Tolerable injury level and control threshold of the anthracnose, *Colletotrichum theae-sinensis* Miyake et al., on tea crop.

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Summary

Tolerable injury level and control threshold of the Anthracnose, *Colletotrichum theae-sinensis* Miyake et al., on tea fields in which third crop of tea is not plucked were evaluated. Occurrence of the disease on leaves of third crop of tea in the previous year influenced the yield of first and second plucked tea, the yield decreased with the injury level on third crop of tea leaves. Relationship between the yield of first plucked tea and the number of diseased leaves of third tea in the previous year was described by non-linear regression, and the point of 5 % yield decrease was about 1100 diseased leaves per m^2. Positive correlation ship was recognized between the number of diseased leaves of third tea and the number of diseased leaves left after second crop of tea was plucked, and the model by Nicholson and Bailey (1935) was applied to this relationship. It was suggested that the number of diseased leaves left after second crop of tea was plucked is able to be used as the index for decision making of control against the Anthracnose in third tea season.

Keywords

Disease, Tolerable injury level, Control threshold, Anthracnose, Colletotrichum theae-sinensis

Introduction

The Anthracnose, *Colletotrichum theae-sinensis* Miyake et al., is one of the most important diseases on tea crop in Japan, especially on the sensitive cultivar "Yabukita." which is the most popular in Japan. Tea leaves infected with this disease are fallen and tree vigour of the tea crop diseased severely fail. The length of incubation period of the Anthracnose is about three weeks, and consequently quality of plucked tea leaves are not influenced by the occurrence of this disease usually. But on tea fields where third tea is not plucked, which is usual system in tea cultivation in Shizuoka prefecture, the effects of the Anthracnose occurrence in the previous year on the yield of first and second crop of tea have not been clear so far.

We investigated the relationship between the yield of first and second crop of tea and the disease severity in the previous year, and studied tolerable injury level and control threshold of the Anthracnose further.

Materials and Methods

1. Effects of tea season the disease occurs on yield

Six plots in which treatment of either occurrence of the disease or control by fungicide was applied in each season of second tea, third tea and forth tea were established on tea fields of Shizuoka tea experiment station in 1999 (Table 1). Area per plot was 5.8 m^2 and three repetitions were applied. In 2000 first tea in the beginning of May and second tea in the end of June were plucked by a rail-tracking plucking machine and the weight of plucked tea leaves were measured on the plucking day, and effects of the disease occurrence in each tea season in the previous year on the yield were statistically evaluated

by ANOVA.

2. Effects of the disease severity in third tea season on the yield

Various levels of disease severity were established by inoculation of pathogenic fungus and chemical control in third tea season on tea fields of Shizuoka tea experiment station in 1999. Area per plot was 7.2 m^2 and 24 plots were assigned. In 2000 first tea in the beginning of May and second tea in the end of June were plucked by a rail-tracking plucking machine and the weight of plucked tea were measured, and the relationships between the disease severity in the previous year and yields were investigated.

3. Effects of the disease severity in second tea season on the disease severity in third tea season

Infection source in third tea season was diseased leaves left on plucking surface after second tea plucked. Various levels of the disease severity were established in second tea season by inoculation of pathogenic fungus and chemical control on tea fields of Shizuoka tea experiment station. The number of diseased leaves left on plucking surface of second tea and the number of diseased leaves on third tea per plot was examined in the middle of July and in the end of October respectively, and the relationship between the number of diseased leaves on plucking surface of second tea and those on third tea was evaluated. Area per plot was 7.2 m^2 and 18 plots were assigned. These experiments were done twice in 1999 and 2000.

