山形大学紀要（農学）第8巻，第2号，昭和54年2月
Bull. Yamagata Univ., Agr. Sic., Vol. 8, No. 2, Feb. 1979

Studies on Leaf Burn of Pear Trees

IX. Analysis of Promoting Factors in Development of Leaf Burn : Relationships between Leaf Burn, Daily Courses of Meteorological Variables, and Leaf Water Deficits

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(Received September 30, 1978)

Introduction

It has been in previous papers that the leaf burn of pear trees develops as a result of a rapid dehydration of leaves in dry weather just after a rainy season and that a dull closing action of the stomata was a main factor in the leaf burn development[1][11][12][13].

We think that several approaches should be studied to prevent leaf burn, including (1) clarifying and stopping the dull closing action of the stomata ; (2) converting from cultivars susceptible to leaf burn and stocks to ones resistant ; (3) spraying of antitranspirants ; (4) over head sprinkling and furrow irrigation ; and (5) discovering promoting factors of leaf burn.

The relative effectiveness of these approaches must be determined by more detailed investigations. Concerning promoting factors, especially climatic factors and soil moisture conditions, there are several studies[2][3][11]. Regarding leaf water deficits, KUMASHIRO et al. (1974) investigated the relation between affected areas and water saturation deficits (W. S. D.) of individual leaves[4]. In view of their results, leaf burn prevention requires appropriate controls of the air condition and of the soil moisture, especially of leaf water deficits. Because of the great difficulty in forecasting the appearance, degree, and site of leaf burn, and because of a wide range of W. S. D. in leaves of a single tree, it is important in practice to estimate mean W. S. D. of leaves in a tree and to determine a relation between degree of leaf burn and mean W. S. D. of leaves. Further, the authors think that leaf burn will result from a developing process of water deficits in a whole tree which has under gone physiological changes in air-tree-soil water relationships brought on by various changes in meteorological variables. Using regression analysis to estimate mean W. S. D. of leaves of 'Bartlett' trees, the present paper deals primarily with promoting factors of leaf burn in relationships among degree of leaf burn, changes in W. S. D. of leaves, and changes in environmental factors.

Materials and Methods

1. Materials used and meteorological elements.

Five 'Bartlett' pear trees, 23-year old, grown on the orchard of Faculty of Agriculture, Yamagata University, have been used from 1971 to measure W. S. D. and leaf burn. Meteorological factors were calculated from the recording data of the Meteorological Observatory of Faculty of Agriculture located about 50 meters from the orchard and of the Meteorofogical Observatory at Takasaka Agricultural Farm located about 5.5 km distant. Vapor pressure deficits (V. P. D.) were determined by conversion from air temperatures and relative humidities. Soil moisture tensions at 20 cm depth were measured 2 times per day with 8 tensionmeters buried in the orchard soil. Daily trends of soil moisture tensions were interpolated.

2. Measurements of W. S. D. of leaves.

To compare methods of measuring W. S. D., several leaves at lower parts of shoots were sampled several times from 7-year old potted 'Bartlett' pear trees which were well irrigated and exposed to severe dry air conditions in a glasshouse. They were then measured for leaf water potentials (Ψl) by the pressure chamber methods and for W. S. D. by 4 different methods. Further, conditions of measurement of W. S. D., namely, saturation temperature and its time course, were investigated by a polyurethane foam method.

3. A proportionate sampling for measurement of mean W. S. D. of leaves in a tree.

Using the results of a study of stratification of leaves in 'Bartlett' trees[9], the differences in W. S. D. of leaves or in leaf water potentials were compared among these stratified classes.

4. Multiple regression analyses.

For measurements of W. S. D. of leaves, 5, 27-year old 'Bartlett' pear trees were used in 1975. Each day from mid-May through early October leaf disks were taken from the trees by a proportionate sampling methods from 10 A. M. to 3 P. M., and W. S. D. was measured by the polyurethane foam method mentioned above. Multiple regressions to estimate mean W. S. D. of leaves in a tree were made with 15 independent variables of meteorological factors and of soil moisture tension as indicated in Table 1. In addition, W. S. D. s of leaves were measured in the nighttime for 8 days (n=50). Then, estimations of nocturnal W. S. D. were made using the model given in the daytime, and its residuals of estimations were calculated.

