日本植物病理學會報

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桃炭疽病に對する耐病性品種の研究

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STUDIES ON THE VARIETAL RESISTANCE OF THE PEACH TO ARTIFICIAL INOCULATIONS WITH GLOEOSPORIUM LAETICOLOR BERK.

BY

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INTRODUCTION

The peach has been grown in Japan since ancient times, but not so common and plentiful as at the end of last century, when many good varieties were introduced from China and America. At the present time no country except the United States has so many peach trees as Japan. About ten years ago, however, peach growers were threatened by the sudden occurrence of anthracnose, *Gloeosporium laeticolor* Berk. The damage was so destructive as practically to annihilate the crop in large areas, and indeed, the earliest and most profitable varieties such as the Amsden June and the Alexander were so susceptible that they had to be eradicated soon afterwards. But the method of control is very difficult on account of the trouble of peach summer spraying, as is generally known. Suggested by FREEMAN'S¹ announcement, we have recently begun to select resistant varieties, that have good qualities and also early ripening character.

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Station, for their kind instructions. The writers are also much indebted to Mr. K. KAWAKAMI and T. NAKAJIMA in this institute. Again they wish to express their thanks for the liberality of the following experiment stations to submit many samples to be freely used. Imperial Agricultural Experiment Station (Okitsu), Kanagawa Ken Agricultural Experiment Station (Ninomiya), Okayama Ken Agricultural Experiment Station (Ijima), Chiba Ken Agricultural Experiment Station (Matsudo).

METHODS AND MATERIALS

Plants: Following 66 important varieties were inoculated.

1. Imperial	2. Improved Downton
3. Ijima	4. Royal George
5. Akamemomo (red bud peach)	6. Balgowan
7. Hakutô (white peach)	8. Wasesuimitsu (early peach)
9. Wasesakigake	10. Wasehakutô
11. Jitsugetsutô (Victor?)	12. Wheatland
13. Beniware (early red)	14. Doyô (Chinese Free)
15. Triumph	16. Champion
17. Rikaku (Chinese Free)	18. Oonishi
19. Osotogari	20. Waterloo
21. Oldmixon Free	22. Carman
23. Daitôryô	24. Tanakawase (Tanaka's early)
25. Tachibanawase	26. Taishôwase
27. Dante	28. Lemon Free
29. Lovell	30. Greensboro
31. Kugô (No. 9)	32. Grosse Mignonne
33. Mountain Rose	34. Matsubara
35. Briggs' May	36. Precoc de croncel
37. Fukase	38. Foster
39. Kobayashi	40. Connet Southern Early
41. Elberta	42. Denjûrô
43. Teushin (Tian-tsin)	44. Amsden June
45. Alexander	46. Early Newington

47. Early Rivers	48. Admiral Dewey
49. Asahinomihata	50. Asahi
51. Sangô (No. 3)	52. Sakigake (early)
53. Kikusuitô	54. Kintô
55. Muir	56. Sea Eagle
57. Shanhai (Chinese Cling)	58. Shinshûsuimitsu
59. Shinonome	60. Jûichigô (No. 11)
61. Bilyeu's Late	62. Victor
63. Sneed	64. Spenser
65. Switzerland	66. Amelia

These varieties are cultivated in the orchards of the Experiment Stations above mentioned. Generally two individuals for each variety are used. 4 series of inoculations are made on fruits, 2 series on leaves, 8 series on young branches (shoots). The young branches are the most convenient for many purposes, e. g. to get samples in the same conditions, and to measure the degree of the affected regions.

Fungus: I_a strain, isolated from the fruit of Triumph July 22, 1916 is used. There seems to exist neither biologic forms nor adaptation of fungi as mentioned afterwards. A number of culture media were tried to determine which was the most congenial; and the result showed that "Soy agar"² was the most congenial and favourable for all purposes. The fungi when used, the spores are suspended in sterilized water; one loopful of water (with 3 milimeter platinum loop) is put on an inoculation point.

