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AUTHORITY

SMUFD d/a ltr, 8 Feb 1972

TRANSLATION NO. 890

DATE: Sept 1963

DEPARTMENT OF THE ARMY
Fort Detrick
Frederick, Maryland

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THE OIDIUM OF TOBACCO

Revue Internationale Des Tabacs
311-334-1959-60-U.S.D.A.*
pp. 151-160 and 176-180.

By R. Renaud

Phytopathological Laboratory of Plant Protection
Of the Office of Overseas Scientific Research and Techniques

More or less pronounced and depending on the region, the year and also the variety cultivated, tobacco mildew is very widely distributed throughout the world. Under the name of "white", or "white mold or white rust", or "powdery mildew", etc., it is known in almost all countries in which tobacco is cultivated.

A few figures will indicate the extent of the damages caused by oidium. Hopkins (1928) reported losses as high as 30% of the harvest in South Africa on certain plantations. In Russia, Alexandroff (1937) evaluated the loss caused by the disease at 300,000 rubles alone in the region of Yalta in 1926. D'Angremond (1924) estimated the percentage of infected leaves at 3% in 1922 and at 4% in 1923, but noted that the loss was actually much higher because 13-18% of the best leaves (bottom and middle) were affected and due to this completely lost for export to America which is the principal import market. On the other hand, Bouriquet (1946) in Madagascar considered the damage as of little economic importance because the mildew primarily affected the older plants kept to raise seed. However, the situation has since changed in this country during the last 15 years and it has become necessary to institute extensive protection against the disease.

THE IDENTITY OF THE PARASITE

Although the fully developed form of the oidium of tobacco (oidium tabaci Thüm.) is related very generally to Erysiphe cichoracearum D.C., its exact identity is still a subject of discussion in certain countries. Is there only one species of tobacco parasite with a certain number of biological races or are there several species of Erysiphaceae ρ

which are capable of developing imperfect forms on this plant? It is difficult to decide the question because the mopthology of the forms of oidium makes it difficult to distinguish between species. Only the examination of the perithecia can give us valid indications but their formation is far from being constant and, in many countries such as Madagascar, has never been demonstrated.

This question is interesting not only from a theoretical viewpoint. It poses the specific problem of the host plants and consequently that of the risk of contamination which certain types of plantings may represent for tobacco plantations.

Erysiphe cichoracearum possesses a frequently evanescent mycelium producing short conidiophores which carry more or less cylindrical or ellipsoid conidia with a length of 25-45 microns by 16-26 microns wide. The globulose perithecia with a diameter of 80-170 microns carry colored fulcra generally enclosing 10-20 asci ovoid in shape and each normally containing two ascospores of 2-28 x 12-20 microns.

The validity of the binomial E. cichoracearum DC., adopted by Salmon (1900) who admittedly did not always follow the international rules of nomenclature, has been disputed in particular by Cooke (1952) who regards it as a synonym of E. communis Walbr. ex. Fr.

This point of view is contrary to the usage of the greater part of the researchers and Schmitt (1955) did point out that the use of the term E. cichoracearum established by Marat in 1821 was adequate to confirm the validity of this binomial which should be actually E. cichoracearum DC. ex Marat, in order to be entirely correct.

Erysiphe polyphaga, a collective species established by Hammarlund (1945) who here specifically included the oidium tabaci, morphologically differs from E. cichoracearum only by its asci which may contain three or four spores and where the number of asci per perithecium is 8-12 for the matrix form (forma matricalis) Veronicae speciosae and 10-20 for f.m. begoniae (Gloire de Lorraine). As noted by Blumer (1952), the morphological characteristics as well as the series of hosts of E. polyphaga suggests its possible identity with E. horridula (Walbr.) Lev.

The perithecia of E. cichoracearum have been observed on tobacco in several countries of Europe and specifically in Italy (Marcelli, 1949), in Turkey (Ducomet, 1928), and also in Brazil (Averna-Sacca, 1922). The absence of perithecia prevented Palm (1921) in Java from definitely relating this species to the oidium observed on tobacco and characterized by conidiphores of 150-210 x 12-17 microns and of cylindrical conidia of 25-40 x 15-20 microns. However, d'Angremond (1924) believes that it may be identical with E. lamprocarpa (Walbr.) Lev. which is considered to be a synonym of E. cichoracearum.

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The Erysiphe tabaci Saw is also assumed to be a synonym, at least in part, for E. cichoracearum.

THE SPECIALIZATION OF THE PARASITE

Obliged to live as parasites like the rusts, the Erysiphaceae display a more or less pronounced specificity in regard to the plants on which they can develop. Although the same morphologically differentiated species appears capable of existing as parasite on a large number of hosts -- which is the case of erysiphe cichoracearum which, according to Jaczewski (1927) is encountered on 226 species belonging to 25 different families -- research by many authors has demonstrated the existence within this species of numerous physiological races more or less narrowly specialized. Some authors such as Hammarlund in 1925 have considered this specialization as being very strictly confined. Others, such as Blumer (1926), have believed that such specialization was much less advanced than it appeared to be at first sight. The latter, among others, drew attention to the fact that the erysiphaceae can attack weakened plants belonging to species which are totally resistant to infection under normal conditions.

Blumer (1926) was lead to consider, on the basis of biometric methods, that the collective species E. polygoni and E. cichoracearum include lineages or subspecious which are well defined and which can be differentiated by the dimensions of the conidia. However -- perhaps due to the presence of more than one lineage -- these dimensions may not always be on the same host and, on the other hand, the same dimensions may correspond to several different species. Although the biometric characteristics of the conidia can therefore be utilized to a certain extent in the differentiation of the lineages of the same species according to this author, they do not make it possible to reference an unknown oidium or type of tobacco mildew to a particular species.

The work of Schmitt (1954) on E. cichoracearum shows on the contrary that there is no morphological basis which makes it possible to distinguish these different forms.