Results and Discussion

1. Effects of tea season the disease occurs on yield

Table 1. Treatments on each plot in the previous year and the yield of first and second tea (mean±SE)

Plot	The disease occurrence in tea seasons[a]			First crop of tea			Second crop of tea
No.	Second	Third	Fourth	weight of plucked new shoots / m^2	No. of plucked new shoots / frame[b]	Rate of banjhi shoot	weight of plucked new shoots / m^2
1	×	×	×	0.57 ± 0.04 kg	54.9 ± 2.6	20.1 ± 1.7 %	0.81 ± 0.06 kg
2	○	×	×	0.55 ± 0.04	64.3 ± 1.8	21.9 ± 3.0	0.84 ± 0.02
3	○	×	○	0.56 ± 0.02	60.7 ± 3.3	17.0 ± 1.6	0.69 ± 0.03
4	×	○	×	0.36 ± 0.07	48.6 ± 3.9	40.3 ± 2.2	0.53 ± 0.02
5	×	○	N	0.23 ± 0.03	42.1 ± 4.7	49.5 ± 4.0	0.38 ± 0.03
6	○	○	N	0.28 ± 0.02	39.9 ± 4.8	47.2 ± 5.9	0.39 ± 0.03

[a] ×: chemical control, ○: inoculation of pathogen, N: no treatment

[b] 20 × 20 cm

Table 2. The results of analysis by two-way layout ANOVA

Independent factors (treatments)		First crop of tea: weight of plucked new shoots / m^2	First crop of tea: No. of plucked new shoots / frame	First crop of tea: Rate of banjhi shoot	Second crop of tea: weight of plucked new shoots / m^2
Second tea season	F (1,14)	0.16	0.12	0.04	1.66
	p	0.69	0.74	0.85	0.22
Third tea season	F (1,14)	51.95	25.51	68.75	68.22
	p	<0.0001	0.0002	<0.0001	<0.0001
Second × third	F (1,14)	0.006	4.20	0.23	0.04
	p	0.94	0.06	0.64	0.84

Data on the yield of first and second crops of tea on each plots are shown in Table 1. The weight of first and second tea was not significant different between the plots in which the disease was controlled

in fourth tea season and ones in which the disease was not controlled (e.g. plots 2 and 3, $p > 0.05$, Scheffe's multiple comparison). Therefore, the presence of the disease occurrence in second tea and third tea season was treated as independent factors, and yield data were analyzed by two-way layout ANOVA (Table 2). The results suggest that the presence of the disease occurrence in third tea season in the previous year influences the yield, while that in second tea season dose not influence.

2. Effects of the disease severity in third tea season on the yield

The relationship between the number of diseased leaves in third tea season in the previous year and the weight of plucked leaves was shown in Fig. 1. The yield of both first and second tea decreased with the number of diseased third tea leaves, and the yield decreased rapidly in case of more than about 1000 diseased leaves. In case of first tea crop of which relationship between the yield and the disease severity was more clear, a model of non-linear regression was applied on the relationship between the diseased leaves per m^2 (x) and the weight per m^2 (y), the equation $y = 0.716-0.0233\exp(0.000803x)$ was derived ($r=0.927$). Subsequently the relationship between the diseased leaves per m^2 (x) and the rate of yield decrease % (y) was expressed as the equation, $y = 100\,[0.693-\{0.716-0.0233[\exp(0.000803x)]\}] / 0.693$ (Fig. 2), according to the derived equation. Consequently the point on 5 % of the yield decrease of first tea was about 1100 diseased leaves per m^2.

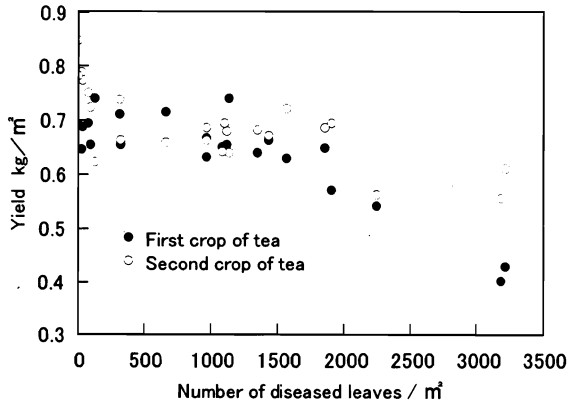

Fig.1 Relationship between number of diseased leaves on third crop of tea in the previous year and yield of tea

