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report (31 pages, English) 50X1-HUM
of a Polish research project entitled "Epiphytology of Apple Scab" which was conducted at the Research Institutes of Pomology located in Skierniewice. Research efforts were made in the following areas:

(A) Ripening of the perfect stage of the fungus

(B) Dissemination of ascospores and conidiospores

(C) Methods of determining the critical periods

(D) Protective and eradicative effectiveness of different fungicides

(E) Evaluation of different spraying programs to control apple scab OFFICIAL USE ONLY

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S u m m a r y

During the thirth year of studies on epidemiology of apple scab, started in 1960, the following observations were continued: 1/-on ripening of the perfect stage of the fungus, 2/-on dissemination of ascospores and conidiospores, 3/-on methods of determination of the critical periods, 4/-on protective and eradicative effectivness of different fungicides, 5/-on evaluation of different spraying programs to control apple scab.

The observation on ripening of perithecia, which were continued at six experimental stations, confirmed the results obtained in the previous seasons. The ascospores were ripe and ready for dissemination two to three weeks before the apple buds started to swell. The present studies also confirmed the theory developed by Holz, namely that there is a relationship between the sum of average daily temperatures /counted starting from January 1st/ on one hand and the date of ripening of the perfect stage of the fungus on the other. The ascospores were ready, for dissemination when the sum of the average daily temperatures /above 0°C/ reached about 150°C.

In 1962 the observation on dissemination of ascospores were conducted at five experimental stations; and those on dissemination of conidia at one station. Due to favourable weather conditions dissemination of ascospores was very abundant. In the orchard at Nowa Wieś on April 27th at 8-9 A.M. 92.000 of ascospores were found in 1 cubic meter of air. On that day, within few hours, in the whole country disseminated majority of the ascospores.

The studies on dissemination of conidia were preliminary ones. They showed that conidia can be disseminated in small drops of water on short distances; practically within the limits of the tree crowns.

Determination of the critical periods was the main objective in 1962. Three methods of determination of the periods during which apple leaf surface remains wet, after rain, were being compared in field conditions. The first method was based on records with the help of the apparatus constructed at the Research Institute of Pomology /Annual Report II/. The second method was based on records with the help of the Schnelle-Breuer apparatus. The thirth one was based on the Smith s method /critical relative air humidity-90 per cent/. Since the first method was proved earlier to be the most correct one, it was considered as a standart. In comparison to that standart usefullness of the other two methods for forecasting of the critical periods was being compared. The readings obtained with the

of
help the two first methods were identical in 96.5 per cent. The readings obtained with the help of the first apparatus and those calculated on the basis of Smith's method did agree in 58,9 per cent, The First method was found to be the best adopted for research work. The second method appeard to be very good for the observations in forecasting stations. The Smith's method could be used for an approximate determination of infection of apple trees by apple scab.

Out of five field experiments on apple scab control, three experiments were devoted to evaluation of effectivness of different fungicides; two experiments were conducted to compare different spraying programs.
The most effective fungicide in apple scab control was found to be 0.1 per cent Cyprex /Dodine/. Satisfactory results were also obtained when the following fungicides were applied: 0.2 per cent Captan, 0.15 per cent Meroutal, 1.5 per cent lime sulphur, 0.2 per cent DNRB. TMTD at the concentration 0.2 per cent showed insufficient effectivness. Application of copper-oxychloride resulted in severe injuries of leaves and fruits. All the fungicides were applied at the time of infection of apples by spores or immediately after infection. Some fungicides were also tried as protectants.

Different spraying programs of apples were studied in order to find out whether it is necessary to replace spraying program based on phenological dates by some more modern programs. Spraying program based on phenological dates was compared to three other programs, namely: schematic one; according to which apple trees were sprayed for the first time when in green bud stage, followed by 3 sprays at seven days interval and then followed by 3 sprays at twelve to fourteen days interval. The other two spraying programs studied were based on forecasting of the critical periods. Is was found that spraying of apples according to the all four above mentioned programs secured sufficient protection of the foliage and of fruit. Nevetheless the spraying program based on phenological dates was the poorest one.

III. Detailed report

1. Introduction . The aim of the studies involved is to elaborate an effective method of apple scab control. This method should also permit apllication of possibly small number of sprays. The studies are divided into three parts. Part one involves epidemiology of apple scab in Poland; part two involves field experiments on comparison of different spray programs; part three considers some technical problems related to forecasting of critical periods by forecasting stations.

The observations on epidemiology of apple scab, conducted earlier, showed that climatic conditions of

Poland are very favourable for the development of Venturia inaequalis. Previous observations showed that apple scab overwinters in Poland in perfect stage; ripening of which depends on temperature and is typical for the climatic conditions of the Central Europe. This conclusion is being drawn basing on the agreement of our own observations, on the relationship between the sum of daily temperatures /counted from January 1st/and time of ripening of the perfect stage of the fungus, with those made by Holz /1939/. The observations on dissemination of ascospores, conducted in the first year of the studies, showed that number of the ascospores found in air, during dissemination, was higher than ever noted in the literature /Annual Report I/; those findings were confirmed by the 1962 observations, when the number of the ascospores found in 1 cubic meter was several times higher than in has been reported in the literature. The epidemic of apple scab in 1962 in Poland was extremally severe. In the whole country yield of apples was destroyed by apple scab in about 70 per cent. There is no record of a similar infestation of apples by apple scab in chronicles of the Polish plant pathology.

Our observations made in 1962 are in full agreement with the conclusions drawn by Preece /1961/. That author, basing on records compiled for the period from 1915 to 1960, showed that intensity of apple scab infestation, in a given year, depends primarilly on the amount of rain in April and in May.

Second part of the present studies was devoted to evaluation of different sprayingprograms of apples. Originally most of the attention was being paid to evaluation of different fungicides applied before or after expected infection. It was found, in the first year of studies, that number of fungicides, known as typically protective ones like DNBB, Captan or lime sulphur, are very effective in apple scab control, when applied immediately after infection. It was also found that spraying program based on phenological dates and not related to development of the fungus do not secure satisfactory control of apple scab. More of the time was spent therefore on elaboration of a more modern spraying programs based on forecasting of the critical periods.

In the fifth part of the studies described here, attention was being paid mainly to an accurate determination of the period during which the surface of apple leaf remains wet after rain. Contrary to determination of temperature, determinations of wettness of leaves in field conditions, which was indispensable if the Mills table /1951/ had to be used, was very difficult. Number of a very precise apparatus was being easily damaged by rain and wind. An approximate method of determination of wettness of leaf surface, based on critical relative humidity of air was often leading to

erranous conclusions /Report II/. In the preliminary stage of the studies the critical periods were being determinated basing on rainfall and on air humidity; later on a surface wettness recorder was being constructed at the Institute. That apparatus is well adopted to work in field and records of it are very precise. Description of that apparatus was given in Report No II. In the literature are described more simple surface wettness recorders, /Soenen C.A. and Aerts 1960/; one of such surface wettness recorders, which in fact is a modified termohygrograph /Lembcke 1961/ was tried in our studies. Comparison in field conditions of those two surface wettness recorders enabled us to determine their usefullness for the forecasting stations.