On the other hand, within the same biotype, considerable biometric differences may show up depending on the species which is host to the parasite. The experiences of experimental innoculation of Hammarlund (1954) in Sweden which induced this author, in contrast to what he himself thought 20 years earlier, to establish the collective species E. polyphaga demonstrates this problem very well. This author therefore employs the term matrix form or forma matricalis for designating these morphological forms which have no relation to the specialization of the parasite. The conidia of the E. polyphaga f.m. chrysanthemi-indici, for example, measure on the average 40 x 20 microns whereas those of E. polyphaga f.m. solani-tuberosi measure only 27 x 15.

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Concerning specifically the tobacco mildew, many plants in various countries have been suspected of hosting the parasite responsible for the disease.

In Java, an oïdium was reported by Schwarz (1926) on a very widely distributed weed, physalis minima. The measurement of the conidia gave as average dimensions 30.27 x 17.01 microns as against 31.90 x 16.19 and 31.18 x 15.16 for those collected on tobacco respectively at Buitenzorg and in Vorstenland. The author therefore concludes -- perhaps hastily -- on the identity of the parasites of physalis and of tobacco. The same is supposed to be true for heliotropum indicum (D'Angremond, 1924).

Also in Java, Thung (1937) reported an oïdium on crotolaria juncea and also on peanut plants growing in plantations of infected tobacco. However, he made no statement on the possible identity of the parasites.

The plants of the family of Cucurbitaceae, on which mildew is very frequent, may have special importance as sources of infection. In the Crimea, inoculations carried out by Deckenbach (1924) on various species of cucurbitaceae by means of conidia collected on tobacco gave positive results. However, the author did not observe the formation of sexual fructification on these plants -- nor anywhere else except on tobacco -- whereas both he and Koreneff (1927) found them in abundance on the melon of the perithicia of E. cichoracearum and of sphaerotheca fuliginea.

In Italy, Marcelli (1949-1950) demonstrated by cross inoculation under glass that S. fuliginea was not pathogenic for tobacco. On the other hand, E. cichoracearum, identified on tobacco due to the formation of numerous perithecia, only slightly infected various species of cucurbitaceae -- without here forming perithecia -- and was entirely incapable of infecting the species of 11 other families tested, although they are known as hosts of E. cichoracearum. Such a degree of specialization in regard to tobacco is sufficient, according to this author, to justify the designation proposed by Jaczewski of E. cichoracearum f. nicotianae.

In opposition to this, Uozumi Yoshii (1952) in Japan experimentally infected Cucurbitaceae with various types of mildew and found that E. cichoracearum of tobacco was not pathogenic for cucumber.

Blumer (1952), during his investigations at Zurich on the specialization of the Erysiphaceae, found new species sensitive to E. polyphaga of cucumber which brought the total of known hosts for these species to some 100 including tobacco. Inversely, he was able to infect cucumber by conidia collected from tobacco.

In France, Ducomet (1921) reported a mildew on the potato which he was not able to determine with certainty since the existing perithecia did not contain any asci. However, he believed that this concerned E.

cichoracearum or a related form, perhaps E. solani, a species reported by Vahna (1902) but not described. In regard to this, we should point out that Hopkins (1948) in Rhodesia was able to infect tobacco plants under glass through conidia collected on potatoes. However, the disease then developed with a lesser virulence when the conidia used for infection originated directly from tobacco.

It is evident that the results obtained are somewhat different according to the different authors. This can be explained at least partially because it is almost certain that not only one biological race of oïdium exists on tobacco but regional forms and perhaps different species (Erysiphe cichoracearum and E. polyphaga, for example, inasmuch as these two species may be definitely distinct) which may be the cause of the disease.

The general absence of perithecia, the uncertain systematic reliability of the morphology and the biometrics of the imperfectly developed form, the necessarily fragmentary character of the few experiments of cross inoculation which have been carried out, prevent us from formulating a definite conclusion on this point.

However that may be, there seems to exist one or some races of oïdium specialized on tobacco, if not exclusively at least by preference. From certain of the investigations referred to above, it would seem that a rather large number of vegetable species are frequently capable of providing minor development of some form of the parasite whereas a large development and the formation of sexual fructification -- outside of conditions of the milieu -- require a much more advanced specialization.

THE SYMPTOMS OF THE DISEASE

The oïdium first develops on the lowest leaves of the tobacco plants in the form of small circular spots which are covered by a white efflorescence and have a diameter of 1 cm or less. The spots rapidly appear in large numbers on the upper face of the leaves and sometimes even join to form a continuous white coating. However, d'Angremond (1924) in Java observed that, contrary to popular opinion, the first symptoms do not appear on the upper but on the lower face of the leaves and some foci of infection then form on the upper face from where the fungus spreads along the lateral ribs.

Depending upon the severity of the attack, the infection may be limited to the leaves of the base or spread over the entire plant. The stalk itself and the ramifications may also be attacked (Bouriquet, 1946).

The powdery white appearance characteristic of the disease is due to the mass of conidia formed by the fungus but it also happens that, during incubation, the climatic conditions become unfavorable for the normal development of the parasite. Spores are then not formed and the infection is difficult to detect locally. However, the affected leaves present a pale yellow shade different from the normal yellowing of the mature plants. The upper layer of cells of these leaves is entirely penetrated by the mycelium and, when the conditions become favorable for sporulation, the entire surface is rapidly covered by the typical whitish coating.

If such infected leaves not carrying conidia are erroneously considered as mature and are harvested and stocked, they rapidly turn black and may rot completely (Hopkins, 1956).

At processing, we occasionally see clear, round, small or large spots or pustules on the leaves which were not apparent on the green leaf. As a general rule, they are caused by the action of the oidium on the cells of the leaf.

According to Moore and Retief (1938), the adoption of the practice of "flue curing" in South Africa has greatly increased the importance of oidium. Leaves which presented only traces of the infection upon harvesting become, after processing, so strongly marked that they lose any commercial value.

It would seem very unlikely that oidium, a disease of the vegetative organs, has any action on the seeds. This point was confirmed by Morozoff, Zelenina and Kuzmina (1936) who observed that the infection did not alter the viability of the seed grains.

