

Effects of Weather Conditions on Sunburn in Stalk Curing of Burley Tobacco

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ABSTRACTS : The effects of stalk cutting time and environmental factors such as air temperature, leaf temperature, solar radiation and leaf moisture content during harvesting and curing in burley tobacco (*Nicotiana tabacum* L.) on weight loss of fresh stalks and sunburning in leaves were investigated at Chonju Experiment Station, Korea Ginseng & Tobacco Research Institute in 1996 and 1997. Twelve to fifteen percent of the fresh weight was lost in 3 to 4 hours after stalk-cutting, and sunburned leaves could be observed in case of stalk cutting between 11:00 and 15:00 O'clock on a clear sunny day, when the air temperature was 34 to 35°C, leaf temperature 52 to 54°C, and solar radiation 700 to 940 w/m². The leaves exposed to this weather condition were sunburned within 1 hour after stalk cutting. But low temperature (below 25°C) with high solar radiation (above 700w/m²) or high temperature (above 30°C) with low solar radiation (below 600w/m²) did not induce the sunburn damage in leaves. As the leaf temperature and leaf moisture content were higher, the sunburned leaves increased. The leaves at the higher stalk position were more easily sunburned than those at the lower. This result indicates that the immature leaves with higher chlorophyll content might be more susceptible to sunburning.

Key words : *Nicotiana tabacum*, Stalk curing, Percent sunburned leaves

In Korea, burley tobacco has reached 7,400ha in cultivation area and 20,000 metric tons of cured leaves are expected to be produced this year. The harvesting and curing process of burley tobacco is carried out in very hot, rainy and wet season. Priming has been a major harvesting method of burley tobacco in Korea. Recently, the stalk curing method has been recommended to the farmers who cultivate burley tobacco in field area over 0.7ha, and approximately 20% of burley tobacco yield is stalk-cured. The stalk curing process in Korea is a little different from that in the United States (Massie & Smiley, 1974. Nutt

et al, 1991. USDA, 1979. Walton *et al*, 1991. Yoder, 1970). The lower leaves (3 to 6 leaves) from the ground are primed from the stalk and threaded on a string, then strung in the curing facility made of iron-pipe and covered with vinyl sheets. The rest leaves are stalk-cured in the curing facilities in which stalks are hung vertically or horizontally. Before transporting the stalks from tobacco field to the curing facility, the cut stalks are laid down on the ground until the weight loss of the stalks reaches about 15% of the original weight.

In the United States, the cut stalks are left

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on the field ground for several days in order to induce wilting in leaves. The wilting process has many advantages (Smiley & Palmer, 1990). It makes the stalks lighter and easier to house. The wilted leaves are less brittle, so lead to less leaf loss and bruising, and the wilted leaves are better for curing process. More tobacco can be put in the barn. But sometimes sunburn occurs easily during wilting and causes the lower leaf quality. When air temperature is over 90°F (32°C) on a sunny day, leaves are sunburned so easily that the cut tobacco must be moved to curing barn as soon as the leaves wilt before sunburning (Tso, 1990). Smiley & Palmer (1990) also reported that tobacco should not be left on the field longer than 3 to 5 days for wilting, and the amount of wilting would be up to 20% less than fresh weight. Link (1972) also reported that there was a 16.6% reduction in green weight of tobacco left in the field for three days for wilting.

It is very difficult to leave tobacco for a few days after cutting on the field in Korea, because it rains quite often during tobacco harvesting season. Rain might wash soil onto the leaves, that causes the tobacco quality to be low. However, 12 to 15% weight loss of the fresh stalks without serious injury from sunburn is desirable for stalk curing in Korean weather condition.

This study was carried out to find out (1) the effect of stalk cutting time on weight loss of the fresh stalk in a day, (2) the relationship between weather conditions at the stalk cutting day and the percent sunburned leaves (PSL), (3) the effects of air temperature, moisture content of leaf on PSL, and (4) the effects of stalk positions on PSL.

MATERIALS AND METHODS

This study was carried out at Chonju Experiment Station, Korea Ginseng & Tobacco Research Institute in 1996 and 1997. KB 108 (*N. tabacum L. cv. burley*) was transplanted on April 15 and stalks were cut on 30 days or later after topping for the experimental treatments. The

cultural practices recommended for burley tobacco in Korea were used in this experiment.

