An Improved Measure of the Intensity of Blister Blight in the Field

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For economising on chemical control measures, for reducing residue levels of made tea and for screening of resistant clones, regular monitoring of blister blight infections in the field plays a very important role.

This paper discusses the practicality and the efficiency of using second-leaf-counts instead of the hitherto used, third-leaf-counts in assessing the intensity of disease in the field. Infected second leaf counts and the individual blister counts on the second leaf were both found to be more closely correlated and therefore more superior than the former, to the total blister count of a given shoot (bud+three).

It is suggested here, that a blister count of 0.065 per second leaf can be used as the criterion for testing efficacy of a given fungicide. Using infected-second-leaf, a revised economic threshold of 20% infections is recommended as against a 33%, using infected-third-leaf.

INTRODUCTION

Blister blight leaf disease of tea is caused by a virulent pathogen, *Exobasidium vexans* Massee (1898). This got introduced in South India a few months earlier than in Sri Lanka, in 1946, possibly from North India (Gadd & Loos, 1949). This has been the major disease, causing the highest impact by any single disease or pest on the economy of tea in Sri Lanka.

Blister blight is a disease favoured by high RH, low sunshine and misty weather conditions. During monsoon weather, the occurrence of disease is unavoidable and therefore, the main control measures are chemical.

In order to economise on control measures and more importantly, to maintain chemical residues to the lowest possible, judicious use of chemicals is advocated. The basic criterion is to adopt measures to control blister blight, when the level of infection is in excess of 33% (Webster & Park, 1956, Visser *et al.*, 1959).

Therefore, frequent assessments of the intensity of blister blight is of prime importance: to the researcher, because he has to, ever try out more economical and environmentally friendly methods of controlling this important disease; to the breeder, because he has to be assisted in selecting resistant cultivars from the Old Seedling Teas (OSTs) and for screening of numerous lines and to the grower, because he has to consider both, economics of chemical control and their likely residues.

The system of counting the infected-third-leaf for the intensity of blister blight in the field, dates back to 1950. For the best quality of product, tea bushes are to be plucked at 'bud+two' (Tubbs, 1949). But for practical considerations, when the plucking rounds get out of hand particularly during rush cropping periods, it would be necessary to accommodate 'bud+three' leaves. And it has become invariable to have a mixture of 'bud+two' and 'bud+three' -leaved shoots in the grower's basket.

In this context if one is to employ the present standard of estimation, i.e. Infected-third-leaf counts (Loos, 1950) of the disease, one has to either do a selective plucking or do a selection after plucking. This study attempted at reassessing the method of accounting for the infection level of blister blight with some certainty in which, the main objective was to screen a series of clones.

MATERIALS AND METHODS

Three existing phase three trials conducted by the Plant Breeding Division of the TRI were used as test material. These three trials included three estate clones, TRI 2025, TRI 2026 and other TRI clones of the 3000 and 4000 series.

The three estates/fields are Stockholm (replicated twice) (at 1310 m elevation; 6E46'N, 80E36'E), Sheen (replicated twice) (at 1150 m elevation; 7E00'N, 80E40'E) and Venture (one replicate) (at 1210 m elevation; 6E46'N, 80E37'E). These consisted of 25, 24 and 16 plots respectively.

Blister blight assessments were undertaken from August to October at weekly intervals, alternating among the three locations. From each clone/plot, 100 shoots with a bud plus three leaves were sampled selectively. The following counts were taken individually, on all 100 shoots; Number of 1st leaves, 2nd leaves and 3rd leaves infected, Number of individual blisters on 1st leaf, 2nd leaf and 3rd leaf.

All the values were pooled together as individual observations and each parameter was regressed with the total number of blisters on a shoot, because it was assumed that the number of blisters per shoot is a direct expression of the degree of its over-all susceptibility. The data were analysed using both 'SAS' and 'Genstat' statistical packages.