We sometimes observe, for example in Madagascar (Bouriquet, 1946), on the conidiophores of oidium, small pycnidia of the super-parasite Cicinnobolus cesatii de By. which is known to attack a large number of Erysiphaceae.

CONDITIONS FOR DEVELOPMENT OF THE PARASITE

These are not all known in detail and, depending on the stage of development such as infection, growth of the mycelium, and production of conidia or the formation of perithecia, optimum conditions may be entirely different. Several authors have investigated this problem by artificially varying temperature and hygrometric conditions. Perhaps due to the probable presence of several forms or species of the tobacco mildew, the results of these experiments sometimes are appreciably different.

High humidity is apparently necessary for the germination of the spores of oidium and consequently for infection. An atmospheric moisture of 80-90% according to the investigations of Blumer (1927) on Lappa spp. or at least 85% according to those of Deslandes (1954) on lettuce, appears to be essential for germination of the conidia of Erysiphe cichoracearum. In the experiments of Blumer, the duration of the period of incubation was shorter by one or two days at 80-90% of saturation than at the other hygrometric conditions tested (60-70 and 40-50).

Opposed to this, Levykh (1940) in Russia found that the optimum humidity for the germination of the spores of oidium tabaci lay between 60 and 100% and for infection between 60 and 75% of saturation and further found that the oidium germinates well in humid chambers on dry slides but not in drops of water. Marcelli (1950) in Italy also obtained satisfactory development of E. cichoracearum on tobacco plants under glass with an hygrometric state of 60 to 75%

The appearance of fructifications requires entirely different conditions. A very high humidity is not favorable for the formation of the conidia. Levykh obtained conidia by lowering the atmospheric moisture to 70-76%. In regard to perithecia, they are formed only under rather pronounced dry conditions as was shown by various researchers including Blumer (1927). We do find in general that the perithecia appear only rarely in humid tropical countries.

As concerns the temperature, the observations of the various authors differ somewhat in this respect. Levykh (1940) observed germination of conidia at temperatures between 11 and 25 degrees C. Optimum conditions for infection lie between 16 and 23% and the most favorable mean between 18 and 19%. Deslandes (1954) on lettuce also found that temperatures between 18 and 24°C were favorable for the germination of the spores of Erysiphe cichoracearum and of about 18° C for the parasite. In contrast to this, Rossouw (1957) in South Africa found as optimum temperature 23.5° C. No development occurs below 5° or above 25° C. However, Marcelli (1950) obtained very favorable conditions for infection under glass at 25-28° C.

As pointed out by Levykh, the infection may produce itself under natural conditions even if the daily temperature exceeds the maximum -- 26.2° C. according to this author -- provided that the optimum temperature (18-19° C.) is attained during the night.

Although cool and moist weather and a very low luminosity favor the infection and the growth of the mycelium within the leaf tissues, the spores are produced in great number (Hopkins 1928) only when the weather becomes dryer and more sunny. On the other hand, several authors including d'Angremond (1924) stressed that heavy rains beating the spores to the ground where they are incapable of developing saprophytically, retard the spread of the disease.

Consequently, alternately cool and moist weather (in particular cold nights) and sunny days favor both the infection and the formation of the conidia (Hopkins, 1928, 1936). Such weather therefore constitutes an essential factor for the rapid extension of the epiphyte. In contrast, late heavy rains and abnormally hot nights considerably interfere with the development of oidium as was the case in Rhodesia in 1927 (Hopkins 1930).

All these facts correspond perfectly to the observations made in various countries. In Java, d'Angremond (1924) observed the first attacks in plantations with a high ground water level and in the indigenous gardens where wind and sun do not enter freely. Thung (1936) also found these initial foci of infection along ditches or in other low, humid and shaded zones. In South Africa, Moore (1926) also attributed the importance of the infection to a moist season and excessive irrigation.

The well defined conditions for the development of the epyphite make it understandable why the disease is of very variable extent as a function of geographical location. In Madagascar where oïdium is negligible along the coast, it is frequent on the high plateaus (Bouriquet, 1934). These conditions also explain the seasonal development of the epiphyte which may vary considerably in intensity from one year to the next.

Although climatic conditions play a preponderant role in regard to oïdium, other factors also enter into the problem. The question of the resistance of a specific variety will be discussed further below but some facts merit being already pointed out here.

In addition to conditions favorable for the infection relative to their position on the plant, it seems that older leaves are more sensitive to oïdium. Thung (1935) noted that the severity of the attacks increased with the age of the plants and Bouriquet (1946) noted that the disease was particularly frequent on seed plants. This was correlated by D'Angremond (1954) who showed that Erysiphe cichoracearum develops best on the adult leaves of lettuce but does not grow well on seedlings and on rapidly growing plants.

It has also been reported that heavy doses of nitrogen fertilizer favor the infection by increasing the vegetative development of the tobacco (Hopkins, 1956). However, D'Angremond did not observe any relation between the intensity of the disease and the application of fertilizer (1924) or ammonium sulphate with or without superphosphates (1926).

The conidia of oïdium are easily carried by wind and rain. Those carried by the wind may cover great distances and could cause the appearance of primary foci.

However, the question of wintering of Erysiphaceae is still in dispute. In hot countries, it is evidently less acute since the parasite may normally survive from one season to the other on the tobacco plants kept for bearing seed or simply forgotten and also on spontaneous or non-spontaneous host plants. By contrast, during winter in temperate countries, the organs able to conserve the fungus in a vegetative form are rare or are of doubtful a value such as buds, remaining leaves, and non-lignified shoots.

There have been reported supposed chlamydosporae but, according to Viennot Bourgin (1949), the thickening observed at the extremity of the hyphae of various species such as Erysiphe cichoracearum is primarily a sign of degeneration.