Methods of inoculation: The point of inoculation is prepared with needles in the following ways: one thrust (1 mili-meter both in depth and width) on a fruit or a leaf, three thrusts (1 mili-meter both in depth and length, $\frac{1}{2}$ mili-meter in width) on a branch.* After inoculation they are to be covered with sacks made of paraffin paper; then some sterilized water is sprayed in the sacks when it is dry.

How to criticize the result: Affected spots or regions appear after about a

* When the inoculation is made without a thrust, the result is somewhat uncertain; and accordingly we usually made a thrust. It is very probable that the phenomena of resistance are not due to the physical structure of plants, but to the vital action of protoplasm or the biochemical effect of cell sap, as was shown by Ward, Marryat, and others.

week. Then the dimension of the spots or the regions are measured by millimeter. The average of the dimension thus measured is to be considered as showing the degree of susceptibility or the resistance of each variety.

INOCULATIONS

The virulence of the fungus in use had preliminarily been proved many times from May to June 1917, and then the inoculation experiments continued for three years. The results are shown in Table I.

Fruits of resistant varieties.

Tachibanawase.

Jitsugetsutō.

Table I. Results of Inoculations

No. of Exp.	Location	Date		Orchard	Number of Varieties	Number of Samples	Results		Remarks
		Inoculated	Measured Year				Resistant Vars.	Susceptible Vars.	
I	Leaf	June 7	June 14 1917	Okitsu	42	6 leaves	Denjûrô Carman Taishô-Wase	Loyal George Lemon Free Amsden June	Plants are generally three years old: Nos. 5, 15, 22, 42 are 7 years old.
II	Shoot	do.	do.	do.	do.	2 shoots	Taishô-Wase Tachibana-Wase Carman Denjûrô Victor Kintô Rikaku	Champion Imperial Lovell Precoco de croncel	do.
III	Leaf	do.	do.	do.	do.	Many leaves	Denjûrô Tenshin Shan-hai	Akanemomo Early Rivers Triumph	Spores are sprayed on leaves: results are criticized by the No. of leaves infected.
IV	Shoot	June 17	July 25 Aug. 2 9	Ninomiya	18	18 Shoots 6 being control	Tenshin Doyô Wase-Suimitsu	Admiral Dewey Briggs' May	Plants are generally ten years old: Nos. 11, 24, 25 and 26 are three years old.
V	Fruit	July 17 " 18	July 25 Aug. 2	do.	25	18 fruits 6 being control	Tenshin Rikaku Doyô Wase-suimitsu Carman	Bokhara Hikobet Foster Early Newington	Comparisons are made among varieties having nearly the same date of ripening. Fungus Ia strain is used.
VI	Shoot	June 2	June 22 1918	Okitsu	17	10 Shoots	Shan-hai Rikaku Kintô Carman	Pecoco de croncel Alexander Amsden June Early Rivers Triumph	Plants are four years old. Fungus Ia Strain is used.
VII	Shoot	July 5	July 13 " 20	Ninomiya	30	10 Shoots	Ijima Shan-hai Tachibana-Wase Shinonome Victor Jitsugetsutô Wase-Suimitsu Doyô Denjûrô Rikaku	Pecoco de Croncel Tanaka-wase Early Newington Waterloo Champion Foster Amsden June Briggs' May	Plants are generally ten years old: Nos. 3, 7, 11, 24, 25, 26, 37, 55, 57 and 59 are five years old.