A. - Observations on ripening of the perfect stage of Venturia inaequalis

2. Experimental procedures. Observations on ripening of peritheoia of apple scab were conducted at six experimental stations: Nowa Wieś, Swierklaniec, Sinołęka, Skierniewice, Dąbrowice, and Brzezna. Geographical localisation of those stations was given in Reports I and II. Since the observations at Brzezna had to be stoped, because of spoilage of some weather recording apparatus, results were obtained only from the remaining five stations.

The experimental procedure used in those experiments was described in Report No I. It was not changed in 1962. Developmental stages of peritheoia were being determined at 7 days interval, starting on January 1st. At each sampling date 100 leaves were being collected in the orchard; then 10 leaves were being randomly chosen and 10 peritheoia in each leaf were being checked. The total number of peritheoia checked on each sampling date was 100 for each of the five orchards. The following four developmental stages of peritheoia were being distinguished: 1/-peritheoia without asci, 2/- peritheoia with asci just beginning to form, 3/-peritheoia with the beginning of ascospores formation process, 4/-peritheoia with beginning of ascospores ripening. At the moment when 95 to 100 per cent of peritheoia were found to be ripe, the sum of average daily temperatures above 0°C /starting from January 1st 1962/ was being calculated. This was done to find out whether there is any relationship between temperature and time of ripening of peritheoia.

3. Results. As it is shown in Tables 1 and 2, time of ripening of peritheoia in 1962 was very closely depending on temperatures in January, February and March. Since those months were cool, formation of asci, as well as ripening of ascospores was delayed. The first asci were found on January 15th at Swierklaniec and on January 22nd at the other

remaining stations. The first ascospores were found on February 12th at Swierklaniec, on February 19th at Skierniewice and Sinołęka and on February 26th at Dąbrowice and Nowa Wieś. The first ripe ascospores were found on March 5th at Nowa Wieś and on March 12th at other stations. In the first part of March development of the fungus was very slow; an increase of temperature in April hastened ripening of the ascospores.

On April 10th, at all stations, the ascospores were ready for dissemination. On April 16th about 100 per cent of the perithecia was ripe at all stations, except for Nowa Wieś where perithecia ripened few days later.

Results of the observations on ripening of perithecia are given in table 2. Table 3 shows the relationship between the sum of average daily temperatures /above 0°C/ on one hand and the time of ripening of perithecia on the other. In 1962, similarly like in 1961, the average sum of daily temperatures needed for ripening of perithecia was close to 150°C. It varied from 144,2°C for Skierniewice to 158°C for Swierklaniec. The differences in the total of average temperatures between stations were larger in 1962, than in 1961. This was probably caused by prolonged development of perithecia. It is interesting to note that in 1961 perithecia ripened after 62 to 72 days /counting from January 1st/, whereas in 1962 they ripened after 101 days.

B. Observations on dissemination of ascospores and conidia of apple scab

2. Experimental procedures. Observation on dissemination of ascospores were conducted at five experimental stations: Dąbrowice, Nowa Wieś, Sinołęka, Swierklaniec i Brzezna. The results obtained at Brzezna could not be taken under consideration, however, because the air sucking pump got brocken.

In 1962, similarly like in 1960 and 1961, the observations were conducted with the help of Hirst's apparatus. The apparatus was located in a block of apples of McIntosh variety; 0.5 m above the ground level. In each case the size of the experimental orchard was above 10 hectars /about 25 acres/.

Observations on dissemination of conidia were conducted at Dąbrowice. Those observations did not cover the whole season of spores dissemination. This experiment was aimed to give a preliminary answer to the question, to what distances conidia can be disseminated. Conidia were traped in Hirst's apparatus, which were located at three different places: a-in the crown of apple tree, b-five

meters apart from the crown of apple tree, c-fifteen meters apart from the crown of apple tree. It should be pointed out here, that the tree involved was not sprayed with any fungicides and that it was severly attacked by apple scab. In order to trap larger numbers of conidia, the sucking capacity of the pump was increased to 60 liters of air per minute. Since conidia were often traped on the glasses in drops of water it was difficult to determine exactly the time of dissemination. For that reason was calculated only the total number of conidia traped in 24hrs period.

3. Results. In 1962 the pattern of dissemination of the apple scab ascospores were very much alike at all the stations involved. This was in spite of a fast that those stations are located in different parts of the country. Majority of ascospores had disseminated on April 27th, from 8 to 11 A.M. At that time had disseminated 78 per cent, 65 per cent, 30 per cent, 30 per cent of the total amount of ascospores at Nowa Wieś, Sinołęka, Swierklaniec and Dąbrowice respectively. Dissemination of ascospores, which took place on April 27th resulted in an extremally heavy epidemic of apple scab observed in Poland in 1962. Explanation to that fact is not very difficult. Due to a cool and moist weather the ascospores were not ready for dissemination in March. In the middle of April, when perithecia were ripe, appeard a spell of a dry and very warm weather. During that period only very small numbers of ascospores were forced by dewto disseminate. On April 26 th started a period of rains, which lasted until June 5th, Out of 41 days, in that period, 33 days were rainy.

Pattern of dissemination of ascospores at the stations involved are shown in Fig.1, 2, 3 and 4. At Dąbrowice the latest heavy dissemination took place on May 13th; rains which occured on the following days could not result in dissemination of ascospores because there were no more ascospores in perithecia. A detailed studies of perithecia under the microscope showed, that contrary to the previous yeare, in 1962, at the end of dissemination period, perithecia were containing only 1.8 per cent of asci with 8 ascospores. At the end of dissemination period in 1960 and in 1961 perithecia were containing about 12 per cent and about 18 per cent of asci respectively.

At Nowa Wieś dissemination of ascospores was lasting for a longer period of time. Very large numbers of ascospores found in air at that station, resulted not only from local climatic conditions. It was found that up there occured relatively the largest numbers of perithecia on the previous years leaves; besides accumulation of the old leaves in that orchard was very large. A block in which the spore-trap was located consisted of low-headed apple trees of McIntosh

wariety. The crowns of the trees were not pruned and therefore they were very dense. The trees were 16 years old and they were planted rather densly-6 x 6 m. That block of apples formed a very favourable microclimatic conditions for development of apple scab. In that orchard on April 27th at 8-9 A.M. 92.000 of ascospores were found in 1 cubic meter of air. It was an explosion tips dissemination, because the number of ascospores in 1 cubic meter of air was equal 42 at 7 A.M. and 480 ascospores in 1 cubic meter of air at 11 A.M.Dissemination of ascospores on April 27th was taking place in optimal humidity; at besides the night proceeding that dissemination there was a heavy rain. Temperature on April 27th was 14.8°C.

The pattern of ascospores dissemination at Sinołęka were similar to those at Dąbrowice. In Swierklaniec dissemination of ascospores was lasting until the end of May.