For the tobacco mildew, the role played by the perithecia in wintering does not seem very important in view of their general infrequency. As to the various types of oidium, they lose their capability for germination more or less rapidly depending on temperature and atmospheric moisture. In the experiments of Levykh (1940), where virulence decreased most rapidly between 19-21 degrees and 40-58% of moisture. With an atmospheric moisture of 80 to 89%, the conidia survived only 12 days. However, the conidia of E. horridula (synonyme of E. polyphaga?) may be capable of wintering (Viennot Bourgin, 1949).

INDIRECT CONTROL BY PROCESSES OF CULTIVATION

Wherever oidium is widespread, cultivation techniques must be designed to render the milieu unfavorable for the development of the epiphyte and to avoid in particular an excessive humidity at the base of the plants. One of the first rules is to avoid shaded and poorly aerated locations as well as poorly drained soils. In a given case, the installation of a more or less developed drainage system may be contemplated.

The spacing of the plants should produce maximum conditions of free air circulation in order to avoid to the greatest possible extent that the atmospheric moisture under cover of the leaves reaches the saturation point. It is therefore generally recommended to space the rows sufficiently. However, Thung (1937) noted in regard to this point that increased leave development as the result of wide spacing of the plants increased the importance of the attacks.

Experiments carried out in 1956 at Madagascar by the Agronomical Research Station of Lake Alaotra established no correlation between the five methods of spacing experimented and the intensity of the attacks.

On the other hand, the rows may be oriented as a function of the prevailing winds of the particular region. Putterill (1923) thus recommends, for the western province of the Cape, to orient them south-east and north-west in such manner that the "southeasterly winds" can freely aerate them. Hopkins (1956) on his part advised orienting them from east to west which allows the plants to receive a maximum of sunshine. This orientation also showed itself to be very favorable in Madagascar in 1956 and gave, by comparison to a north-south orientation, a higher yield in sound and in non-graded leaves.

The lower leaves contribute both to maintain a high humidity at the base of the plant and on the other hand regularly carry the first fungi of infection. Their elimination is a highly recommended measure by numerous authors. Hopkins (1928) found that the removal of six to eight of the lower leaves did not affect the harvest since the plants produces new leaves above them, and reduces the attacks of oidium appreciably. In other experiments, this author (1930) noted that the plantings so pruned produced 658.8 pounds of green leaves per acre (with a 49% loss from Bacterium angulatum and Cercospora nicotianae) as against 583.21 pounds and 54% of losses for plants not having been pruned.

Moore and Retief (1936) suggest carrying out this operation in the plants to about 30 cm above ground and to continue it at suitable intervals until maturity approaches. At that time, all the leaves located at less than 30 cm from the ground must be removed and, obviously, the lowest leaves remaining on the plant should not touch the ground.

At Madagascar in 1957, it was observed, on the other hand, that pruning to a height of 30 cm exceeded the objective and lost valuable leaves. Continued pruning, i.e., the removal of 4 or 5 leaves during the growth of the plant in such manner that no leaves touch the ground was much preferable since it permitted a yield of an average per planting ("parcelle") of 3.25 kg of sound leaves after drying as against 2.75 kg with systematic pruning to a hieght of 20 cm off the ground, 2.25 kg without pruning and only 1 kg with pruning to a height of 30 cm above the ground.

Pruning is often accompanied by chemical treatment and increases the efficacity of the latter very much. The results of the experiments carried out at Madagascar even lead to the conclusion that chemical treatment should be carried out only on plantations which are well cared for and regularly pruned.

In certain regions, oidium is heavy in seedbeds. It then becomes necessary to select a well exposed, warm, sunny location distant from trees and with a fertile, well drained and cultivated soil. Retief (1951) also recommends, in addition to chemical treatment and eventual sterilisation of this soil, to raise the top of the rows about 15 cm above the ground in order to further improve drainage.

It is obviously inadvisable to introduce into crop rotation plants sensitive to tobacco mildew unless the planting of the tobacco and that of such plants has been preceded by cultivating several other species which are resistant to oidium (Hopkins, 1956). In addition, sensitive plants in the neighborhood of tobacco plantations constitute a danger for the latter which should be avoided as much as possible.

Furthermore, since the development of the oidium is seasonal, judiciously selected dates of planting may make it possible to place the development of the plants outside of the period favorable for the epiphyte. Very special importance should be given to the fact that harvesting should begin before the onset of cool nights. Early planting therefore constitutes an essential step in the Union of South Africa (Hopkins, 1956). The same was true in the experiments at Madagascar in 1956 which established comparisons between four dates of planting starting between 15 January and 1 March where the plots planted in January were free of infection but the attacks became more and more heavy for the later dates.

RESISTANT VARIETIES (OF TOBACCO)

Naturally, the use of varieties combining good economic qualities with a tested resistance to the parasite constitutes a choice method in the control of the disease. In the case of tobacco mildew, the problem is complicated by the fact of the multiplicity of lineages of the parasite. As pointed out by Hopkins (1956), varieties having proved their resistance in a given location may be very vulnerable elsewhere. Selection must therefore be made locally and the producers of seed grains should place their fields of seed plants so that optimum conditions exist for the development of the disease and it will become easy to eliminate the sensitive plants.

In Java, Thung (1935) noted that the large-leaved varieties such as E-3-K and E-K were more seriously affected than those having a less luxurious growth such as Kassari or Y-10. The same author (1938, 1939) stressed the resistant character of the variety Timor-Vorstenland which remained practically free of oldium when brought into contact with heavily infected lineages of the variety Chlorina x K-w-10.

In South Africa, the variety Hickory Prior with large and thin leaves which was widely cultivated during a certain period, showed itself to be sensitive and was replaced by tobacco of the Orinoco type. Hopkins noted in 1931 that the heavier types such as Orinoco white stem and Warne presented a certain resistance. Several years ago, research was undertaken on a variety combining satisfactory agronomical and technological characteristics with the nearly complete immunity found among various members of the tobacco family but unfortunately not very close to the commercial type (Stephen, 1954).