5. Measurements of degree of leaf burn per day.

Leaf burn in 5 secondary scaffold branches of the 5 'Bartlett' trees mentioned above were measured at 5 P. M. each day during summer in 1971, 1972, 1974 and 1975. Burned leaves were classified into 6 grades according to burned area in a

Table 1. The kinds of independent variables.

		units
y	: Mean water saturated deficits (W. S. D.) of leaves of 'Bartlett' pear trees	(%)
x_1	: Soil moisture tension at the time of W. S. D. measurement	(mmHg)
x_2	: Mean air temperature for 24 hours before the time of W. S. D. measurement	(°C)
x_3	: Mean air temperature for 8 hours before the time of W. S. D. measurement	(°C)
x_4	: Mean air temperature at the time of W. S. D. measurement	(°C)
x_5	: Total rainfall for 24 hours before the time of W. S. D. measurement	(mm)
x_6	: Mean wind velocity for 24 hours before the time of W. S. D. measurement	(m/s)
x_7	: Mean wind velocity for 8 hours before the time of W. S. D. measurement	(m/s)
x_8	: Mean wind velocity at the time of W. S. D. measurement	(m/s)
x_9	: Total sunshine hours for 24 hours before the time of W. S. D. measurement	(hrs.)
x_{10}	: Total sunshine hours for 8 hours before the time of W. S. D. measurement	(hrs.)
x_{11}	: Mean V. P. D. for 24 hours before the time of W. S. D. measurement	(mmHg)
x_{12}	: Mean V. P. D. for 8 hours before the time of W. S. D. measurement	(mmHg)
x_{13}	: Mean V. P. D. at the time of W. S. D. measurement	(mmHg)
x_{14}	: Mean solar radiation for 8 hours before the time of W. S. D. measurement	(ly $cm^{-2}hr.^{-1}$)
x_{15}	: Mean solar radiation at the time of W. S. D. measurement	(ly $cm^{-2}hr.^{-1}$)

leaf, namely 0, 0–one sixth, one sixth–one fourth, one fourth–one half, one half–three quaters and over three quaters. A total count was obtained for each grade. Multipling each count by a coefficient of the median of each grade and summing up, percentage of total burned area per day were calculated. The total numbers of observed leaves were 4507 in 1971, 5981 in 1972, 12048 in 1974 and 14995 in 1975. The total number of days for the 4 years was 132.

Results

1. Results of comparative studies of W. S. D. measurements.

Among the four measurement methods, immersion of leaf blade for 24 hours produced a higher W. S. D. against Ψl than the 3 methods, as shown in Fig. 1. Among the other 3 methods, results of both immersion of petiole-base for 24 hours and leaf disks in polyurethane foam for 4 hours were roughly similar. And W. S. D. from these two had larger correlation coefficients against Ψl than that from the fourth method, immersion of disks in water for 4 hours.

As shown in Fig. 2, in the polyurethane foam method leaf disks were fully saturated for about 4 hours, and few differences in saturation were found in a range of room temperature (20 - 25°C) throughout the experimental period.

2. Distributions of W. S. D. of leaves in a tree.

From the data of stratifing leaves in 'Bartlett' trees, the proportins of sampling leaves are summarized in Table 2. The effects of light type, kinds of shoots and positions in shoots on the W. S. D. of leaves are indicated in Table 3. The differences in W. S. D. or Ψl between direct sun light and both first and second scattering day light were apparently significant except on Sep. 16 (Table 3a).

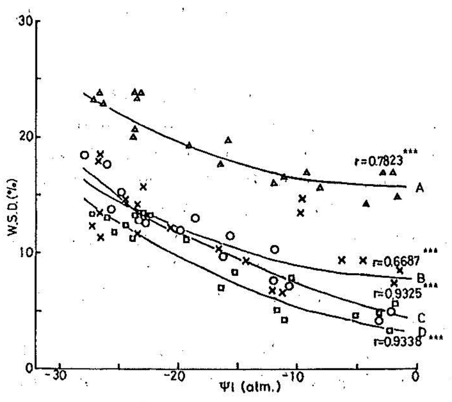

Fig. 1. Relations between W. S. D.s of leaves and leaf water potentials. Triangles, crosses, circles and squares indicate immersion of leaf blades in water for 24 hrs., immersion of leaf disks in water for 4 hrs., immersion with polyurethane foam of leaf disks for 4 hrs. and immersion of petiole bases in water for 24 hrs. respectively. and their coefficients of correlation against *Ψl* were 0.7823***, 0.6687***, 0.9325*** and 0.9338***, respectively.

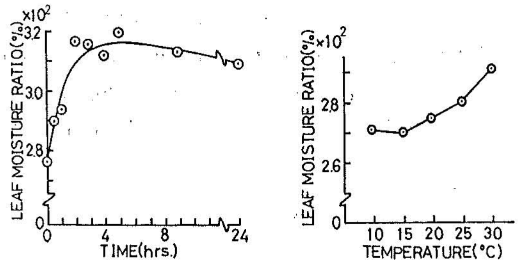

Fig. 2. Comparison of condition for measuring W. S. D. of leaves.

However, significant differences were not found among kinds of shoots and positions in shoots (Table 3b, c). Consequently, in sampling leaves, light type was adopted as the primary indicator in proportionate sampling, and the kind of shoots was used as a second indicator. That is, an effort was made to sample leaves in such way that the ratio of spur leaves to leaves on vegetative shoots was 6 : 4 ; leaves on vegetative shoots were restricted to the shoot base.