A positive effect of light on dissemination of ascospores was revealed in 1962. It was partioulary clear at Dąbrowice on April 26th to April 30th/Fig.5/. It is commonly known that dissemination of ascospores starts within 15-30 minutes after the leaves get wet. Dissemination of ascospores can be restrained either by low temperature or by lack of a light. On the night between April 26th and April 27th leaves were remaining wet for five hours and only at 7 A.M. appeard the first ascospores in air. The same phenomenon took place on April 28th. From Fig.5 it is also ~~thark~~ clear that dissemination of ascospores is an extremally dynamic process. Mass dissemination on April 27th caused, that on April 28th, 29th and 30th only a small numbers of ascospores were occuring in air.

Observations on dissemination of conidia were conducted on three different periods, namely: June 1st to June 10th, June 26th to July 2nd and August 16th to August 26th. Results of those observations are presented in table 4. The largest numbers of conidia were traped /with the help of Hirst's apparatus /in August, during the period of prolonged rains and heavy winds. Majority of conidia were spreading within the limits od tree crown; small numbers of conidia were traped at the distance of 5 meters from the tree crown and only a single conidia could have been traped at the distance of 15 meters from the tree crown.

C. Observations on methods of determination of critical periods

2. Experimental prodndures. Observations on occurrence of the critical periods were conducted at four experimental stations: Dąbrowice, Nowa Wieś, Sinołęka and Swierklaniec. The aim of those experiments was evaluation of different

methods of determination of a period during which leaf surface remains wet and determination of the periods of apple leaf infection by apple scab.

Three methods of determination of a period during which leaf surface remains wet were studied, namely: 1/-with the help of an electronic wettness recording apparatus, described in Report No II, 2/-with the help of Schnelle-Breuer apparatus /Report No II, Lemboke 1961/, 3/-with the help of Smith's method, based on critical relative air humidity equal 90 per cent /Report No [illegible], Smith 1961/. At each of the above mentioned experimental station was organised a forecasting station. The forecasting stations possessed leaf surface wettness recorders; besides they possessed equipment for recording weather conditions. Critical periods were being determined according to the Mills table, bassing on records of the above listed equipment. Since preliminary experiments showed that electronic wettness recorder gives the most correct readings, that recorder was considered as a standart. To increase accuratness on the records obtained two electronic wettness recorders were placed in the Dąbrowice orchard.

3. Results. In 1962 the following numbers of critical periods were found to take place at the stations involved: Dąbrowice 14, Nowa Wieś 16, Sinołęka 15 and Swierklaniec 13. Detailed data on numbers and intensity of the critical periods are presented in tables 5,6,7 and 8. Majority of the critical periods occured in May.

A detailed analysis of the data obtained showed that, out of total 58 critical periods observed, the electronic wettness recorder and that of Schnelle-Breuer construction predicted the critical periods in 56 cases identically and correctly. With the help of the Smith's method the critical periods were predicted correctly only in 36 cases. In the remaining 22 cases the records obtained with the help of the Smith's method did not agree with those obtained with the help of the standard wettness recorder. Those differences were pertaining minly to a degree of infection. When the temperature amplitude was not large then the Smith's method was giving correct results. Large daily temperature amplitude were resulting in great changes of the relative humidity of air, what subsequently was decreasing accuratness of the Smith's methods. There were also periods of time, without any rain, during which the relative air humidity equal 90 per cent /critical according to the Smith's method/ was persisting.

Results of the observations on critical periods were being used in field experiments on apple scab control.

D. Preliminary observations on increase of the leaf area in apple as related to infection by apple scab

In the Dąbrowice experimental orchard preliminary observation were conducted on increase of leaf area in apple. Those observations were carried out on check trees located in experiments on effectivness of different fungicides and on different spraying programs.

The observation on increase of leaf area were conducted on eight trees. On each of those trees one three years old branch, possessing also two-and one year old wood and spurs, was choosen. The observations were started at the biginning of buds development, namely on April 26th and were continued until July 23th. At 7 days interval leaf area of all leaves was measured. This was being done by measuring the lenght and the wideness /in the widest point/ of the leaf blades.

Leaf area was calculated by multiplying lenght x wideness and then by a factor 0.68. The values obtained for the single leaves on a branch were then summarized to get a total leaf area. This was being done for each of the eight branches.

Those preliminary observation were expected to demonstrate some weak points of the protective methods of apple scab control. Namely, they were expected to show that there is a need of almost continuus supplement of a fungicide to protect rapidly growning leaf surface.

Results of the observations are presented in Fig.6. The rate of increase of leaf area was depending to a great extent on temperature. Before the bloom time leaf area increased within a week three times. At that time temperature was rather low. Determinations of leaf infection by apple scab showed that starting from May 17th the area of leaves covered by the spots of apple scab was increasing rapidly until the end of June. In the second part of summer there were no larger changes in a degree of leaf infection, except that the severly infected leaves were being shedded.

... Preliminary observations on a relation between the number of ascospores in an inoculum on one hand and subsequent degree od leaf infection on the other failed. This was due to a very severe natural infection with apple scab observed in 1962 on all trees involved in that experiment.

E. Effectivness of different fungicides applied according to the phenophases of the trees and according to the critical periods

2. Experimental procedures. These experiments were started

in 1961 at the Sinołęka Experimental Station. Experimental procedure of those experiments was described in Rexport No.II.

In the first experiment six fungicides /table 9/ were being applied as protectants and in the second experiment the same fungicides were being applied as eradicants to control apple scab. Those two experiments were conducted in two different apple blocks. When used as protectants the fungicides were applied according to the phenological spray program/first sign of green tissue, early pink bud, pre-bloom, period of bloom, petal fall and five cover sprayings/. The fungicides used as eradicants were applied within 24-36 hrs after the determined critical period, on April 28th, May 10th, 16th, 23th and 27th and July 21st and 26th.

In the first experiment the fungicides were applied 10 times and in the second experiment 9 times. It should be pointed out here, that the definition of protective and eradicative method of apple scab control, applies to to the method of aplication of fungicides and not necessarily to the mode of their action on the fungus. Number of eradicative sprays were also acting as protectants if in a short time after application of it successive infection occured.

Basides the above mentioned experiment, conducted at Sinołęka, in 1962, a new experiment on eradicative effectivness of different fungicides was started at Dąbrowice. In that experiment the following fungicides were being compared: 0.1 per cent Cyprex /Dodine/, 0.2 per cent Captan, 0.2 per cent DNRB, 1,5 per cent lime sulphur and 0,15 per cent Meroutal. The experiment was conducted on 12-years old apple trees of McIntosh variety and it was layed down according to the randomized blocks method. A plot consisted of one tree, which was isolated by guared trees. There were four replications in the experiment. All the fungicides studied were applied eight times.

In the experiments on effectivness of different fungicides the following data were collected:

1-Number of infected leaves in per cent

2-Leaf area covered by spots of apple scab in per cent

3-Number of infected fruits in per cent

4-Area of fruits covered by spots of apple scab in per cent

5-Total yield

6-Number of a first grade fruit in per cent

7-Injuries of leaves and fruits caused by the fungicides

To determine infection of foliage 200 leaves were examined; determination of fruit infection was based on examination

of a sample consisting of 100 fruits.