It has been noted in Russia that hybrids of Nicotiana glutinosa and N. tomentosiformis presented a very interesting degree of resistance to tobacco mildew and also to tobacco mosaic (Ternovsky, 1947). Experiments were carried out on "vegetative hybrids" obtained by grafting types of tobacco sensitive to oldium on immune varieties. According to Ternovsky, 1951, these forms preserved constant immunity for 4 or 5 generations and maintained this characteristic during cross breeding of the subsequent generations.

At Krasnodar, hybrids resistant to various diseases including oldium were obtained by crossing the variety Dubec 44 with Nicotiana silvestris, N. tomentosiformis and N. glutinosa and by again crossing the resulting hybrids with Dubec 44. The immunity of N. alata and N. sandere were shown to be unsuitable due to the sterility of the hybrids. Crossing of N. glauca with tobacco and N. rustica produces infertile hybrids. Resistant characteristics exist in the varieties Dubec 7, Dubec 566, Samsun 47/10, Alma-Atinsky 315, Trapezoid 161, Trapezoid Talassky and Ostrolist Immuny (Ternovsky, 1958).

In Italy, Marcelli (1949) did research on the degree of sensitivity of various species of Nicotiana and races of N. rustica, on plants growing under glass, under conditions favorable for the development of oidium. About two weeks after the appearance of the conidia, the percentages of leaf surface affected by the parasite were the following in the various species of Nicotiana:

N. lancifolia 75%
N. virginica 75
N. harvanensis 70
N. frusticosa 51
N. basiliensis 48
N. macrophylla 30

whereas N. glauca, N. glutinosa, N. tomentosa, N. paniculata and N. alata remain unaffected and N. silvestris shows only a negligible degree of infection. Among the commercial varieties, the author recorded the following percentages:

Perustitsa 86%
Xanthi Jaka 74
Erzegovina 60
American Burley 56
Virginia Bright 54
Sumatra 51
American Kentucky 51
Resistente 232 43
Maryland di Cava 38
Maryland Riprodotto 37
Burley di gran reddito 36

According to him, these figures show that the planters should plant one of the last three or possibly five varieties wherever the disease is endemic.

CHEMICAL TREATMENTS

Since the leaves of tobacco very strongly retain the f'ne particles which come into contact with them, any chemical treatment app..ed to the leaves has the risk of irremediably altering the quality of the prepared tobacco. Fungicides which give excellent results against oidium on other plantings may therefore show themselves useless in this case or may require special methods of application.

Sulphur, which is a valuable anticryptogamic agent in the control of oidium when applied as a powder, renders tobacco totally unfit for consumption. It is of little use therefore that it is effective to 98-99% in the control of the disease (D'Angremond, 1924). However, sulphur acts largely by emitting vapors and the difficulty can therefore be avoided by replacing dusting of the plant elements above ground by spreading the sulphur at the foot of the plant.

Such spreading must obviously be effected with sufficient care to prevent any of the sulphur from reaching the leaves and during a time when the air is perfectly still. However, Alexandroff (1927) recommended in the Crimea that not only the ground but also the low leaves should be dusted. On the other hand, in spite of all care, Moore and Retief (1938) found through chemical analysis that appreciable quantities of the sulphur were deposited on leaves, even those formed after processing, so that they unqualifiedly rejected this method of control. Be that as it may, the method has been and is still being used to some extent everywhere.

Originally, the quantities used were very high. In Java, experiments effected in 1922 included doses of 500 kg of sulphur per hectar. Due to the treatment, the percentage of sound leaves after drying and fermentation reached 98%. From the adjacent untreated plots, it was still 90% which shows the far-reaching action of sulphur because the percentage dropped to 41.6% on plots further away. Later on, attempts were made to reduce the quantities and, in 1923, satisfactory control was obtained with doses on the order of 175 kg/ha, provided that the sulphur was spread at the beginning of the attack. However, if the disease had already affected three to six leaves of the plant, doses of 265 kg/ha were unable to control the epiphyte. In 1924-1925, unusual climatic conditions made the treatment less effective (D'Angremond, 1924, 1926). With lower quantities, Thung (1940) obtained appreciably less satisfactory results during the second harvest. In the experiments of this author, the percentages of sound plants on plots having been treated with about 190 and 95 kg of sulphur per hectar and on the control plots were respectively 81.5, 73.4 and 57.8%.

In South Africa, Hopkins (1928) obtained nearly complete control of the oidium on the sensitive variety Hictory Prior with 1-3 applications of 40 kg of sulphur per hectar. In later tests, in addition to spreading low quantities of sulphur (20 kg/ha), pruning to 25-30 cm above the ground was carried out in such manner as to permit the development of 9 or 10 leaves of good size. The number of infected plants, of a total of 620, was lowered to 378, and in the controls to 26.5, on plots treated in this manner. Pruning by itself lowered the number from 398 to 88. However, without pruning, a single application of sulphur at the dose utilized was without effect and two applications did not reduce the infection by more than about two-thirds (Hopkins, 1930).

Also in South Africa, Moore and Retief (1938) carried out experiments on the influence of the date of application. A single application carried out one or two months after planting gives protection persisting for several weeks. Upon harvesting, the latest treatment was shown to be slightly more effective. In contrast to this, spreading of about 60 kg of sulphur per hectar before planting does not provide a satisfactory degree of control.

Sempio and Lucacci (1953) recommended, in Central Italy, doses of 100-120 kg of sulphur per hectar spread along alternate rows, with the first application taking place at the end of July or beginning of August and repeating the treatment after irrigation or heavy rains. According to these authors, this method is suitable for a hot climate and for sunny fields where the leaves are thick enough to prevent dispersion of the sulphur vapors. With varieties of tobacco which do not cover the ground very well and when a cool and moist summer favors the development of the epiphyte, Lucacci and D'Armini (1953) advise dusting with colloidal sulphur V.P. at 0.3-4% and of calcium polysulphate at 0.2-0.3%. Under the conditions prevailing in these regions, a first application on the upper surface of the leaves should be effected during the first two weeks in August and repeated upon the first signs of infection or after heavy rains. With such a treatment, the plants showed only traces of infection whereas the control plants were seriously affected. According to the authors, the leaves so treated conserve a normal or improved aroma.

