded 40 C.

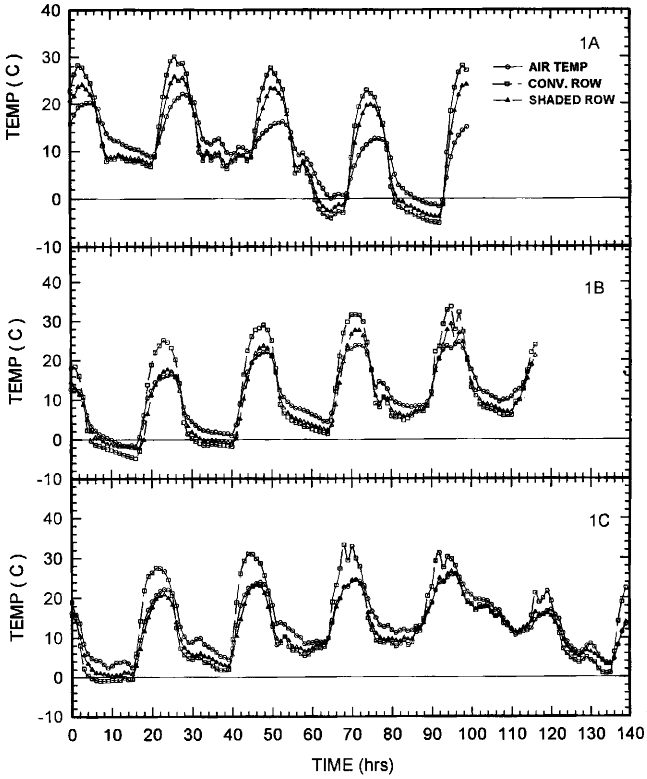

Fig. 1. Ambient temperature and peanut temperatures for the conventional and shaded windrows measured during the windrow curing for tests 1 (1A), 2 (1B) and 3 (1C) in 1988.

The peanut temperatures in the conventional windrow fluctuated over a greater range than the peanut temperature in the shaded windrow (Fig. 1). That is, the temperatures in the conventional windrow were higher during the day and lower during the night. In test 1 (Fig. 1A), the peanut temperature in both windrows dropped below freezing on the third and fourth night after digging. In test 2 (Fig. 1B), the peanuts were exposed to temperatures below 4 C the first and the sixth nights after digging. Peanuts in test 2 were directly exposed to the coldest temperatures for a 10-hr period following the digging operation. These peanuts were at a high moisture content and exposed to a heavy frost. In general, the peanut moisture content at the time of exposure and the duration of exposure to the cold temperatures influenced the severity of damage.

For the windrow period from 12 to 5 p.m. each day, the "average" maximum (Av_{max}) peanut temperature in the conventional windrow ranged from 1.3 to 5.9 C higher than the peanut temperature in the shaded windrow. The mean difference was 3.7 C higher (Table 2). From 2 to 7 a.m., the "average" minimum (Av_{min}) peanut temperature in the conventional windrow ranged 0.6 to 1.8 C lower than peanuts in the shaded windrow. The mean difference was 1.1 C lower (Table 2). The higher temperature of the peanut in the conventional windrow was not above the recommended curing air temperature of 35 C maximum. The ambient conditions of temperature and relative humidity in the Virginia-Carolina production area was not high enough to cause quality deterioration. Extended wet periods and freezing conditions caused the greatest quality problems during harvesting.

Table 2. Average maximum and average minimum peanut temperature for the conventional and shaded windrows in 1988 and 1989.

Test no.	Test year	Av_{max} temp.[a] Conv.	Shaded	Diff.	Av_{min} temp.[a] Conv.	Shaded	Diff.
		------C------			------C------		
1	1988	25.3	22.2	+3.1	1.9	3.1	-2.1
2	1988	31.1	26.6	+4.5	0.7	1.8	-1.1
3	1988	27.2	21.3	+5.9	5.6	6.9	-1.3
4	1988	20.9	16.4	+4.5	7.0	7.9	-0.9
5	1989	24.3	21.0	+3.3	6.9	8.8	-1.8
6	1989	19.4	18.1	+1.3	6.7	7.3	-0.6

[a]Av_{max} temp. is for the time 12 - 5 p.m., and Av_{min} temp. for the time 2-7 a.m.

All the peanuts in tests 1, 2, 3, and 4 were evaluated with the alcohol headspace volatile meter (Dickens *et al.*, 1987; Young, 1989). Only samples from the conventional windrow in test 2 gave readings greater than 25%, or the rejection level for freeze damage. Although the minimum temperature of peanuts in the shaded windrow was only slightly above the temperature in the conventional windrow, some protection was provided by the shaded windrow. This suggested that frost or freeze damage may occur at a critical temperature and exposure duration.

Samples of peanuts from all tests were sent to the South. Reg. Res. Ctr. for sensory and gas chromatograph analyses (Crippen *et al.*, 1989; Lovegren *et al.*, 1989). The shaded windrow type showed less severe freeze damage, more potential to preserve the development of the roasted peanutty flavor, and less potential for off-flavor development compared to the conventional windrow type (Crippen *et al.*, 1989; Lovegren *et al.*, 1989).

General recommendations of the NC and VA Extension Service are that peanuts should not be dug on a day when frost or freezing temperatures are predicted for the next three or four nights. Although not proven scientifically, peanuts at moisture contents lower than 30% are apparently not severely damaged by 0 C temperature for a short duration (A. H. Allison, pers. commun., 1985). Peanuts that are damaged by frost are often those that are smaller, less mature, and higher in moisture content than the average. Based on the above results, peanuts placed in conventional or shaded windrows for 3-d period prior to being subjected to adverse temperatures showed no quality deterioration at harvest.

For the Virginia-Carolina peanut production area, it was concluded that the freeze protection provided by the shaded windrow over the conventional windrow was minimal. Also, the slower rate of moisture decrease in the shaded windrow, and the subsequent increase in weather risk associated with windrow curing, make the shaded windrow method less acceptable compared to the conventional windrow method in humid growing regions.

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