3. Results. Results of the above described experiments are presented in tables 9,10 and 11. In the experiment on protective application of fungicides /Table 9/ the best results gave Captan. It should be pointed out here that the data on yield in this experiment possess only a very limited value, because the trees were yielding very unevenly. The data on a degree infection of foliage and fruit are the most representive ones. Good results produced application of the following fungicides: DNRB and Merpoutal. Mercury containing Merpoutal however, was applied only to the petal fall stage; later it was replaced by 0.2 per cent TMTD. It was probably the reason, why in that treatment a large increase of infection was observed in the second part of summer. TMTD was less effective than DNRB or Merpoutal. Lime sulphur very effectively controled scab, but at the same time it caused chlorosis of leaf margines, incomplete development of the leaves and depression of growth of the shoots. Moreover application of lime sulphur resulted in lower yields and in poor color of fruit. Application of copper oxichloride resulted in a very severe injuries of foliage and of fruit. Leaves on the trees sprayed with that fungicide possessed numerous small necrotic spots; besides the lower side of the leaf blades was yellowing-brown in color, what was due to dying out of the hairs. The severly injuried leaves were being sheded abundantly. Up to the end of July the trees sprayed with copper oxichloride lost about 70 per cent of their leaves. Fruits on those trees were strongly rasseted and deformed. Severly injuried fruits were droping prematurely. This was the main cause of decreased yield in that treatment. Fruits, which remained on the trees until harvest time were not or very little injuried by copper oxichloride; therefore 83,17 per cent of them were evaluated as grade I. Because of premature sheding of leaves it was very difficult to determine degree of infection of foliage on the trees sprayed with copper oxichloride. For that reason those results have only a limited meaning.

Application of DNRB resulted in only very moderate russetting of fruits.

In the experiment on eradicative effectivness of fungicides on apple scab /Table 10/ the best results gave Merpoutal. Captan, DNRB and lime sulphur were fairly effective; the least effective was TMTD. Copper oxichloride resulted, similarly like in the above described experiment, in severe injuries of foliage and fruit. Quite severe injuries of foliage occured also on the trees sprayed with lime sulphur and light injuries of fruit were found on the trees sprayed with DNRB.

The aim of the experiment conduoted at Dąbrowice

was to compare effectivness of the fungicide Cyprex /that fungicide was never before studied in Poland/ with the effectivness, in apple scab control, of the most important in this country fungicides. Results of that experiment are presented in Table 11. As it can be seen from this table, Cyprex was proved to be the most effective fungicide; it slightly surpassed Captan or Merqutal and definitely so DNRB or lime sulphur. Cyprex, Merqutal and Captan did not cause injury on foliage or fruit apples, whereas application of lime sulphur or DNRB resulted in injuries, similarly like it was described above, for the experiments conducted at Sinołęka. Particularly interesting results were obtained for Merqutal; the trees sprayed with that fungicide showed substantial increase in foliage infection by apple scab in the second part of summer. This can be explained by shortlived effectivness of mercury containing fungicides.

F. Experiments on comparison of different spray programs

2. Experimental procedures. Experiments on comparison of different spray programs were conducted at two stations: Dąbrowice and Swierklaniec. In Dąbrowice this experiment was conducted on twelve years old apple trees of McIntosh variety. It was arranged according to the randomized blocks method, with four replications. In Swierklaniec the experiment was conducted on fiveteen years old apple trees of Signe Tillisch variety. It was also layed down according to the randomized bloks methods, but with six replications. In each of those two experiments six following treatments were involved:

1-Spry program based on phenophases of the trees /first green tissue, early pink bud, period of bloom, petal fall and three cover sprays/.

2-Schematic spray program /three application of fungicides at 7 days interval, followed by four sprays at 12-14 days interval. The first spray was applied at the stage of first green tissue/.

3- Protective spray program. The number of sprays was not decided a priori; sprays were applied just before the expected critical periods.

4-Eradicative spray program. Sprays were applied immediately after the determined critical period; except that protective activity of the fungicides lasting for 7 days after application was also considered.

5-Mixed, protective and eradicative, spray program. According to that program trees were supposed to be sprayed immediately before infection; but if it could not have been done then, the xxx trees were sprayed after infection.

6-Check treatment-trees were not sprayed at all.

The aim of those experiments was: a/-to compare effectivness of chemical control of apple scab applied according to a

different spray programs, b/-to evaluate adaptation, for practice, of these different spray programs. In all of the above mentioned programs the same fungicides were being used. Namely for the early sprays, until the end of bloom period, a mixture of 0,2 per cent DNRB with 0.1 per cent Maroutal was bexing used. For all the following sprays was applied exclusively 0.2 per cent DNRB.

In this experiment similar data were collected as it was described above, for the experiment conducted at Sinołęka. In Swierklaniec, however, the trees were not blooming /year off/; therefore at that station only infection of foliage by apple scab could have been determined.

3. Results. Results of the experiments on comparison of different spray programs are summarized in Tables 12 and 13. In Dąbrowice orchard all the spray programs studied produced satisfactory results. The lightest infection of foliage and fruits was observed, when the trees were sprayed according to the schematic program. The most severe infection of foliage and fruits was on the trees sprayed according to the program based on phenophases of the trees. From the point of view of practice, the most difficult was the protective program.

In the Swierklaniec orchard the best results gave eradicative spray program; the worst results were obtained when it was tried to spray the trees just before infection. The mixed, protective-eradicative, program was also satisfactory.

4. Discussion. The results of studies on ripening of peritheoia of Venturia inaequalis obtained in 1962 are in agreement with those obtained in 1960 and 1961. They also agree with the results obtained by Holz/1939/. Egzistance of a relationship between temperature and time of ripening of peritheoia appears to be sufficiently prooved. It is doubtful however, whether studying of this relationship has any larger value for practical control of apple scab. It is particularly clear when one rembers that pertitheoia ripen 2-3 weeks before the buds start to show any green tissue. These findings seem contradict the Friedrich's opinion /1952/, who proposed the first spring spray of apple trees when the ascospores are ready for dissemination.

The observations on dissemination of ascospores showed that in favourable conditions the number of disseminated ascospores can be severel times larger, than it was reported in the literature. The most important factors, which enabled in 1962 such a mass dissemination of ascospores were: rain, which moistened leaves with fully ripe peritheoia in them, on one hand and the temperature, optimal for dissemination on the other. A great value of Hirst's apparatus fot the studies on epidemiology of apple scab was prooved at all stations involved.

Studies on spreading of oenidia indicate, that oenidia can hardly be disseminated to any larger distance.

Field experiments on determination of periods during which leaves remain wet, after rain, showed that the Smith's method based on determination of a relative air humidity is only an approximate one. In majority of cases this method was giving correct indications; nevertheless it is not sufficiently accurate for the purposes of forecasting stations. The Sohnelle-Breuer surface wettness recorder was found to the best adopted for forecasting stations. It is very simple in Construction and very easy in operation; it also determines very accurately periods during which leaf surface remain wet after rain. The electronic surface wettness recorder constructed at the Institute was found to be very well adopted to research work.