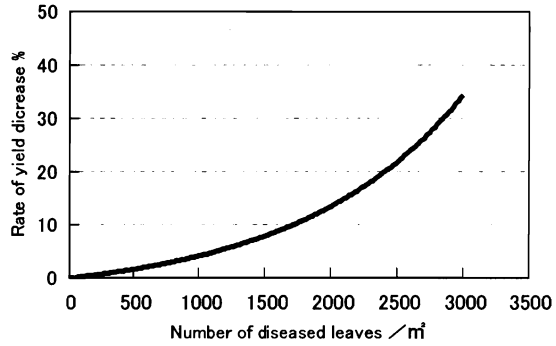

Fig. 2 Relationship between number of diseased leaves on third crop of tea in the previous year and rate of yield dicrease of first tea

3. Effects of the disease severity in second tea season on the disease severity in third tea season

Relationships between the number of diseased leaves left on plucked surface of second tea per m^2 and that on third tea leaves per m^2 were shown in Fig.3 and Fig. 4. The number of diseased leaves of third tea increased with the number of diseased leaves left on plucked surface of second tea, the coefficients of correlation (r) were 0.92 ($p<0.001$) in 1999 and 0.94 ($p<0.001$) in 2000. It is assumed that the number of infection chance obeys a Poisson distribution, because

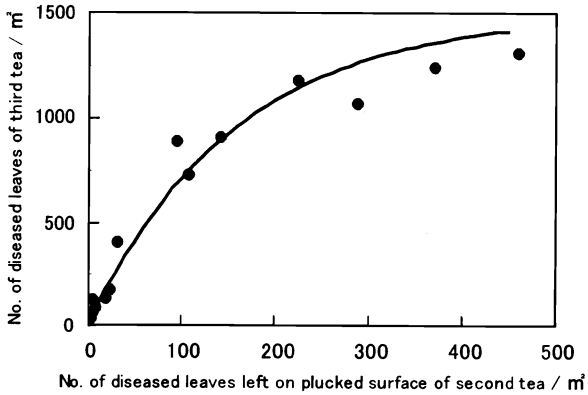

Fig. 3 Relationship between the number of diseased leaves left on plucked surface of second tea and the number of diseased leaves of third tea in 1999

conidiospore of the Anthracnose scatters on rain drops which hit on the lesion. Then, the model by Nicholson and Bailey (1935), $y = H[1\text{-}\exp(-ax)]$, was applied on the relationship between the number of diseased leaves left on plucked surface of second tea per m^2 (x) and the number of diseased leaves of third tea per m^2 (y). Here it is assumed that the number of leaves of third tea which are able to be infected (H) was 1500 per m^2. Consequently, the equations, $y = 1500[1\text{-}\exp(-0.0064x)]$, r=0.98 and $y = 1500[1\text{-}\exp(-0.0067x)]$, r=0.77, were derived from the data obtained in 1999 and 2000, respectively. These results suggest that the number of diseased leaves left after second crop of tea was plucked is able to be used as the index for decision making of control against the Anthracnose in third tea season.

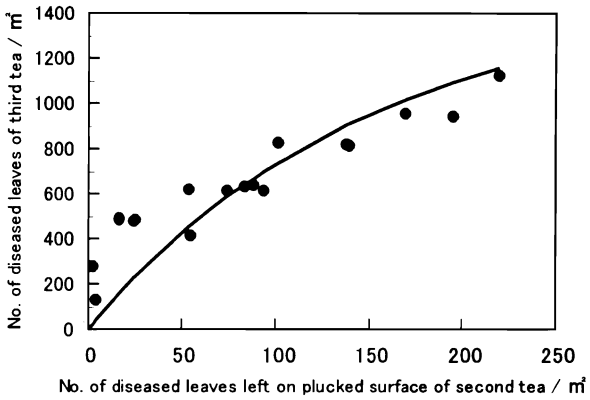

Fig. 4 Relationship between the number of diseased leaves left on plucked surface of second tea and the number of diseased leaves of third tea in 2000

However, the field in which this experiment were different from that in which foregoing experiment to make the effect of the disease severity on the yield clear was carried out, and then it has been conceivable that these derived equations is not able to be applied on many and unspecified tea fields for control threshold. Environmental conditions such as weather which can influence infection of the disease and numbers of tea leaves per unit area are different among tea fields. Including some parameters which express environmental conditions into the equations is necessary to establish control threshold of the Anthracnose in the future.