3. Results of multiple regression analyses.

Independent variables used are shown in Table 1, and the correlation matrixes among major variables and correlation coefficients between these variables and W. S. D. s are indicated in Table 4. In the present study, it was desirable to estimate mean W. S. D. of leaves as frequently as possible (for instance, mean W. S. D. at each hour), using only a few, simple variables. Results of multiple regressions with 3 and 5 variables are indicated in Table 4. The regressions were significant at 0.1 percent level by F-test. The estimations of noctural W. S. D.

Table 2. The proportions of the sampling leaves in relation to the light types in a tree crown, the kinds of the shoots and the positions in the shoots.

Periods of measurement	The light types: Direct sun light	First scattering light	Second scattering light
(1) June	5	2	3
(2) July	4	2	4
(3) August	3	2	5
	The kinds of the shoots: Spurs		Vegetative shoots
(1) (2) (3)	6		4
	The portions in the shoots: Basal	Middle	Terminal
(1) (2) (3)	1	1	1

Table 3 a. The effects of the light types in a tree crown on W. S. D. and Ψl of the leaves of 'Bartlett' pear trees.

Light types	Dates of the measurement: Jun. 24	Jul. 11	Sep. 16	Mean	Ψl Aug. 2
Direct sun light	16.34%	17.22%	19.34%	17.46%	−18.09 atm.
First scattering light	10.37**	15.52***	22.98***	15.95	−15.20***
Second scattering light	9.71**	9.92***	15.58*	12.29***	−12.08***

, * indicate significant with 1% and 0.1% level, respectively

Table 3 b. The effects of the kinds of shoots on W. S. D. and Ψl of the leaves of 'Bartlett' pear trees.

Kinds of shoot	Dates of the measurements: Jun. 24	Jul. 11	Sep. 16	Mean	Ψl Aug. 2
Spurs	14.20%	14.10%	19.27%	15.79	−15.03 atm.
Vegetative shoots	11.84	14.17	17.22	14.59	−16.53

Table 3 c. The effects of the position in the shoots on W. S. D. and Ψl of 'Bartlett' pear trees.

Positions in shoots	Dates of the measurements: Jun. 24	Jul. 11	Sep. 16	Mean	Ψl Aug. 2
Terminal	14.19%	13.99%	14.05%	14.07%	−16.41 atm.
Middle	10.27	15.02	19.31	15.57	−16.13
Basal	10.90	13.49	14.05	12.81	−16.94

Table 4. Coefficients of single correlation among variables and multiple regressions.

	x_1	x_3	x_4	x_5	x_7	x_8	x_{10}	x_{12}	x_{13}	x_{14}	x_{15}
x_1	1.0000										
x_3	0.6999	1.0000									
x_4	0.7002	0.9490	1.0000								
x_5	−0.3187	−0.1308	−0.2136	1.0000							
x_7	−0.1630	−0.4716	−0.3594	0.2427	1.0000						
x_8	0.0292	−0.1035	−0.1815	0.0694	0.7645	1.0000					
x_{10}	0.0194	0.2747	0.2297	−0.3103	−0.0201	0.0592	1.0000				
x_{12}	0.6966	0.7498	0.8022	−0.2995	−0.1516	0.0830	0.5943	1.0000			
x_{13}	0.6451	0.6605	0.6994	−0.2825	−0.3236	−0.1870	0.6184	0.8155	1.0000		
x_{14}	0.2745	0.2213	0.2487	−0.3057	−0.1151	−0.0037	0.7538	0.4998	0.5794	1.0000	
x_{15}	0.2623	0.1053	0.2397	−0.2973	−0.2245	0.0266	0.8360	0.4968	0.4680	0.8069	1.0000
y	0.5612***	0.6812***	0.6692***	−0.1004	−0.2575**	0.0655	0.4982***	0.7330***	0.7266***	0.3711***	0.3286***

	Coefficients of multiple correlation	Coefficient of determination	Variance ratio	n
3 element multiple correlation analysis	0.7362***	0.542	54.9	132
5 element multiple correlation analysis	0.7753***	0.601 (Residual=2.538)	38.3	132

$$y=0.0024\,x_1+0.2816\,x_4+0.2398\,x_7+0.3532\,x_{13}-0.0049\,x_{15}+2.2892$$

were made using the model with 5 variables in the daytime. And 3.280 percent of standard deviation of residuals of the estimations was obtained, which was larger than that in the daytime. Simple correlations between mean W. S. D. s measured and these variables are indicated in Fig. 3. There were high positive correlations