To calculate the percent weight loss from original fresh weight during wilting, 20 stalks were cut and laid down on the field ground from 08:00 to 16:00 hours and the stalk was weighed every 1 hour after stalk cut. To find out the effects of weather conditions on percent sunburned leaves (PSL), air temperature (temp.), leaf temp. and amount of solar radiation were measured on 1) a clear sunny day, 2) on a sunny but relatively cool (low temperature) day and on 3) a cloudy but very hot day, respectively, by DataLogger with Pyranometer sensor (LI-COR, inc). PSLs were investigated in each of the three weather conditions in the field. PSLs were also checked in environmentally controlled chambers adjusted at 45, 50, 53 and 55°C with 85% relative humidity. PSLs were also investigated at different stalk positions.

RESULTS AND DISCUSSION

The percent weight losses (PWL) from the original weight of the stalk cut is shown in Table 1.

PWLs reached to 11 to 13% in 3 hours when stalks were cut down at 8:00, 9:00 or 15:00 on a clear sunny day. But 12% of PWL being reached in two hours when stalks being cut at 11:00 or 12:00. Smiley & Palmer (1990) reported that wilt occurs in a few hours if the weather is warm and dry, and PWL is up to 20% during 3

Table 1. Effects of stalk cutting time and wilting periods on percent fresh weight losses (PWL) of the cut stalks on a sunny day

Time of Stalk cutting (hrs)	Hours after stalk cut			
	1	2	3	4
	----- (% , PWL) -----			
08:00	3.1	6.5	10.6	15.3
09:00	5.5	8.7	13.8	16.5
11:00	8.2	12.8	16.2	19.0
12:00	8.3	12.2	16.7	18.6
15:00	7.6	9.5	11.4	12.5

to 5 days(Akehurst, 1981. Davis, 1991. Duncan *et al*, 1993. Gastobac Co., 1960).

To move the cut stalks more easily from tobacco field to curing facility, at least 12 to 15% of PWL is desirable. But it's very dangerous to leave cut stalks for 3 to 5 days on tobacco field for wilting, because it rains so often during stalk-cutting season in Korea. However, to get 12 to 15% of PWL, stalks might be left on field at least 3 to 4 hours regardless weather conditions.

The time of sunburned leaves being first observed at the different stalk cutting time on a sunny day are shown in Table 2.

Table 2. Time of the sunburned leaves being observed at different stalk cutting time

Time of stalk cutting	Time of sunburn observed ----- (hrs) -----
0800	11:00, same day
09:00	11:00, "
11:00	12:00, "
13:00	14:00, "
14:00	15:00, "
15:30	11:00, next day

When stalks were cut and laid down on field at 8:00 or 9:00, the sunburn was appeared from 11 o'clock in the morning. But in stalks cut during 11:00 to 14:00, the leaves were sunburned in one hour. In stalks cut at 15:30, sunburned leaves were observed at 11 o'clock next day morning. To prevent the leaves from sunburning, it is recommended that the stalks should not be cut from 11:00 to 14:00, especially on a hot clear day in Korean weather condition.

The changes in air temperature(temp.), leaf temp. and amount of solar radiation(SR) during daytime on a sunny day are shown in Figure 1. The sunburned leaves were observed from 11:00 to 15:00 on the same day.

The stalk-cut leaves are generally sunburned under the weather condition of 31°C or higher air temp. and 700 w/m² or more intensive SR. On a sunny day, the higher percent of leaves were

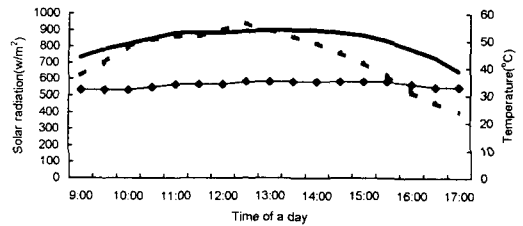


Fig. 1. Changes of air temperature, leaf temperature and amount of solar radiation during daytime on a clear sunny day(··· Amount of solar radiation, — Leaf temp., and ---◆--- Air temp.). Note : stalks were cut at 11:00 on a clear sunny day.

sunburned from 11:00 to 15:00. At the time span of a day, air temp. was 34 to 35°C, amount of SR 700 to 940 w/m², and leaf temp. 52 to 54°C, respectively. When stalks are cut before 11:00 or after 15:00 and left on the field until 12% of the fresh weight is lost, leaf sunburn may be avoided.

Changes of air temp., leaf temp. and amount of SR during daytime on a sunny but relatively cool day are shown in Figure 2. The sunburned leaves were not observed during daytime on a sunny but relatively lower air temp. day.