Comparison of the course of critical periods in 1962, with that in the previous years indicates on a number of weak points of the spray programs, which are not based on observations of development of the pathogen. In 1962 the eradicative sprays applied during infection or immediately after infection were playing a particularly important role in apple scab control.

The field experiments conducted in 1962 showed that number of typically protective fungicides, like lime sulphur, Captan or DNRB, when applied immediately after infection, give satisfactory results in apple scab control. This finding confirms the results obtained in 1961 /Report No.II/, but it is contrary to the conclusions drawn by Hadorn /1957/ and at least partially contrary to the opinion ~~xxxxxxxxx~~ expressed by Roosje /1959/. This last author states that theoretically Captan, TMTD and DNRB can control apple scab within a short period after infection; nevertheless in practice that period is to short in order to recomende the above listed fungicides as eradicants.

Field experiments on comparison of different spray programs showed, once more, that spray program based on phenophases of the trees does not insure the most effective protection of apple against apple scab. It is so, because pattern of apple development and those of fungus development are not related in such a manner which could enable determination of spray dates according to the phenophases of the tree. When at spring time the weather is cool and wet then apple tree developes very slowly and possibility of infection of it by apple scab increases; contrary when at spring time the weather is warm and dry then phenophases of the tree follow quickly one each other and there is no need to spray orchard against apple scab.

5. Conclusions

1/-The results on ripening of perithecia, presented

in this Report, are in full agreement with those obtained in some other countries of Central Europe. These results possess only a limited value for forecasting stations, the aim of which is to organize apple scab control.

2/- Results of the observations on dissemination of ascospores indicate on a large calus of this method for theoretical and for practical purposes.

3/-Comparison of a work and of the records done by different leaf surface wettness recorders permitted to evaluate their value for: a-scientific purposes, b-practical control of apple scab, c-approximate determination of critical periods.

4/--The results obtained up to date indicate on a need of further research work on comparison of effectivness, in apple scab control, of different fungicides applied as eradicants; they also indicate that spray programs based on phenophases of apple tree should be replaced by spray programs based on forecasting of critical periods.

6. Plan of work for 1963 . In 1963 studies will be continued on dessemination of ascospores and conidia. Besides field experiments also the laboratory studies will be started on the effect of temperature, humidity and light on dissemination of ascospores.

Also the observations on distances of spreading of conidia will be continued in 1963; they will be substantially broadened by use of modified spore-trap.

Experiments on determination of critical periods will be extended by observations on the effect of microclimatic conditions on infection of apple foliage by apple scab.

Similarly like in the previous years, also in 1963, the field experiments will be devoted primarily to evaluation of protective and eradicative effectivness of fungicides. Moreover field studies will be continued on comparison of different spray programs.

In 1963 will be renovated studies on finding out the relationship between the number of ascospores on leaves and a degree of their infection by apple scab.

/Doc.Dr Z.Borecki/

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Table 1

Weather conditions at Skierniewice during the period January 1962 - December 1962

Months	Temperature of air in C°				Reinfall	
	Mean	Deva-tion	Maxima	Minima	mm	Deviation index in per cent
January	0,08	+ 3,80	2,3	-2,2	19,3	91,9
February	-2,9	- 0,37	0,5	-5,0	23,5	101,6
March	-1,4	- 2,88	1,7	-4,5	49,9	219,3
April	10,6	+ 3,52	15,6	6,0	35,3	95,7
May	11,0	- 2,45	15,0	7,0	166,1	386,4
June	14,9	- 1,99	19,4	10,2	57,0	88,7
July	16,3	- 2,23	21,5	11,3	23,2	29,0
August	16,7	- 0,84	22,3	12,5	51,2	71,7
September	12,1	- 1,50	27,5	8,0	60,1	133,4
October	8,1	- 0,10	13,0	4,1	10,4	32,6
November	4,1	- 0,90	5,8	2,3	32,5	96,3
December	-4,1	- 3,43	- 1,7	-6,8	14,4	56,2

Table 2

Ripening of the perithecia of Venturia inaequalis fungus in different areas of Poland during 1962

Date of observation	Number of the ripe perithecia in % at :				
	Nowa Wieś	Świer-klaniec	Sinołęka	Skier-niewice	Dąbro-wice
26.II	0	0	0	0	0
5.III	2	0	0	0	0
12.III	5	4	8	9	4
19.III	3	4	36	2	0
26.III	5	19	49	12	10
2.IV	58	68	73	26	18
9.IV	75	92	93	91	75
16.IV.	86	100	100	100	100
24.IV	97	100	100	100	100
30.IV	99	-	-	-	-
7.V.	100	-	-	-	-

Table 3

Relation between the total of dayly temperatures since 1st January and the date of perithecia ripening

Experimental station	Total of dayly temperatures since 1st Jenuary to:	Number of days since 1st january to:
	The date of perithecia ripening	
Nowa Wieś	148,4°C	101
Świerklaniec	158,9°C	98
Sinołęka	153,6°C	101
Skierniewice	149,2°C	96
Dąbrowice	156,3°C	100

Teble 4

Observation results on the conidia spreading at Dąbrowice in 1962

Time	Number of conidia traped during 24 hours			Reinfeal in mm	Average daily tempera-ture	Wind meters/ sek.
	in the crown of tree	5 meters beyond the crown	15 meters beyond the crown			
1.VI.62	820	24	0	1.4	9.1	5.0
2. "	25	0	0	1.1	8.9	1.0
3. "	379	11	0	3.0	9.0	3.3
4. "	560	2	0	19.0	8.4	4.3
5. "	480	4	0	10.0	8.5	3.0
6. "	31	0	0		8.8	6.3
7 "	28	0	0		10.5	6.7
8 "	0	0	0		13.5	2.7
9 "	0	0	0		16.1	3.3
10 "	8	1	0		14.3	1.7
26.VI.62	110	3	0	0.9	17.5	3.0
27. "	6	0	6		13.8	5.0
8 "	780	10	1	0.9	10.2	5.0
29 "	1.220	39	3	9.3	11.7	6.0
30 "	96	5	0	0.0	11.5	4.0
1.VII.62	14	1	0		12.1	3.0
2. "	75	1	0	2.7	11.1	2.3
16.VIII.62	0	0	0		18.0	2.0
17. "	2.500	41	2	17.1	18.5	3.0
18 "	720	9	1	1.9	18.4	2.7
19 "	3.700	76	2	2.0	15.9	5.0
20 "	1.200	26	0	0.0	12.7	5.0
21 "	64	0	0		15.1	1.3
22 "	940	4	4	3.0	14.3	2.3
23 "	320	0	0	0.0	14.8	5.0