In order to evaluate the damage from mildew, Scaramuzzi and Ciferri (1949) developed a simple method. Each leaf is divided into 12 sectors to each of which is assigned a value of 1, or into 8 sections each of which has a value of 1.5. On each sector, a trace of infection is noted at the beginning (C_1), and at the end of the experiment (C_2). When the averages of C_1 and C_2 are known, a control index (D)

$$D = 100 - 100 \frac{C_1}{C_2}$$

can be obtained.

Scaramuzzi (1949) employed this method on tobacco plants under glass artificially inoculated and then treated by various fungicides and found that sulphur composed of particles of 60 microns or larger gave better control than sulphur with smaller particles. Colloidal sulphur with particles of a maximum of one micron in diameter were even less effective. However, the concentrations utilized in this experiment were different, according to the product, i.e., 1 to 0.25% for dusting sulphur, 0.5 - 0.12% for micronized sulphur, and 0.05 to 0.01% for colloidal sulphur.

At Madagascar, several experiments to be discussed later were carried out to compare the effectiveness of treatment by sulphur spread at 25 and 50 kg/ha to that of other products. In cases where oidium appeared belatedly, sulphur had the advantage of its greater duration of action.

Since the organoleptic modifications due to treatment need not be considered in the seed-bed, the selection of products is much more easy. Hopkins (1956) suggests weekly dusting of the young plants with a special mixture ("seed-bed mixture") composed of 2.5% of DDT with 5% of active matter, 5% of copper oxychloride, 25% of finely powdered sulphur and 67.5% of talcum.

Such other standard anticryptogamic agents as copper and calcium sulphite is practically not used due to their damaging effect on processed tobacco.

D'Angremond (1924), from findings obtained in Java in 1918, also reported that the control by calcium sulphite spray or Bordeaux mixture was not satisfactory in comparison to dusting with sulphur: 48.77 and 8.06% of sound plants as against 98-99%. In addition, the calcium sulphite spray produced serious burns on the leaves. However, calcium sulphite was recommended in Russia by Grooshevoy and Levykh (1940) at a concentration of 1%. Although they acknowledge that the treatment lowered the quality of the tobacco somewhat, these authors did consider that the oidium would otherwise have affected the tobacco even more strongly. On the other hand, Venkatarayan (1937) in India reported that oidium had been controlled by using the Bordeaux mixture at 1% in combination with the removal of the lower leaves.

Recommended by Lucacci and d'Armini (1953), calcium polysulphide at 0.2-0.3% was found to be effective by D'Angremond (1926) as well as also potassium polysulphide but was abandoned by this author due to the particles adhering to the leaves.

In experiments in Algeria in 1956 (Frezal, 1957), calcium polysulphides at 2% produced satisfactory control without any phytotoxic action. Unfortunately, the disagreeable organoleptic characteristics of the tobacco produced were so pronounced that this treatment had to be abandoned.

Polysulphide of polyethylene applied to various young plants provided the same or better control than that obtained with soluble ("mouillable") sulphur; however, at 0.5% the results were on the average less satisfactory than those with soluble sulphur (Ciferri and Scaramuzzi, 1949).

Sometimes recommended as a curative agent for plant mildews, potassium permanganate has been tested on tobacco by various authors. The experiments under glass of Scaramuzzi (1949) showed an appreciable effectiveness of this product at a concentration of 0.1 to 0.5%. On the other hand, d'Angremond (1926) in Java has held that it makes the infection more severe and Marcelli (1952) also held that it caused severe burns.

Salicylic anilide has been tried out on tobacco for more than 20 years. Thung (1936) reported that "shirlan," trade name of the product, was effective against mildew by dusting but did not consider an extended use possible. Shirlan had already been employed successfully against the same parasite on cucumber (Orchard, 1933). During experiments under glass, Marcelli (1952) noted that dusting with salicylic anilide repeated twice had a remarkably preventive action and provided better control than dusting with sulphur.

Consideration has been given to controlling mildews by means of products penetrating into the tissues of the plant with the sap. Experiments in this direction were made in Italy on tobacco seedlings under glass by wetting the soil with solutions of thiosulphate or lithium salts. The first product was effective only as a curative agent at concentrations of 1.5 to 2% which caused serious damage to the plants. On the other hand lithium carbonate in 50% and in fully-saturated solutions (about 0.685 and 1.37%) was a very effective preventive but not a curative agent: 30 days after infection, plants treated 3 times at intervals of 3 days with the saturated solution had an index of infection of 22 as against an index of 337 for the controls (Vidali and Ciferri, 1951). Wetting of the soil a second time and 25 days later with solutions of 50% and 25% of saturation -- concentrations perhaps too low -- did not give satisfactory control. However, the plants so treated showed a better development than that of the control (Vidali, 1952).

New tests under glass by D'Armini (1953) showed that the treatment actually reduced the number of infected plants but caused mark burns on the leaves. The author therefore concluded that, although lithium carbonate is effective against mildew, the optimum dose is easily either exceeded or not reached, depending on the quantity and the quality of the ground so treated.

A recent product, "Karathane" (methyl-heptyl dinitrophenyl rotomate?) is a specific for mildew. Furnished as soluble powder at 25% of active matter, emulsifiable products at 25% and 50% of active matter or in dusting powder form at 1.5 and 3% of active matter, it has been the subject of numerous tests with promising results.

Whereas the action of the sulphur by emission of vapors is a function of the temperature, Karathane is very active beginning at 3-4°C. Due to this particular property, it is, according to Hey (1957), more effective than sulphur below 18° but has the disadvantage, above 32°, of the possibility of damaging the leaves.

On cucumber infected with Erysiphe cichoracearum, three treatments with Karathane at concentrations of 0.41 and 0.60 ppm showed themselves more effective than sulphur or copper (McKeen, 1954). The author noted that the application of the product in the form of a fog caused much less damage to the leaves than the standard dusting methods.