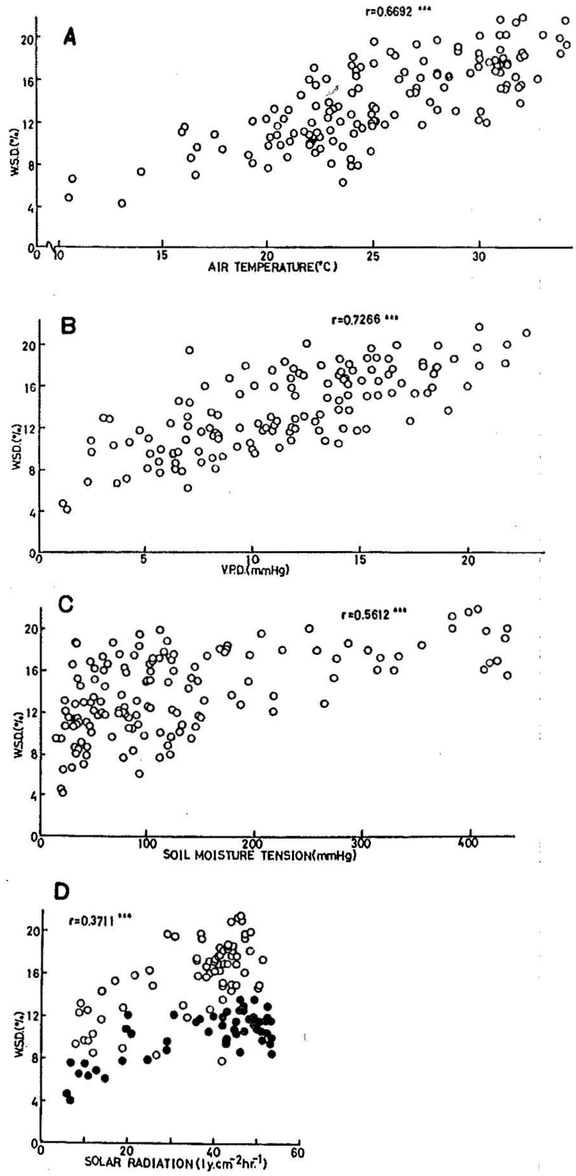

Fig. 3. Single correlations between mean W. S. D. s of leaves of 'Bartlett' and meteorological variables, where air temperature (A), V. P. D. (B), soil moisture tension (C) at the time of measurement, and solar radiation (D). In (D), solid circles indicate W. S. D. s before and during rainy season and open ones indicate W. S. D. s after the season.

Table 5. Coefficients of correlation between percentages of burned leaves per day in basis of leaf area and the representative meteorological variables.

year	1971	1972	1974	1975	Total
n	25	20	40	57	142
Daily mean air temperature (P. M. 6 ～P. M. 5)	0.6473***	0.4858*	0.1203	0.2411	0.2576**
Mean air temperature in the daytime (A. M. 5 ～P. M. 5)	0.6480***	0.4904*	0.3939**	0.2283	0.2589**
Daily maximum air temperature	0.6914***	0.4636*	0.3688*	0.1948	0.2408*
Daily mean VPD (P. M. 6 ～P. M. 5)	0.8327***	0.1660	−0.1291	0.1852	0.2932**
Mean VPD in the daytime (A. M. 5 ～P. M. 5)	0.7548***	0.2038	0.3406*	0.1734	0.2691**
Daily maximum VPD	0.7007***	0.1907	0.3353*	0.2017	0.2704**
Daily mean wind velocity (P. M. 6 ～P. M. 5)	0.6220***	0.2307*	0.0851	0.3262*	0.2717**
Mean wind velocity in the daytime (A. M. 5 ～P. M. 5)	0.5960**	0.2085*	0.0793	0.2523	0.2096*
Daily total solar radiation (A. M. 5 ～P. M. 7)	0.3847*	−0.3526	−0.0556	−0.2939*	−0.1089
Daily total rainfall (P. M. 6 ～P. M. 5)	−0.0028	0.0675	−0.0030	0.0359	0.0050
Total rainfall in the daytime (A. M. 5 ～P. M. 5)	−0.2663	−0.1907	0.0504	−0.0456	−0.0609
Daily soil moisture tension (P. M. 1)	0.4374*	−0.3512	−0.0051	0.0135	0.1261