RESULTS

Infected leaf counts

Total number of leaves infected averaged 99, across the three estates, on four individual sampling dates. This represented a percentage of 33%, per leaf basis. Third-leaf-infected averaged a highest, 57% (57 out of 100 shoots) and the first-leaf-infected was at its lowest at 10%. The second-leaf-infected averaged, 32%, a value very close to the overall 33% (Table 1).

In Stockholm, Sheen and Venture Estates, exactly similar trends were seen, the highest percentage values of 3rd leaf-infected, at 67%, 53% and 50% and the lowest values of 1st leaf-infected, at 15%, 7% and 8% respectively. The 2nd leaf-infected at 43%, 25% and 25% closely followed the average leaf-infected at 42%, 30% and 27% (Table 1).

Table 1: Mean numbers of infected leaves in samples of 100 shoots (bud+3 leaves)

Location/Date	Infected leaf-1	Infected leaf-2	Infected leaf-3	Infected leaf - Total
Stockholm				
29/08	37±3.64	70±3.74	74±3.88	181±9.60
12/09	8±1.96	34±4.31	67±3.04	109±8.45
10/10	13±2.29	49±3.39	80±2.94	142±7.78
24/10	3±0.73	19±4.10	46±4.33	67±8.37
Pooled	16±1.78	43±2.70	67±2.19	126±5.97
Sheen				
03/09	11±1.57	41±3.71	71±3.43	123±8.10
17/09	5±1.16	13± 1.90	35±3.27	53±5.65
08/10	7±1.06	31±2.94	73±3.23	111±6.58
22/10	4±1.12	14±2.78	33±4.22	52±7.43
Pooled	7±0.66	25±1.86	53±2.59	89±4.92
Venture				
05/09	7± 2.48	22±6.40	48±5.18	77±13.33
19/09	8±2.93	24±6.00	35±6.23	67±14.6
03/10	12± 2.40	40±4.70	75±4.38	127±10.55
17/10	4± 2.00	14±5.48	40±5.70	57±12.38
Pooled	8±1.26	25±3.00	50±3.25	82±7.05
Overall	10±0.8	32±1.56	57±1.56	99±3.63

Individual blister counts

Total number of blisters when averaged on individual leaves and collectively on all leaves (1st, 2nd and 3rd), followed almost a similar trend. The overall number of blisters per leaf averaged at 0.83, across the three estates, on four individual sampling dates. The highest was recorded at 1.47 blisters, on the 3rd leaf and the lowest at 0.22 on the first. The second leaf recorded an average of 0.81 blisters, a value very close to the overall 0.83 blisters per leaf (Table 2).

This same trend continued in Stockholm, Sheen and Venture Estates, as before. The highest individual blisters on the 3rd leaf, at 1.84, 1.30 and 1.17 and the lowest number of blisters at 0.36, 0.12 and 0.14 on the 1st leaf, respectively. Average number of blisters on the 2nd leaf at 1.22, 0.51 and 0.61 very closely followed the average number of blisters per leaf at 1.14, 0.64 and 0.64 (Table 2).

Table 2: Mean numbers of total blisters on individual leaves, in samples of 100 shoots (bud+3 leaves)

Location/Date	Leaf-1 Blisters	Leaf-2 Blisters	Leaf-3 Blisters	Total Blisters
Stockholm				
29/08	101±16.14	247±29.38	264±34.50	612±72.6
12/09	16±5.32	70±13.49	129± 15.10	214±32.47
10/10	22±3.78	120±14.86	230±29.41	371±46.02
24/10	4±1.20	46±15.47	111±27.55	161±43.41
Pooled	36±5.84	122±12.42	184±15.03	342±30.73
Sheen				
03/09	20±4.12	102±17.69	222±31.53	345±52.78
17/09	8±2.18	21±4.00	60± 8.73	89± 14.35
08/10	13±2.25	58±6.90	178± 16.33	248±22.77
22/10	6± 1.71	25±5.65	62± 11.35	93±17.71
Pooled	12±1.45	51±5.98	130±11.86	193±18.77
Venture				
05/09	13±5.65	51± 19.55	101± 19.40	165±43.53
19/09	19±7.78	71±25.83	89± 24.35	179±57.08
03/10	18±4.78	90± 23.20	184±27.13	292±35.78
17/10	7±3.95	33± 17.18	94±25.95	133±46.03
Pooled	14±2.84	61± 10.84	117±12.78	192±25.53
Overall	22±2.50	81±6.25	147±8.13	249±15.75

Data from all three estates, and from the four sampling dates were pooled together to regress the total number of blisters per shoot on all individual parameters separately and a correlation matrix was obtained (Table 3).