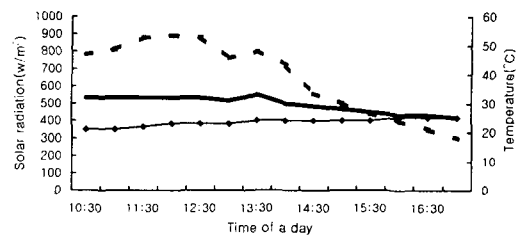


Fig. 2. Changes of air temperature, leaf temperature and amount of solar radiation during daytime on a sunny but lower temperature day (--- Amount of solar radiation, Leaf temp., and ◆--- Air temp.).

The amount of SR from 10:30 to 14:00 was very high as 700 to 900 w/m², but no sunburned leaves were observed. At the time span, air temp. was 21 to 24°C, and leaf temp. 30 to 33°C. It

suggests that the air temp. and leaf temp. was too low to sunburn the leaves, even though the amount of SR was very high.

Changes in air temp., leaf temp. and amount of SR during daytime on a slightly cloudy but very hot day are shown Figure 3. The sunburned leaves were not observed during daytime on a cloudy but hot day.

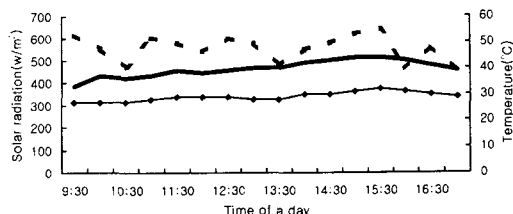


Fig. 3. Changes of air temperature, leaf temperature and amount of solar radiation during daytime on a slightly cloudy but very hot day (--- Amount of SL, Leaf temp., and ---◆--- Air temp.).

The cut stalks laid down on the ground for wilting did not show the sunburn symptom. Though air temp. and leaf temp. was above 30°C and above 44°C, respectively, the amount of SR was somewhat low(600 w/m²) to sunburn leaves during wilting period. It could be concluded that the sunburn during wilting period might not occur under air temp. of 25°C or lower. and SR of 600 w/m² or less.

The above results(Fig. 1-3) show that the sunburn was occurred on the field condition when the leaf temp. was 50°C or higher. In the envi-

Table 3. Effects of temperature on percent sunburned leaves(PSL) after different treatment period in the environmentally controlled chamber

Treated time (hrs)	Temperature (°C)			
	45	50	53	55
	----- (% , PSL) -----			
0.5	0	0	0	85
1.0	0	0	0	95
2.0	0	15	35	100

ronmentally controlled chamber(ECC), sunburn was also occurred at the temp. was 50°C or higher (Table 3). The sunburn was occurred faster at the higher temp., and PSL was higher at the higher temp.

These results from the ECC were similar to those from the field. To prevent the stalk from sunburning during wilting on the tobacco field, it could be recommended that the stalks should not be left on the field at the hottest time period around noon on a hot clear day.

The effects of leaf moisture content on PSL in the ECC adjusted at 53°C temp. and 85% relative humidity are shown in Table 4.

Table 4. Effects of leaf moisture content on percent sunburned leaves(PSL) after different treatment period in the environmentally controlled chamber

Treated time (hrs)	Moisture content of leaf (%)		
	89.7 ¹⁾	84.8 ²⁾	72.6 ³⁾
	----- (% , PSL) -----		
1.0	0	0	0
1.3	20	12	0
2.0	50	35	10

Note : air temp. was 53°C and stalk position of the treated leaves were leaf. The moisture content of leaves were ¹⁾at the state of saturation, ²⁾at harvest, and ³⁾after wilting on the tobacco field, respectively.

The higher the leaf moisture content was, the higher PSL, and the earlier sunburn occurred. This result indicates that if stalks are cut just soon after rainfall, when leaf moisture content is high, leaf sunburn may be more easily occur.

PSLs among leaves from different stalk position are shown in Table 5. PSL was highest at tips and lowest at lugs. It is considered that the mature leaves(lugs) may be less sunburned than the immature leaves(tips). Tips have more chlorophyll content and may absorb more light, thus be sunburned easily. The results suggest that PSL is also affected by the leaf maturity at stalk cutting.

Table. 5. Effect of stalk positions on percent sunburned leaves(PSL) at different wilting period after stalk cutting

Treated time (hrs)	Stalk position			
	Lugs	Cutters	Leaf	Tips
1.0	0	0	0	0
2.0	10	40	60	80
3.0	40	50	90	98

Note : Stalks were cut at 11:00 on a clear sunny day.

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