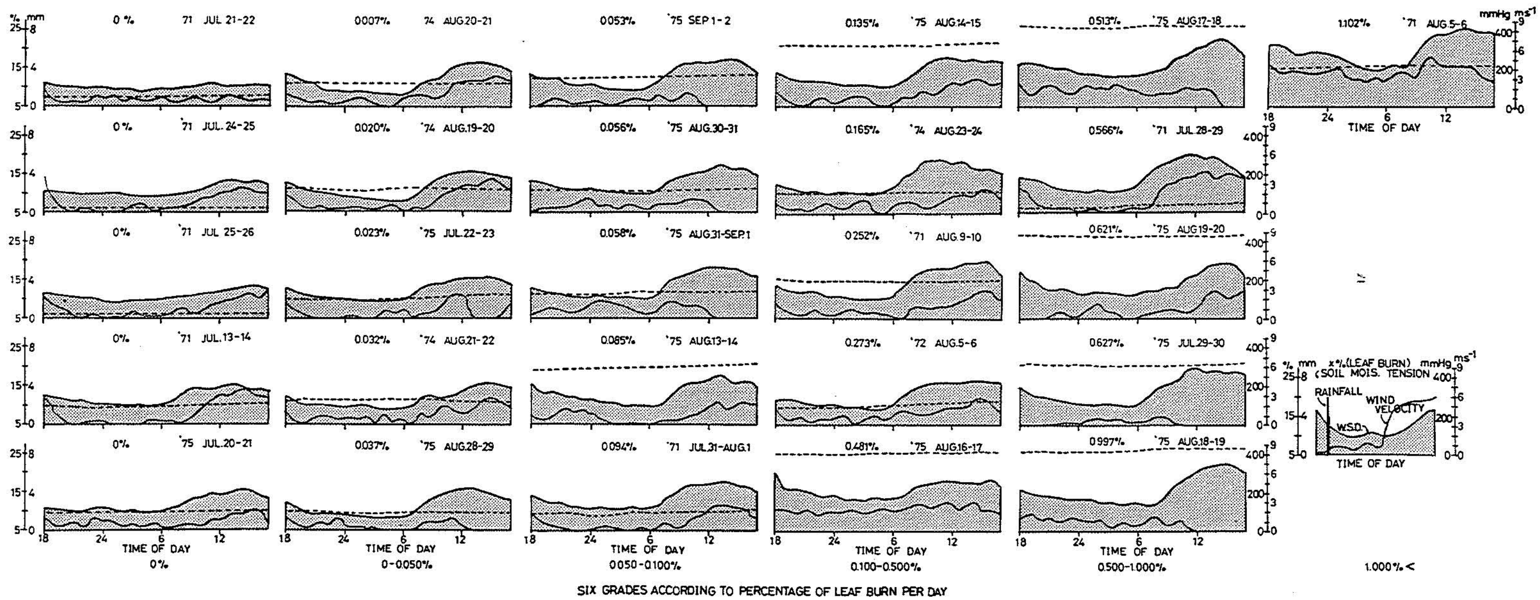

Fig. 4. The relations between percentage of leaf burn per day and daily course in W. S. D. estimated of 'Bartlett' pear trees in calm weather conditions. Solid and dotted lines indicte wind velocity and soil moisture tension, respectively. Further detailed, see a illustration at right in the figure.

with air temperature and V. P. D. at the time of the measurement, but mean W. S. D. s of leaves were separated into 2 groups in relation to solar radiation, as shown in Fig. 3-D ; one was data before and during the rainy season (mean air temperatures were below about 20℃), and the other was data after the season (mean air temperature were over about 20℃).

4. *Simple correlations between percentages of leaf burn per day and several representative meteorological elements for 4 years.*

Self correlation coefficients of percentages of leaf burn per day were small in relation to the percentages of a day before or two days before ($r_{k1}=0.1988$, $r_{k2}=0.1122$). Therefore, it seems that the degree of leaf burn development was closely related to the weather of that day. Then, simple correlation coefficients between percentages of leaf burn per day and several representative meteorological factors have been calculated and summarized in Table 5. In 1971 and 1972, correlations with air temperature group and humidity were relatively high, but almost all correlations were low in 1974 and 1975. For the 4 years period, all correlation coefficients were within ±0.3 for 142 data.

5. *The relations among percentages of leaf burn per day and levels (or durations) of mean W. S. D. s of leaves estimated in these days.*

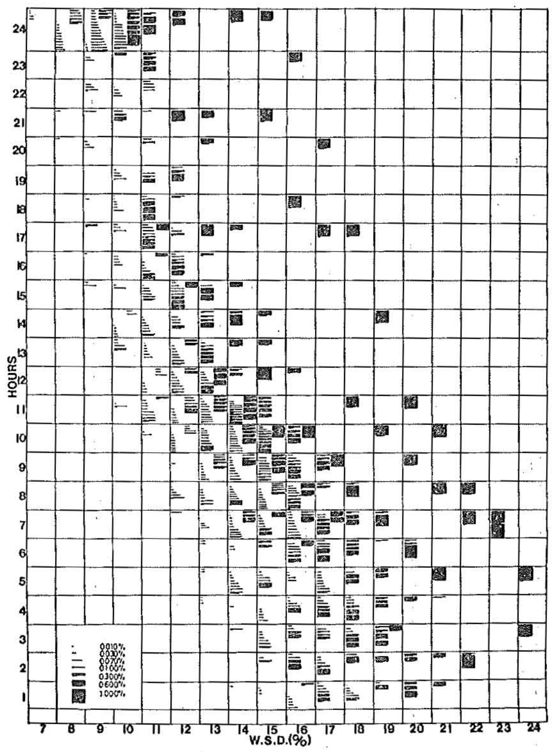

Fig. 5. The relations between percentage of leaf burn per day, levels of W. S. D. of leaves and its duration in hour of 'Bartlett' pear trees.