VIII	Shoot	July 9	July 16	1918	Matsudo	16	10 Shoots	Rikaku Tenshin Doyô Greenboro Denjôrô	Asahinohata Amsden June Champion Triumph Early Rivers	Plants are generally ten years old: One plant for each variety.
IX	Fruit	June 15 July 2	when picked	do.	do.	15	15 fruits	Champion Beni-Wase Connet Southern Early Rikaku Doyô	Triumph Amsden June Grosse Mignonne Sakigake Amelia	Comparisons are made among early and late varieties.
X	Shoot	July 15	July 22	do.	Tachibana gun	10	10 Shoots	Wase-sunimitsu Denjôrô Rikaku Jitsugetsu-tô Doyô	Taishô-Wase Sakigake Sneed Tanaka-Wase	Plants are generally ten years old.
XI	Shoot	June 18	July 13	do.	Ijima	19	11 shoots, 1 being Control	Hakutô Daitôryô Wase-hakutô Doyô Carman	Sakigake Amsden June Taishô-Wase Tanaka-Wase	Plants are generally ten years old: a platinum needle was used for a thrust.
XII	Fruit (young)	May 22 " 30 June 5 " 7 " 16	when picked	do.	Ninomiya	21	24 Fruits 6 being control	Tenshin Shan-hai Doyô Jitsugetsu-tô Oku-go-gô Kintô Hakutô Daitôryô Tachibana-wase Carman Rikaku	Triumph Briggs' May Admiral Dewey Early Rivers Tanaka-Wase Amsden June	Plants are generally ten years old. Plants are classified to five groups as regard to their date of ripening. The varieties are inoculated on the day a month and a half before ripening.
XIII	Fruit (very young)	May 23	June 2	1919	Ninomiya	15	20 fruits	Tenshin Doyô Wase-Sunimitsu Rikaku Hakutô Tachibana-Wase Taishô-Wase Denjôrô	Briggs' May Muir Amsden June Triumph	Plants are generally ten years old. Fungus I strain is used.

DISCUSSION

There is no immune varieties among the 66 varieties inoculated. But the degrees of susceptibility are quite various. The varieties shown in Table I are the remarkable ones; the nine varieties shown in Table II are especially resistant.

Table II. Nine varieties especially resistant

Varieties	Date of ripening	Quality	Size
Jitsugetsutô (Victor)	earliest	better	medium (rather small.)
Tachibanawase	early	good	medium
Taishôwase	do.	not good	do.
Tenshin	early (later)	do.	largest
Denjûrô (Carman)	middle	better	medium
Wasesuimitsu	do.	good	do.
Rikaku (Chinese Free)	do.	better	larger
Doyô (Chinese Free)	do.	do.	do.
Shanghai (Chinese Cling)	late	best	largest

The two varieties of these, Jitsugetsutô and Tachibanawase are the most promising on account of their early ripening character. Perhaps they will be cultivated in the place of Amsden June or Alexander in near future. Most species belonging to Chinese race are resistant, while Persian race usually susceptible.

Two objections, however, may arise against these experiments; one is the phenomenon of so called "bridging species," and the other is the existence of many biologic forms of the causal fungus.

(1) The theory of bridging species or adaptation of fungi were announced by WARD³ and then corroborated by FREEMAN⁴, SALMON⁵, FREEMAN and JOHNSON⁶. The theory, however, is opposed to the fact pointed out by RIFFEN⁷ that the immune varieties are constant for many years: secondly it is explained by STAKMAN and his co-workers^{8,9} as a result of using impure samples, i. e. two or more biologic forms in mixture.

(2) The existence of biologic forms is yet in the way. All the authors but

one BARRUS¹⁰ who reported about the anthracnose of beans, worked upon "rust problem." BARRUS stated that a variety of bean was resistant to a strain of anthracnose, but it was quite susceptible to another strain.

Experiments are therefore made to determine if the above phenomenon is true to the present case.

Experiment I. From May 25 to June 7, 1919.