Table 2

Critical periods observed at Dąbrowice orchard in 1962

No	Date	Average temperature	Conformity of readings	Period of wetness of leaf surface and intensity of infection		
				Electronic apparatus 1	Schnelle-Breuer apparatus 2	Smith's method 3
1	27.IV	12.0	1-2-3	14.5-M	14.0-M	14.0-M
2	7.V	12.0	1/ 2-3	23.0-H	18.0-M	18.0-M
3	8-9.V	14.5	1-2-3	15.0-M	15.0-M	14.0-M
4	13-15.V	10.2	1-2-3	59.0-H	54.0-H	57.0-H
5	20-21.V	9.6	1-2-3	23.0-M	25.0-M	21.0-M
6	24-25.V	11.0	1-2-3	17.0-M	18.0-M	19.0-M
7	26-27.V	9.4	1-2-3	36.0-H	36.0-H	34.0-H
8	28-28.V	13.5	1-2-3	16.0-M	15.0-M	14.0-M
9	4-6.VI	6.5	1-2-3	28.0-M	36.0-M	36.0-M
10	24.VI	14.0	1-2 3	11.0-L	10.0-L	14.0-M
11	6-7.VII	12.0	1-2-3	12.0-L	13.0-L	11.0-L
12	15-16.VIII	19.0	1-2 3	12.0-M	11.0-M	16.0-H
13	16-17.VIII	16.4	1-2 3	9.0-L	10.0-L	14.0-M
14	17-18.VIII	16.4	1-2 3	14.0-M	15.0-M	20.0-H

Intensity of infection: L-light, M-moderate, H-heavy
Conformity of readings: 1-2-3 - all three readings conform
1-2 - readings 1 and 2 conform, reading 3 [illegible]

Table 6

Critical periods observed at Nowa Wieś orchard in 1962

No	Date	Average temperature	Conformity of readings	Period of wetness of leaf surface and intensity of infection		
				Electronic apparatus 1	Schnelle-Breuer apparatus 2	Smith's method 3
1	26-27.IV	10.5	1-2 3	21.0-M	20.0-M	36.0-H
2	7-8.V	11.7	1-2 3	25.0-H	26.0-H	17.0-M
3	8-9.V	13.2	1-2-3	15.0-M	16.0-M	15.0-M
4	13-16.V	8.4	1-2-3	62.0-H	66.0-H	67.0-H
5	20-21.V	8.8	1-2-3	31.0-H	36.0-H	33.0-H
6	24-25.V	10.1	1-2-3	20.0-M	19.0-M	19.0-M
7	25-26.V	10.9	1-2-3	36.0-H	34.0-H	36.0-H
8	30-31.V	9.6	1-2-3	18.0-M	18.0-M	16.0-L
9	4-6.VI	7.3	1-2-3	42.0-H	40.0-H	38.0-H
10	11-12.VI	10.1	1-2 3	18.0-M	20.0-M	15.0-L
11	24.VI	17.1	1-2 3	12.0-M	13.0-M	10.0-L
12	29-30.VI	9.4	1-2-3	48.0-H	44.0-H	39.0-H
13	3.VII	9.2	1-2 3	30.0-H	28.0-H	24.0-M
14	22-23.VII	17.9	1-2-3	19.0-H	20.0-H	19.5-H
15	4-5.VIII	15.5	1-2 3	13.0-M	12.0-M	11.0-L
16	24.VIII	14.3	1-2 3	20.0-H	21.0-H	16.0-M

Intensity of infection: L-light, M-moderate, H-heavy
Conformity of readings: 1-2-3 - all three readings conform
1-2
3 - readings 1 and 2 conform, reading 3 unconform

Table 1

Critical periods observed at Sinołęka orchard in 1962

No	Date	Average temperature	Conformity of readings	Period of wettness of leaf surface and intensity of infection		
				Electronic apparatus 1	Schnelle-Breuer apperatus 2	Smith's method 3
1	26-27.IV	11.3	1-2-3	17.0-M	16.0-M	16.5-M
2	8-9.V	14.2	1-2-3	15.0-M	14.0-M	15.5-M
3	9.V	12.0	1-2 , 3	14.0-M	14.0-M	12.0-L
4	10-11.V	10.8	~~1-2-3~~	16.0-M	16.0-M	16.0-M
5	13-14.V	10.2	1-2 , 3,	38.0-H	39.0-H	21.0-M
6	14-16.V	9.0	1-2-3	43.0-H	44.0-H	44.0-H
7	21-22.V	9.8	1-3 , 2	10.0-M	15.0-L	18.0-M
8	24-25.V	9.9	1-2 , 3	23.0-M	22.0-M	36.0-H
9	25-26.V	11.2	1-2 , 3,	17.0-M	18.0-M	24.0-H
10	4-6.VI	7.0	1-2-3	47.0-H	40.0-H	46.0-H
11	24.VI	15.1	~~1-2-3~~	10.0-L	10.0-L	11.0-L
12	29-30.VI	10.0	1-2-3	38.0-H	36.0-H	36.0-H
13	23-24.VII	16.0	1-2 , 3.	15.5-M	16.0-M	19.0-H
14	5.VIII	18.2	1-2-3	14.0-M	13.0-M	13.0-M
15	16-17.VIII	16.6	1-2-3	26.0-H	32.0-H	38.0-H

Intensity of infection: L-light , M-moderate, H-heavy
Conformity of readings: 1-2-3 - all three readings conform
~~1-2~~ - readings 1 and 2 conform, reading 3 unconform

Table 8

Critical periods observed at Świerklaniec orchard in 1962

No	Date	Average temperature	Conformity of readings	Period of wetness of leaf surface and intensity of infection		
				Electronic apparatus 1	Schnelle-Breuer apparatus 2	Smith's method 3
1	27.IV	14.1	1-2-3	16.0-M	15.5-M	16.0-M
2	8-9.V	15.6	1-2-3	25.5-H	24.0-H	23.5-H
3	12-14.V	12.1	1-2-3	48.5-H	47.5-H	44.0-H
4	20-22.V	9.8	1-2 .3	31.0-H	28.0-H	23.5-M
5	25-26.V	10.3	1-2 .3	23.5-H	24.0-H	21.0-M
6	17-28.V	13.9	1-2-3	22.5-H	21.0-H	22.0-H
7	1-2.VI	6.3	1-2 .3	36.0-M	34.5-M	27.0-L
8	4-5.VI	7.4	1-2 .3	30.0-M	29.0-M	22.5-L
9	29.VI	11.3	1-3	14.5-L	- -	14.0-L
10	6-7.VII	12.9	1-2 .3	18.0-M	17.0-M	22.0-H
11	23.VII	18.4	1-2 .3	11.0-M	12.0-M	9.5-L
12	15.VIII	19.3	1-2 .3	14.0-M	13.5-M	10.0-L
13	18.VIII	17.1	1-2 3	19.0-H	18.0-H	13.5-L

Intensity of infection: L-light, M-moderate, H-heavy
Conformity of readings: 1-2-3 - all three readings conform
1-2 - readings 1 and 2 conform, reading 3 unconform

Table 9

Experiments results on apple scab control at Sinołęka
/Fungicides applied as a protectant/