With 5 elements multiple regression, mean W. S. D. s of leaves every hour were calculated for 142 days for 4 years. Daily courses of mean W. S. D. were than estimated, 5 meteorological variables and soil moisture tension for all days were charted, and comparative studies were made among percentages of leaf burn, levels (or durations) of W. S. D. and meteorological variables. Several examples from the charts are indicated in Fig. 4 and 7. Leaf burn per day distributed from 0 to about 5 percent. Days with relatively calm weather conditions without rainfall or strong wind were classified into 6 grades according to percentages of leaf burn : 0, 0–0.05, 0.05–0.1, 0.1–0.5, 0.5–1 and above 1 percent (see Fig. 4). It was demonstrated that the higher the level of W. S. D. and the longer the duration of that level, the higher the percentage of leaf burn per day. Fig. 5 summarizes relationships among these 3 variables. It shows what percentage of leaf burn per day develop with what percentage of W. S. D. of leaves and with how long W. S. D. levels are maintained. By averaging each block in Fig. 5 and then drawing boundary lines of each grade of leaf burn percentage as shown in Fig. 6, it is clear that about 1 percent of leaf burn developed per day when a W. S. D. level of about 20 percent was maintained for about 10 hours ; there was no development of leaf burn below 15 percent W. S. D.. Several examples of days with changeable weathers were out of the relations and have been added to Fig. 6.

Further, data for exceptional days with strong wind and/or heavy rainfall are indicated in Fig. 7 in the same manner as Fig. 4. For example, on Aug. 4–5, 1974

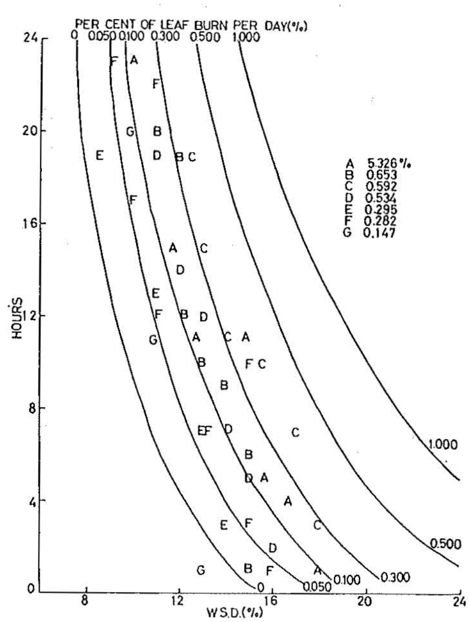

Fig. 6. The summarized relation among the three. Lines indicate boder-lines of each step of percent of leaf burn. A, B, C, D, E, F and G are exceptional examples.