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Experiments (with Karathane) on tobacco have been carried out in several countries. In South Africa, control was very satisfactory (Neveling, 1954, 1955; Van Der Blanck, 1955). The latter noted that it was preferable to sulphur which alters the quality of the tobacco. Rossouw (1957) also believes that it has a less damaging effect on quality because the product decomposes rapidly.

In tests carried out in Algeria in 1956, Karathane was compared with other products which had an equal or greater fungicidal property but were considered unsatisfactory due to the alteration of the organoleptic qualities of the tobacco obtained. At a concentration of 0.122%, Karathane slightly modifies the aroma of the tobacco but this disadvantage was no longer noticeable at a concentration of 0.061%. On the other hand, under these experimental conditions, the low dose caused slight burns; unfortunately, at the higher dose, these become rather severe and we also find a yellow and viscous deposit on the leaves. Such a deposit was also noted in some cases at Madagascar.

In Italy, in the experiments under glass of Ciferri (1957) on the variety Xanthy Yaka, dusting with Karathane at 0.08%, in 3 intervals, completely controlled oidium tabaci. Four weeks after treatment, the control index as calculated by the method already explained was 57. Other tests under glass by Marcelli (1957) on Virginia Bright showed that dusting with Karathane at 0.06% 3 days after transfer to the glass house protected the plants for 2 weeks, and was better than the salicylic anilide at 0.8% used as control. At concentrations of 0.12 and 0.18%, the duration of protection by Karathane reached 3 weeks. These results were confirmed in the open field in experiments utilising the product either in the form of powder at 0.06% or in the form of an emulsion at 0.05%. The treatment did not seem to affect either the taste or the aroma of the tobacco.

At Madagascar, a number of experiments were carried out in 1955 for comparing Karathane with various other products. The results varied rather considerably depending on the date at which treatment was started. In 1957, in particular, the delayed appearance of the mildew favored the sulphur treatment, the action of which is more persistent: under these conditions, although the count of green leaves placed Karathane first (dusted 4 times at intervals of 8 days with 500 liters of 0.12% of Karathane combined with a wetting agent ("staldime") at 0.1%), the sulphur treatment (spread twice at intervals of 10 days at 25 kg/ha) provided the largest quantity of dried sound leaves. On the other hand, in 1955, plots subjected to Karathane dusting four times, produced 18,425 g of sound dried leaves as against 12,570 g for plants dusted twice with sulphur and 7,215 g for the controls. Sulphur spread once gave results which differ very little from those obtained by spreading the sulphur twice (11,740 g) but Karathane dusting at 2 instead of 4 times made such treatment practically ineffective (7,300 g).

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Another experiment combining Karathane treatment and pruning proved that the best results are obtained by combining the two operations, regardless of whether the results are expressed as a percentage of leaves infected at harvest time (18% as against 59% for the controls) or by weight of sound dried leaves (3,775 g as against 2,200). It would seem that Karathane and pruning share about equally in this improvement.

CONCLUSION

In the problem of tobacco mildew, the essential point which needs to be clarified therefore seems to be definitely the exact identity of the parasite which remains a subject of discussion in many countries. Actually, only the precise determination of the species or the race responsible for the mildew will make it possible for the planters of a given region to fully avail themselves of the findings of foreign researchers in regard to selection for example. This may also settle the apparent contradictions which can be noted in the observations of various authors on the biology of the parasite and specifically, on the important question of the host plants. However, the impossibility of cultivating the responsible fungus in the laboratory, except by way of tissue or organ cultures, appreciably reduces the chance of obtaining sexual fructifications which so far seem to be necessary for identification since the morphological and biometric characteristics of the forms of oidium (the biochemical and cytological characteristics have not yet been utilized as far as we know) fluctuate too greatly or are insufficiently pronounced to give any indications of real value.

Fortunately, such exact determination is not entirely necessary when chemical agents of control are employed. Inspite of the difficulties of applying such treatments to tobacco, at least two must be taken into consideration; there is first Karathane which must be combined with a wetting agent if it is employed by dusting and second the standard method of spreading sulphur on the ground. The former does not appear to offer any major disadvantages as long as the temperature remains relatively low. The latter becomes increasingly effective in hot weather. Both together therefore make it theoretically possible to cover the entire range of climatic conditions which may be present in the cultivation of tobacco. Both are not entirely free from objections. Karathane has a relatively reduced duration of action so that treatment must be repeated more frequently and thus raises costs. With sulphur, even if the spreading is carried out very carefully, the risk of alteration of the aroma of the tobacco is always present.

In coming years, there will certainly be developed other treatments which may be preferable from the point of view of effectiveness, quality of the tobacco and profitability. Experiments which are not yet sufficiently far advanced to permit any conclusion are being effected and show promising results. One of these, for example, is dusting of the leaves with small doses of colloidal sulphur.

Nor should we forget in regard to control of the epiphyte that some elementary precautions are sufficient in themselves to considerably increase the chances of the planter. A suitable orientation of rows and judicious choice of the date of planting as a function of the climatic characteristics of the region may reduce the risk of infection to a high degree on a sound, well cultivated and maintained terrain. It would seem, moreover, that pruning is essential to provide the maximum effectiveness of chemical treatments without which they tend not to be uneconomical.

LITERATURE REFERENCES

ALEXANDROFF, L. A. - L'oidium du tabac (Oidium tabaci Thum.) sur la Cote meridionale de Crimee en 1926 (en Russe). Mat. pour la Mycol. et la Phytopath., Leningrad, VI, pp. 54-66, 1927.

ANONYME. - Rapport annuel 1956 de la Station de Recherches Agronomiques du Lac Alaotra. Non public, 1957.

ANONYME. - Rapport annuel 1957 de la Station de Recherches Agronomiques du Lac Alaotra. Non public, 1958.

ANONYME. - Essais de lutte contre l'oidium du tabac a Madagascar. Journees Francaises d'Etudes et d'Informations cons. aux fongic. agric., Paris, nov. 1958, pp. 209-212, 1958.