Fungicides	Percentage of areas covered by scab on:			Percentage of infected :		Yield from one tree in kg	Percentage of first grade fruit
	leaves		fruits	leaves	fruits		
	7.VI	9.VII	4.X	9.VII	4.X		
0,2% Captan	0,27	2,78	1,03	28,75	22,63	19,37	83,72
1.5% Lime sulphur	0,32	4,82	0,97	34,12	34,32	35,57	88,17
0,15% Mercutal	0,10	8,64	2,78	41,50	54,80	61,10	67,85
0,2% DNRB	0,28	6,69	2,64	43,37	38,90	41,47	69,17
0,2% TMTD	0,32	15,77	4,60	77,00	59,27	31,17	52,02
0,1% Copper oxychloride	0,09	5,03	1,04	29,87	36,98	13,27	83,17
Check-no spray	21,47	51,80	-	98,25	-	0,00	-
The lowest significant difference for t=0,05	0,75	6,36	1,45	21,80	31.05	-	12.36

Table 10

Experiments results on apple scab control at Sinołęka
/Fungicides applied as a eradicant/

Fungicides	Percentage of areas covered by scab on:			Percentage of infected :		Yield from one tree in kg	Percentage of first grade fruit
	leaves		fruits	leaves	fruits		
	7.VI	11.VII	4.X	9.VII	4.X		
0,2% Captan	0,16	0,63	1,75	26,50	41,20	31,25	73,22
1,5% Lime sulphur	0,01	4,70	1,55	44,75	38,64	7,35	78,67
0,25% Merculal	0,29	2,38	4,28	49,37	70,04	9,50	54,37
0,2% DNRB	0,26	2,71	4,76	51,50	71,13	19,92	50,30
0,2% TMTD	0,40	7,34	6,16	70,00	87,06	9,22	40,52
0,1% Copper oxychloride	0,01	1,04	1,39	27,62	29,63	5,22	35,50
Check-no-spray	22,31	45,56	-	99,00	-	0,00	-
The lowest significant difference for t=0,05	0,30	3,11	2,09	18,00	25,74	-	32,35

Table 11

Experiment results on apple scab control at Dąbrowice
/Fungicides applied as a eradicant/

Fungicides	Percentage of areas covered by scab on:				Percentage of infected :		Yield from one tree in kg	Percentage of first grade fruit
	leaves			fruits	leaves	fruits		
	14.VI	16.VII	10.VIII	4.X	16.VII	5.X		
0,1% -Cyprex	0,69	0,79	1,76	0,31	15,50	4,92	70,93	96,55
0,15% Merculal	0,22	1,66	3,12	0,33	20,00	11,31	73.33	91,32
0,2% Captan	0,49	1,76	1,42	0,47	28,50	11,91	70,07	90,30
0,2% DNRB	0,63	3,05	4,12	1,07	35,62	21,88	72,92	90,71
1,5% Lime sulphur	0,95	3,69	4,01	0,67	37,12	18,91	58,92	68,85
Check no spray	14,99	33,77	33,96	18,91	98,50	100,00	4,06	0,00
The lowest significant difference for t=0,05	0,15	1,79	2,68	2,08	7,78	12,14	22,21	16,69

Table 12

Experiments results on comparison of different spray programs at Dąbrowice

Spray program	Percentage of areas covered by scab on			Percentage of infected :		Yield from one tree in kg	Percentage of first grade fruit
	leaves		fruits	leaves	fruits		
	6.VI	23.VII					
Schematic program	0,008	0,17	0,70	6,50	9,73	52,44	92,11
Eradicative program	0,013	0,59	0,42	13,00	33,40	56,90	90,12
Protective program	0,066	0,73	0,82	14,25	29,11	35,56	93,53
Eradic.prot.program	0,021	1,14	0,91	15,25	33,68	51,45	94,20
Phenological program	0,338	1,54	1,10	20,87	28,93	57,69	91,07
Check-no-spray	8.390	20.97	26.70	73.75	100.00	3.31	0.00
The lowest significant difference for t=0.05	0.159	0,83	0,78	8,20	21,81	32,51	3.81

Table 13

Experiments results on comparison of different spray programs at Świerklanies

Spray program	Percentage of areas covered by scab on leaves			Percentage of infected leaves. 7.VII
	7.VI	22.VI	7.VII	
Schematic program	0,249	6.71	7.82	46.83
Eradicating program	0,234	2,98	2,58	24,67
Protective program	0,751	17,45	15,64	74,67
Eradic.prot.program	0,087	4,15	4,15	32,50
Phenological program	0,193	5,71	7,57	58,58
Check-no-spray	12.110	37,43	29,16	97,33
The lowest significant difference for t=0.05	0.386	4.60	4.13	17.29