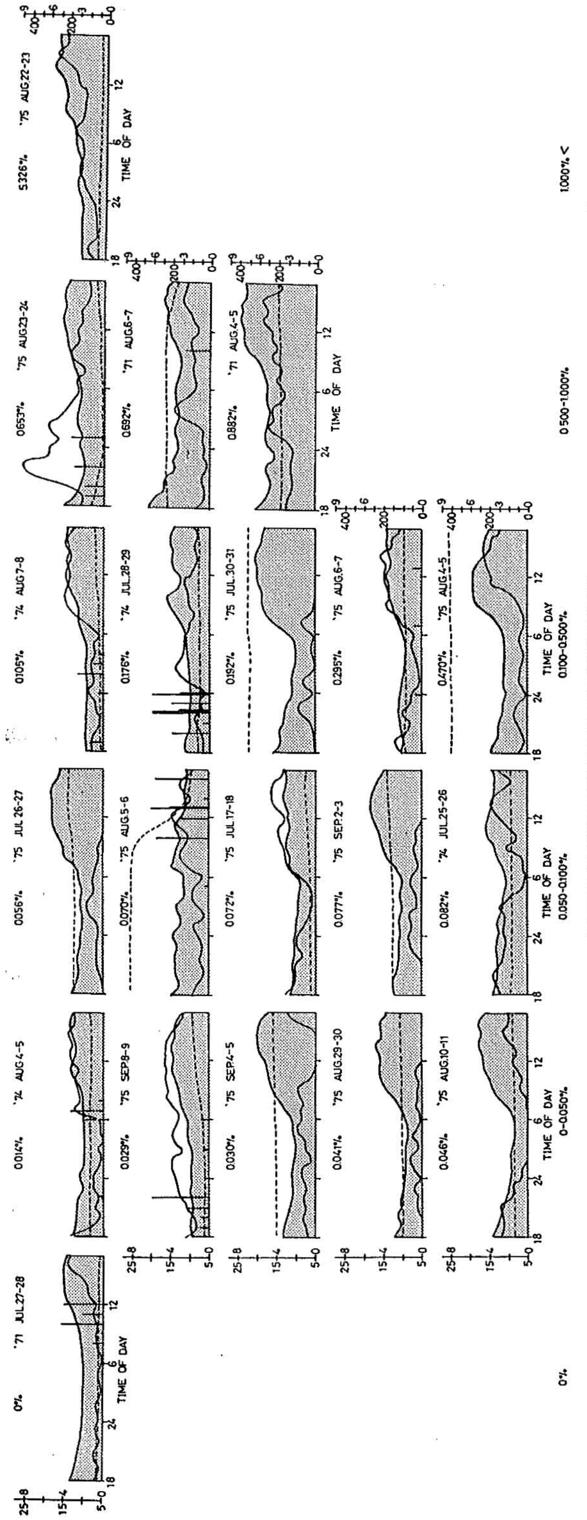

Fig. 7. The exceptional examples of the relation as shown in Fig. 4. See an illustration in Fig. 4 for lines and scales.

(0–0.05 percent grade), in spite of a lower level of estimated W. S. D. than in the same grade in Fig. 4, strong wind accelerated leaf burn (similarily on Jul. 17–18, 1975, and on Aug. 6–7, 1975). On the other hand, on Aug. 29–30, 1975, weak wind inhibited leaf burn in spite of a higher estimated W. S. D. than that in the same grade in Fig. 4 (similarily on Aug. 10–11, 1975, on Sep. 2–3, 1975, on Jul. 30–31, 1975, and on Aug. 6–7, 1971). As to rainfall, on Jul. 27–28, 1971, daytime rain inhibited leaf burn, but on Aug. 5–6, 1975, daytime rain accerelated leaf burn in spite of a lower estimated W. S. D. level than that for the same grade in Fig. 4 (similarily on Jul. 28–29, 1974 and Aug. 6–7, 1975). Examples of accerelation of leaf burn through the combination of strong wind and rainfall are Sep. 8–9, 1975, Aug. 7–8, 1974, and Aug. 23–24, 1975. These examples indicate that actual W. S. D. of leaves was not stable due to changes in solar radiation in cloudy weather, rainfall and strong winds in the daytime, compared to W. S. D. levels in calm weather conditions shown in Fig. 4. Effects of soil moisture tension on leaf burn were not clear in all grades of leaf burn as shown in both figures.

Apart from these general results, one unusual datum was an enormous development of leaf burn on Aug. 23–24, 1975 (see top right, Fig. 7). Leaf burn percent was about ten times greater than leaf burn at equivalent estimated W. S. D. levels in Fig. 4.

Discussion

It is evident that the type of light influences W. S. D. levels of leaves as shown in Table 3a. On a fine day in summer, illumination of direct sun light reaches over 100 klx., but that of scattering day light is around 6 klx. in 'Bartlett' pear trees. Therefore, large differences in water deficits of leaves were seen because of differences in leaf temperature and leaf transpiration rates. However, leaf burn does not necessarily develop in leaves exposed to direct sun light ; indeed it often does not develop. Other indicators of proportionate sampling are possible, for example, directions in a crown and inclination of angles of shoots. However, using too many indicators is inadvisable in practice.

The levels of W. S. D. of an individual burned leaf should be higher than mean W. S. D., but it is not possible to forecast that these leaves will burn. Therefore, it is important to find out relationships between leaf burn and any other predictors ; such relationships can help to control leaf burn. These relationships can be separated into two groups. One is the relation shown in Fig. 4 for calm weather conditions. It seems that representative values of W. S. D. of leaves or of meteorological variables (for example, a critical point of leaf W. S. D. or maximum air temperature), can not dicide simply the degree of leaf burn. This is because although relatively high W. S. D. or high air temperature can occur in a short time subsequent changes in weather conditions can restore water status from the stress within a day. These relations are demonstrated by the low correlations in Table 5. The second group is the relationship for the exceptional examples illustrated in Fig. 6. Its nature is not yet known fully. It is likely that wind and/or rainfall does not explain W. S. D. sufficiently in the multiple regression. The correlation between W. S. D. and wind velocity was very low, and the variance of W. S. D. in the range of wet soil was large (Fig. 3C). Rainfalls affects wet soil moisture conditions.

A leaf burn on Aug. 23–24, 1975 of the enormous degree seems to be a relation distinguished from above ones. There are other significant factors which are not contained in the model. In measuring leaf burn in the range of around 0.3 percent per day, it is very difficult to find burned leaves. In the range of 0.5 percent researchrs can have a sense of leaf burn development, but in the range of 5 percent, several hundred leaves will burn on a single scaffold branch per day. If leaf burn occurs on such a scale several times in a summer, almost all leaves on a tree will shed. Growers are quite afraid of such a leaf burn. No experiment has yet been done anywhere which deals with such large scale leaf burn.