The highest coefficient of correlation of 0.962 was found between the 2nd leaf blisters and the total blisters. This was closely followed by 0.948, between the 3rd leaf blisters and the total. In the third place was the 2nd leaf-infected at 0.871. The correlation between 1st leaf infections and the total number of blisters per shoot remained lowest whether they were individual blister counts (0.589) or infected-leaf-counts (0.719). Whether it is the infected leaf count or the individual blisters per leaf, the total blister count assumed the highest dependability on 'second leaf' (Table 3).

Table 3: Correlation matrix using the total blisters and the individual parameters

1st leaf	1.000							
2nd leaf	0.818	1.000						
3rd leaf	0.545	0.799	1.000					
Tot. leaf	0.819	0.967	0.906	1.000				
Blister-1	0.927	0.705	0.436	0.706	1.000			
Blister-2	0.821	0.887	0.649	0.853	0.822	1.000		
Blister-3	0.596	0.796	0.775	0.818	0.564	0.868	1.000	
Blister-T	0.719	**0.871**	0.677	0.834	0.589	**0.962**	0.948	1.000
	1st leaf Infected	2nd leaf Infected	3rd leaf Infected	Tot.leaf Infected	Blisters 1st leaf	Blisters 2nd leaf	Blisters 3rd leaf	Blisters Total

Using same regression equations, the products of coefficients of correlation, the 't' statistics and the 'estimated Y' values were ranked for their superiority (Table 4). In all of them the superiority of relationship between blister count of second leaves and the total number on the shoot (1st place) to that of blister count of third leaves and the total (2nd place) was confirmed. Similarly, correlation between the infected-second-leaf and the total blisters on a shoot was far more superior (3rd place) to that between infected-third-leaf and the total blisters (6th place).

Table 4: Ranking of the parameters in their relationship with the total blister count of shoots, based on coefficient of correlation 'r', table 't' values and 's.e. of Y estimates', with 255 degrees of freedom

Versus	r =	rank	t =	rank	s.e.of estimated Y	rank
Infected 1st leaf	0.719	5	28.13	5	175.3	5
Infected 2nd leaf	0.871	3	42.90	3	123.8	3
Infected 3rd leaf	0.677	6	26.05	6	185.5	6
All infected leaves	0.834	4	37.54	4	139.0	4
Blister count on 1st leaf	0.589	7	22.79	7	203.7	7
Blister count on 2nd leaf	0.962	1	80.83	1	68.8	1
Blister count on 3rd leaf	0.948	2	68.84	2	80.2	2

*On the scale of 1 – 7 the parameters 'r' and 't' are from highest to the lowest and the s.e. of Y estimates, from the lowest to the highest.

DISCUSSION

Presently, in almost all disease assessment studies the infected-third-leaf is used as the primary criterion. Loos (1950) introduced this, for estimating efficacy of fungicides that were used in the control of the disease. He observed that an average of 0.5 blisters per third leaf would increase the spore population in the air to an enormous extent and therefore, associated with it a high inoculum potential. He further suggested that for any fungicide to be effective, it should be capable of keeping blister average per third leaf, below 0.1. However, the present study suggests that both, individual blisters on the second leaf and the second-infected-leaf counts are superior in their relationship to overall susceptibility, to the individual blisters on the third leaf and the third-infected-leaf counts. Therefore, using the regression equation;

$$Y = m X + C \text{ (using zero intercept)}$$

$$Y = 1.75 \times (.1 \times 100) + 0 \quad (1)$$

$$= 17.5$$

$$17.5 = 2.71X + 0 \quad (2)$$

$$X = 7.5/2.71$$

$$= 6.45 \text{ (for 100 second leaves)}$$

$$= 6.45/100$$

$$= 0.065 \text{ (blisters per second leaf)}$$

Therefore, for an effective controlling programme, we should aim at maintaining the blister count in the second leaf, less than **0.065**. This can be used to measure the efficacy of a given fungicide on its ability to control the disease in future.