Fungi: isolated from various sources as follows:

No.	Date of isolation	Sources	Localities
I _a	July 22, 1916	fruit of Triumph	Tokyo
I _c	May 18, 1917	leaf of Early Rivers	do.
I _e	June 1, 1917	fruit of Hikobei	Shizuoka
I _g	do.	fruit of Briggs' May	Kanagawa
I _h	June 16, 1917	legs of insects in peach orchard	Shizuoka
I _i	May 9, 1918	shoot of Briggs' May inoc. 1917	Kanagawa
I _j	Feb. 25, 1918	shoot of Precoce de Croncel	do.
I _k	May 20, 1918	fruit of Rikaku (Chinese Cling)	Nagasaki
I _l	July 15, 1918	fruit of Denjûrô	Nagano
I _m	Not known	not known	Chôsen
I _n	March 12, 1919	fruit stalk of Bantô	Shizuoka
I _o	March 10, 1919	fruit stalk of Briggs' May	Kanagawa

Plants: ten plants of nine years old Briggs' May, cultivated in the orchard of Kanagawa Ken. Agric. Exper. Station (Ninomiya) are used. 12 branches of each plant are inoculated on three thrusts with 12 strains of the fungi respectively.

The methods of inoculation and measuring are the same as before. Result: as shown in Table III the variation of the length of regions is too small to be considered as a sign of the existence of biologic forms.

Experiment II. From June 2 to 16, 1919.

Fungi: I_a, I_c, I_g, I_i, I_k, I_l, I_m, I_n, I_o, and following three strains:

No.	Date of collection	Sources	Localities
A	May 25 1919	fruit of Tenshin (resist. variety)	Chiba
B	May 26 1919	fruit of Amsden June (extremely susceptible var.)	do.
C	June 2 1919	fruit of Triumph (susceptible var.)	Kanagawa

the spores of the three strains are taken directly from the affected portion of fruits. Plants and other methods are the same as Exper. I. Result: as is shown in Table IV the variation is not so large.

Table III. Inoculations with various strains of *Gl. laticolor*.

No of trees Strains	I	II	III	IV	V	VI	VII	VIII	IX	X	Mean
I _a	3,3,5	6,3,4	5,5,4	3,5,2	3,5,5	5,4,5	6,4,5	3,5,2	4,4,4	5,6,7	4.33
I _b	2,2,5	4,8,6	5,6,2	5,4,4	6,3,2	4,5,4	5,4,6	2,6,4	6,6,4	5,4,6	4.33
I _c	4,5,3	4,5,5	5,5,5	6,4,3	2,3,4	5,5,5	4,4,4	4,4,4	6,3,3	3,4,3	4.13
I _d	5,5,5	3,6,5	8,5,7	6,6,4	6,6,6	2,6,6	3,5,6	4,5,3	4,5,6	3,4,4	4.96
I _e	3,3,5	4,4,4	4,4,5	7,3,4	3,11,6	2,5,5	6,7,5	4,5,5	5,4,4	5,4,6	4.73
I _f	7,4,6	7,7,5	6,7,5	5,6,5	4,3,5	6,5,5	7,6,7	7,4,5	4,5,5	5,5,6	5.06
I _g	7,4,4	3,4,4	4,3,5	5,3,5	5,8,5	4,5,3	3,5,5	5,4,5	4,5,4	5,4,4	4.46
I _h	7,5,5	5,6,5	6,5,5	5,5,5	7,5,5	8,6,5	7,6,4	5,6,6	5,5,4	4,6,6	5.46
I _i	5,6,5	6,5,5	5,6,6	6,6,5	5,8,6	6,4,7	5,8,7	6,5,7	6,4,5	7,6,5	5.66
I _m	4,7,5	7,5,6	6,8,8	5,5,5	5,5,4	3,4,5	6,4,5	4,6,4	4,6,5	6,5,5	5.23
I _n	6,6,5	7,6,6	6,7,6	5,4,4	7,3,5	7,5,6	5,4,6	4,7,5	5,7,4	5,5,6	5.46
I _o	5,7,5	4,4,5	5,5,4	6,5,6	5,4,6	6,6,5	5,6,7	5,4,6	6,6,4	5,7,6	5.33

Table IV. Inoculations with various strains of *Gl. laeticolor*.