From the characteristics on the chart on Aug. 23–24 in 1975, nothing was deduced, but by observing daily courses of mean W. S. D., meteorological variables, etc. in more detail, for the several days before Aug. 23, some further characteristics may be deduced. Some physiological changes in the water relationships in a whole tree could be uncovered from such analyses. Our investigation of promoting factors in such large scale leaf burn is continuing.

Summary

In order to prevent leaf burn in pear trees, it it important to find out and avoid those factors which promote leaf burn. In our experiments to test for such factors, proportionate sampling of leaves was first done to estimate mean W. S. D. because W. S. D. is not distributed uniformally in a tree. Then multiple regression analyses were made with several meteorological variables and the measured W. S. D. s (n=132). Further, comparisons were made among percentages of leaf burn per day for 4 years (n=142), daily courses of mean W. S. D. s of leaves estimated from the model, and other climatic conditions. The results may be summarized as follows.

Self correlations of leaf burn per day were low. Therefore, it seems that the degree of leaf burn development was closely related to the weather of that day. However, simple correlations between the percentages of burn and meteorological variables which were expressed in a form of 'mean' or 'extreme' values were low. Next, among the days with relatively calm weather without rainfall or strong wind, a relationship was observed among the percentages of leaf burn and daily courses of W. S. D. of leaves, namely, the higher the W. S. D. level and the longer the duration of that level, the higher the percentage of leaf burn per day. And,

it is clear from the relation among the three that about 1 percent of leaf burn developed with the duration for about 10 hours of a level of about 20 percent of W. S. D. per day ; no burn developed when W. S. D. was below 15 percent.

Further a few examples which did not follow this relation were seen on days of changeable weather with rainfall and/or strong wind. On these days, percentage of per day was higher than on days of relatively calm weather in spite of the same level and duration of estimated W. S. D.. Individual analyses were made for these days, and it is thought that these results show that insufficient explanatory weight has previously given to rainfall and strong wind in the model.

Finally, apparently distinct from these results, an enormous development of leaf burn was observed for a particular day, the scale of which was ten times above the average for 4 years. The cause of this is not clear from these analyses.

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西洋ナシの葉やけに関する研究（第9報）

葉やけ発生助長要因の解析，とくに葉内水分不足ならびに気象要因の経時変動との関係

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摘　　要

葉やけを防ぐ方策の一つとして，発生助長要因のは握とその回避が必要であり．具体的には葉水分の調節が考えられる．本研究では，樹体あたりの平均的 W. S. D. の推定方法として，不均一葉集団からの比例抽出法（採葉法）を検討し，さらにいくつかの気象要因，土壌水分などの独立変数と実測された葉の W. S. D. (n=132) を用い重回帰分析を実施した．得られた重回帰式を用い，4年間の葉やけ日発生率 (n=146) と毎日の推定平均 W.S.D. の経時変化，気象条件などを比較検討して，葉やけ発生の助長要因を解析した．その結果を要約すると次のとおりである．

4年間をとおして葉やけ日発生率の自己相関は低かったため，葉やけはその日の気象に深く関連していると思われたが，各気象要因の毎日の平均値，極値との相関には各調査年をつうじて一貫した傾向がみられず，4年間のそれは低かった．

次に推定 W. S. D. と日発生率とを比較してみると，降雨や強風のみられない比較的おだやかな日気象の時に限り，おおよそ共通したものがみられた．すなわち，W. S. D. が全体に上昇し，かつ高 W. S. D. が保持されている時間が長いと日発生率は増大していた．すなわち，この3者の関係から約20%の平均的葉 W. S. D. が1日のうち10時間以上あると1%以上の日発生率がみられ，1日のうち15%以上に W. S. D. が上昇しないと葉やけは発生しないことなどが察知された．

さらにこの関係からはずれる例もみられた．とくに，強風や降雨のみられる変りやすい天候の日では，その日の推定 W. S. D. のレベルが低いにもかかわらず，葉やけ発生はいくぶん多かった．この原因について例証的に解析したが，これらの気象要因が重回帰式に大きくとりこまれなかったことも原因の一つと考えられた．しかし，4年間の調査の中で平均日発生率の10数倍の規模の大量発生が1回観察されたが，その原因については，この解析では明らかにしえなかった．

正　誤　表

ペ　ー　ジ	誤	正
277 ページ下から 5 行目	under gone	undergone
278 ページ上から 7 行目	Meteorofogical	Meteorological
同　10行目	tensionmeter	tensiometer
同　下から 3 行目	scaffoId	scaffold
279 ページ下から 5 行目	proportins	proportions
285 ページ Fig. 4 タイトル	indicte	indicate
290 ページ上から 9 行目	distingished	distinguished
同　上から12行目	researchrs	researchers
291 ページ上から13行目	Literatured	Literatures
同　下から12行目	Goverment	Government