Based on 3rd leaf-infected counts, Webster and Park (1956) considered that, achieving a 35% infection level is satisfactory control in commercial scale. Visser *et al.*, (1959), discussing the effect of sunshine on blister incidence considered a range from 30-35% being reasonable levels of control. On many occasions using third-leaf-infected counts, an intensity of 35% infection level was considered as the cut-off point. Therefore, it is assumed here, an infection level of 33% being a reasonable target. Using this as the basis and the regression equation;

$$Y = m X + C \text{ (using zero intercept)}$$
$$Y = 4.81 \times 33 + 0 \qquad (3)$$
$$= 158.73$$

$$158.73 = 8.22 \times X + 0 \qquad (4)$$
$$X = 158.73/8.22$$
$$= 19.3 \text{ (out of 100 shoots)}$$

Therefore, using second-leaf-infected counts in the field, the economic threshold level could be regarded as an approximate 20 out of 100 shoots, hence 20%. De Silva (1967a) made a somewhat similar observation in which 50% infection of blister blight, based on 3rd leaf count was comparable with a 25% field infection, counting infected 2nd leaves. Without mentioning the leaf used for counting, De Silva (1967b) presented a general guidance to the planter in the field, on the severity of disease. He regarded the blister infections exceeding 20% to be high, infections from 5-20% as moderate and anything below 5% as low. But it appears that he meant the 3rd leaf-counts. If we are to follow the second-leaf-infected counts, we should therefore be able to use the same yardstick, in identifying fields with different intensities of infections with more relevance. This will also allow the grower more flexibility in his pick from the basket, because now he can select any 100 shoots, at random and count those infected second leaves and decide the intensity of disease on the spot, in percentile terms.

CONCLUSIONS

I. It is safer to use both 2nd leaf-infected and 2nd leaf-blister counts in the assessment of blister blight infections in plucking fields.

II. It would be more reliable to use 2nd leaf-infected than the 3rd leaf-infected and similarly 2nd leaf-blister counts than the 3rd leaf-blister counts.

III. Besides being more reliable, use of second-leaf-infections for all practical situations would prove to be more convenient.

IV. Second-leaf-blister counts (rank-1) could be used in determining fungicide efficacy in field trials.

V. Third-leaf-blister counts (rank-2) could be used in phase-I trials aiming at quick assessments of intact leaves (where a fewer number of plants are available in each plot).

VI. Second-leaf-infected counts (rank-3) would be most suited for the assessment of phase-II and phase-III trials and for general field assessments of the planter (where large numbers have to be handled).

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REFERENCES

De Silva R L 1967a A new look at the economics of blister blight control. Tea Quart. 38(3), 282-286.

De Silva R L 1967b. The economics of blister blight control. Tea Quart. 38(3), 336-337.

Gadd G H 1949 Nutrition in relation to disease. Tea Quart. 20, 10-18.

Gadd G H and Loos C A 1949 The fungus *Exobasidium vexans*. Tea Quart. 20, 54-61.

Loos C A 1950 Studies in Blister Blight control. II - Preliminary results of tests with fungicides. Tea Quart. 21, 13-26.

Massee G 1898 Tea Blights. Kew Bulletin 109-111.

Tubbs F R 1949 Plucking standards. Tea Quart. 20, 85-93.

Visser T, Shanmuganathan N and Mulder D 1959 The possibility of timing blister blight spraying according to sunshine records. Tea Quart. 30(I), 39-43.

Webste B N and Park P O 1956 Developments in blister blight control - I. Introduction to the 1955 series of blister blight control experiments. Tea Quart. 27(I&II), 3-6.