Fig. 1. Dissemination of apple scab ascospores - Dabrowice 1962

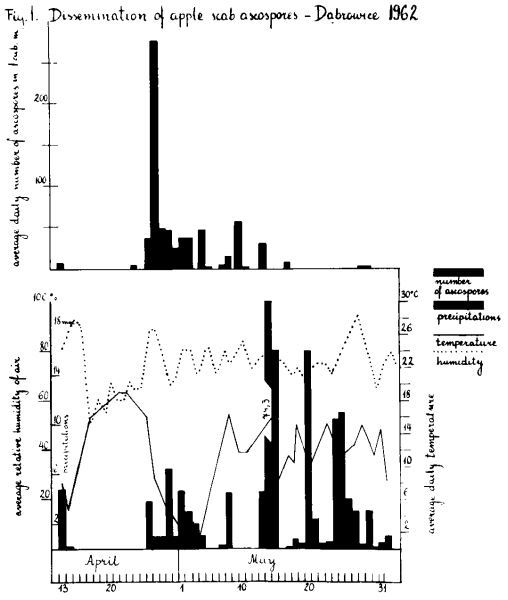


Fig. 2. Dissemination of apple scab ascospores - Nowa Wies 1962

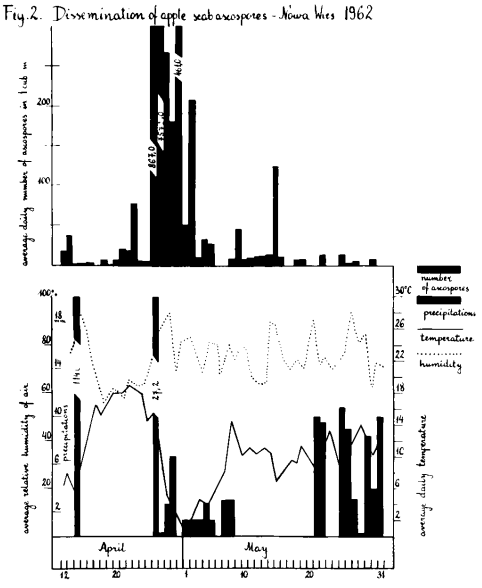
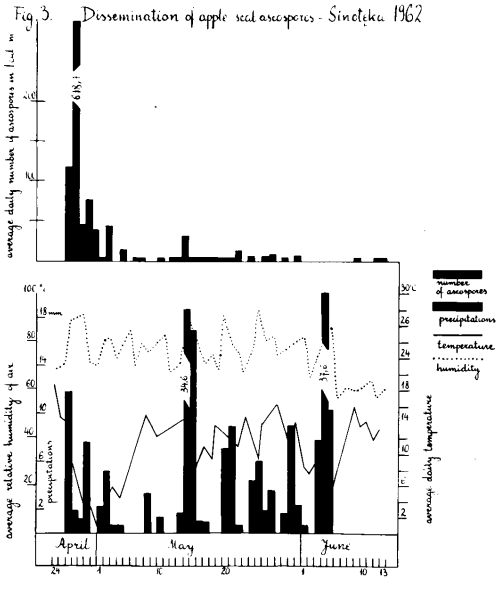
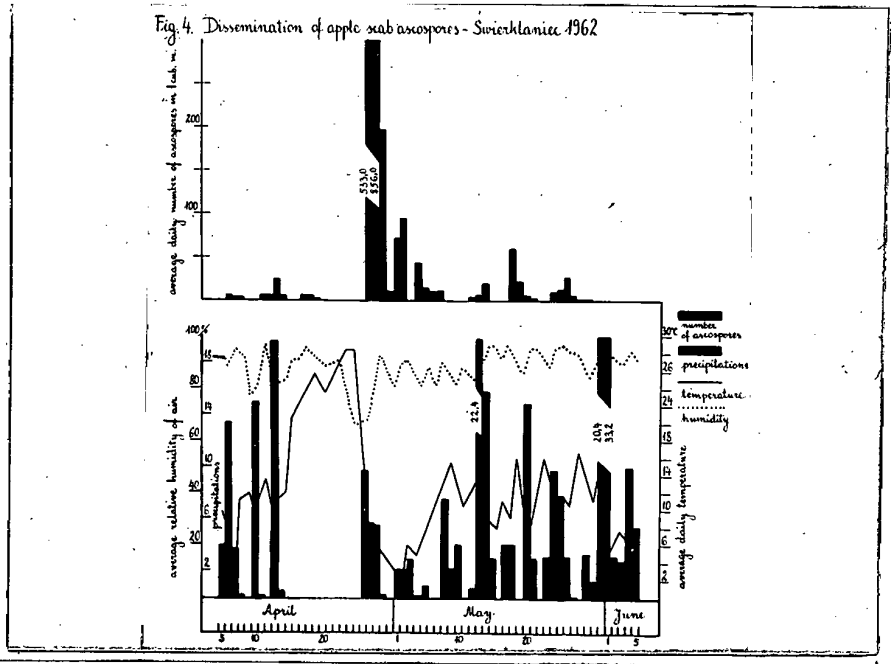
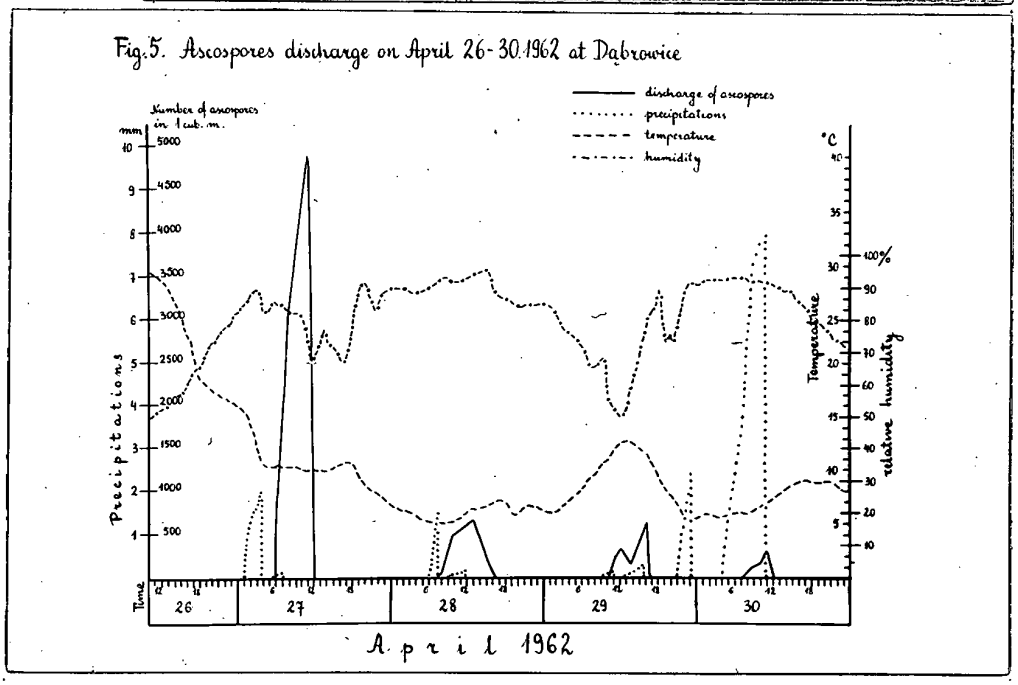
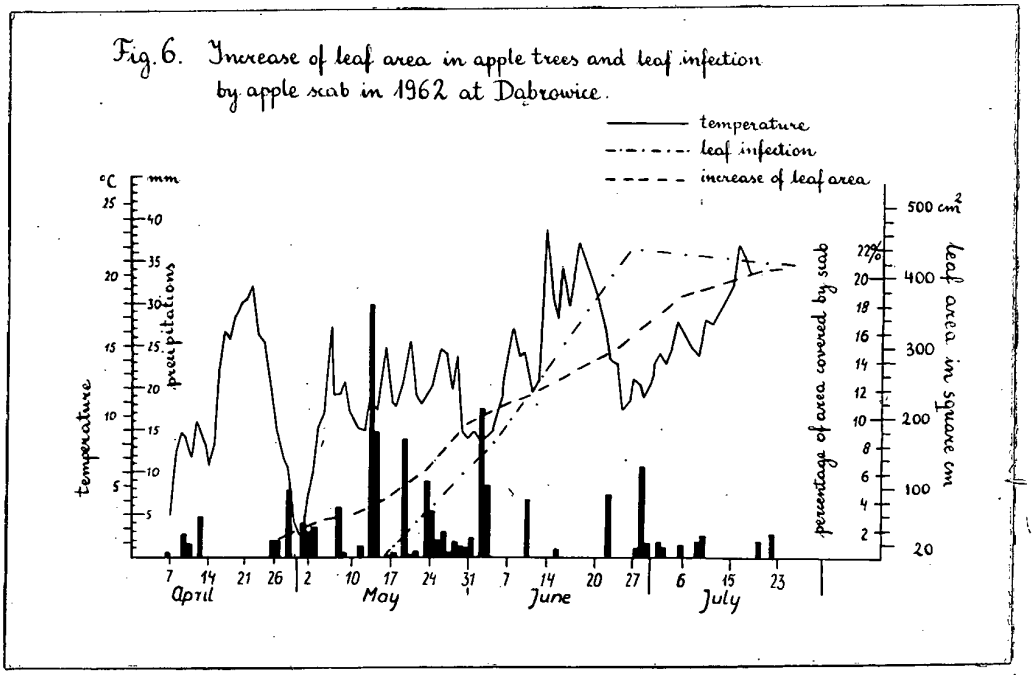


Fig. 3. Dissemination of apple scab ascospores - Sinoteka 1962









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