No. of trees Strains	I	II	III	IV	V	VI	VII	VIII	IX	X	Mean
I _a	9,12,7	9,7,7	10,8,7	4,6,4	7,7,9	7,7,6	10,9,9	8,6,12	10,11,9	6,6,4	7.76
I _b	6,6,6	7,10,6	8,9,8	7,7,6	6,7,4	10,8,7	10,9,8	4,8,7	7,7,6	6,5,9	7.00
I _c	8,7,10	8,9,9	15,9,7	7,6,7	6,7,7	8,8,7	11,9,10	11,8,12	9,7,9	10,8,7	8.53
I _d	8,9,7	6,9,8	8,6,8	8,8,8	9,8,7	7,13,10	8,9,8	11,10,9	10,8,7	7,5,6	8.16
I _e	9,9,6	7,6,8	7,10,7	7,10,9	10,7,7	10,7,8	9,8,7	9,8,8	8,8,7	8,6,7	7.67
I _f	10,6,8	8,7,7	8,5,9	7,10,4	6,7,5	10,10,8	8,9,7	6,8,8	10,8,11	8,6,9	8.10
I _m	11,7,7	10,7,6	13,12,11	8,8,10	10,10,6	11,13,10	9,11,13	9,6,8	16,13,8	10,8,8	9.63
I _n	9,7,7	8,6,7	11,4,11	8,10,6	10,7,7	6,7,7	7,7,8	7,7,8	8,7,11	7,7,7	7.96
I _o	8,8,5	8,7,6	8,10,7	13,8,7	6,9,8	7,8,6	9,6,9	9,12,8	7,12,9	9,9,8	8.16
A	10,11,9	8,9,6	6,7,10	12,9,8	7,8,8	10,10,9	7,9,7	9,7,8	11,9,10	8,8,8	8.60
B	6,6,4	8,7,10	9,10,9	7,5,6	8,9,7	9,8,9	10,7,8	10,11,12	8,8,5	8,9,7	8.00
C	8,7,7	8,6,7	8,11,13	8,8,9	7,7,11	8,9,10	8,10,9	8,7,8	8,7,10	8,8,7	8.30

According to experiments above shown there seems to be no biologic form among the strain of the fungi *Gloeosporium laeticolor* Berk. as far as the experiment is concerned. Further, the virulence of a strain taken from an affected fruit of Tenshin, the most resistant variety, is not superior to a strain taken from Amsden June, the most susceptible variety, and also I_a strain cultivated for more than three years in this laboratory. Accordingly it is very probable that the phenomenon of "adaptation" is out of place in this case.

SUMMARY

1. Important peach varieties are inoculated with the fungus *Gloeosporium laeticolor* Berk.
2. No variety proved immune, as far as the experiment is concerned.
3. Peach varieties showed various degrees of susceptibility.
4. Two varieties, Tachibanawase and Jitsugetsutô proved resistance and have good qualities and early ripening character.
5. Most species belonging to Chinese race are resistant, while those belonging to Persian race are generally susceptible.
6. There seems to be no biologic form among the strains of *Gloeosporium laeticolor* Berk.
7. Adaptations of fungi can not be accepted in this experiment.

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摘 要

- 1. 主要なる桃品種につき桃炭疽病菌の接種試験を行へり。
 - 2. 本試験の範圍内にては免疫性品種なし。
 - 3. 桃諸品種は種々の程度に於て罹病性を示せり。
 - 4. 日月桃及橘早生は有望なる耐病性品種なりとす。
 - 5. 支那系に屬する品種は大概耐病性にして、ペルシャ系のものは一般に罹病性なり。
 - 6. 桃炭疽病菌には生態學的品種なきが如し。
 - 7. 本試験に於ては菌の適應を認むる事能はず。
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