AVERNA-SACCA R. - Algumas das molestias cryptogamicas do tabaco (Nicotiana tabacum). Bol. de Agric. Sao-Paulo, Ser. XXIII, pp. 201-268, 1922.

BLUMER S. - Variation statistische Untersuchungen an Erysiphaceen. Ann. Mycol., XXIV, 3-4, pp. 179-193, 1926.

BLUMER S. - Neue Wirtopflanzen von Mehltaupilzen. Zeitschr. fur Pflanzenkrankh. u. Pflanzenschutz, XXXVI, 7-8, pp. 232-236, 1926.

BLUMER S. - Ueber den Einfluss ausserer Faktoren auf die Entwicklung der Mehltaupilze. (Autorreferat). Mitt Naturforsch. Gesellsch. Bern., 1926, pp. XXVII-XXVIII, 1927.

BLUMER S - Beitrage zur Spezialisation der Erysiphecen. Ber Schweiz. bot. Ges., LXII, pp. 384-401, 1952.

BOURIQUET G. - Les Maladies du tabac a Madagascar. Ann. de Cryptog. exot., VII, 2, pp. 97-112, 1934.

BOURIQUET G. - Les Maladies des plantes cultivees a Madagascar. P. Lechevalier ed., Paris, pp. 309-313, 1946.

CIFERRI R. - La lotta contro l'oidio del Tabacco con il caratano. Tabacco, Roma, LXI, 682, pp. 3-9, 1957.

p

CIFERRI R. et SCARAMUZZI G. - Saggi dell' attivita anticrittogamica dei polisolfori di polietilene in testi di laboratorio e contro l'oidio del tabacco. Notiz. Malatt. Piante, 2, pp. 11-15, 1949.

COOKE W. B. - Nomenclatural notes on the Erysiphaceae. Mycologia, XLIV, 4, pp. 570-574, 1952.

D'ANGREMOND A. - De Veldschimmel (Oidium spec.) in de Vorstenlanden. Meded. Proefstat. Vorstenlandsche Tabak, XLIX, pp. 7-25, 1924.

D'ANGREMOND A. - Verdere onderzoekingen over bestrijding van veldschimmel (Oidium spec.) in de Vorstenlanden. Meded. Proefsat Vorstenlandesche Tabak, LII, 23 pp., 1924.

D'ANGREMOND A. - Jaarverslag van het Proefstation voor Vorstenlandsche Tabak. 1 Mei 1924, 30 April 1925. Meded. Proefstat. Vorstenlandsche Tabak, LV, pp. 31-58, 1926.

D'ANGREMOND A. - Nadere gegevens over bestrijding van veldschimmel (Oidium spec.) in de Vorstenlanden. (34 de Publicatie). Meded. Proefstat. Vorstenlandsche Tabak, LVI, 48 pp., 1926.

D'ARMINI M. - Esperienze di endoprevenzione condotti con carbonato di litio contro l'oidio del tabacco. Tabacco, Roma, LVII, 649-650, pp. 319-323, 1953.

BECKENBACH K. M. - Sur des champignons des oidiums parasitant les cucurbitacees et le tabac sur la cote meridionale de Crimee (en Russe). Morbi Plantarum, Leningrad, XIII, 3-4, pp. 98-102, 1924.

BECKENBACH K. M. et KORENEFF M. S. - Contribution a l'etude des champignons des oidiums des cultures de Crimee (en Russe). Morbi Plantarum, Leningrad, XVI, 2, pp. 155-160, 1927.

DESLANDES J. A. - Studies and observations on Lettuce powdery mildew. The Plant Dis. Reporter, XXXVIII, 8, pp. 560-562, 1954.

DUCOMET V. - Oidium de la pomme de terre et oidium de la betterave. Bull. Soc. de Pathol. veg. de France, VIII, 4, pp. 133-134, 1921.

DUCOMET V. L'oidium du tabac (Erysiphe cichoracearum) en Turquie. Rev. Path. veg. et Entom. agric., XV, 10, p. 288, 1928.

FREZAL P. - Resultats d'etudes et d'experimentations de zoologie agricole, de phytopathologie vegetale et de phytopharmacie obtenus en 1956. Minist. de l'Algerie. Direct. de l'Agric., du Paysannat, des F.r.'s et de la Restauration des sols. non publie, pp. 135-138, 1957.

p

GROUSHEVOY S. E. et LEVYKH P. P. - Methode chimique de controle de l'oidium du tabac (en Russe). Inst. de Rech. pan Soviet. A. I. Mikoyan sur l'Ind. du tabac et tab. indien, Rostoff sur Don, Publ. 141 pp. 78-79, 1940.

HAMMARLUND C. - Zur Genetik, Biologie und Physiologie einiger Erysiphaceen, Hereditas, VI, 1, pp. 1-126, 1925.

HAMMARLUND C. - Beitrage zur Revision einiger imperfekten Mehltau-Arten. Erysiphe polyphaga nov. sp. (Vorlaufige Mitteilung). Bot. Notiser, 1945, 1, pp. 101-108, 1945.

HOPKINS, J. C. F. - Wildfire and angular leaf spot of Tobacco, Rhodesia Agric. Journ., XXV, 2, pp. 139-143, 1928.

HOPKINS, J. C. F. _ Preliminary experiments on the control of white mould of Tobacco. Rhodesia Agric. Journ., XXV, 12, pp. 1342-1348, 1928.

HOPKINS, J. C. F. - Report of Plant pathologist for year ending December 31st, 1929. Rept. of the Secretary, Depart. of Agric., Southern Rhodesia, for the year 1929, pp. 84-86, 1930.

HOPKINS, J. C. F. _ Further experiments on the control of white mould (Erysiphe cichoracearum DC.) of tobacco, 1927-28. Rhodesia Agric. Journ., XXVII, 4, pp. 381-387, 1930.

HOPKINS, J. C. F. - Plan pathology in Southern Rhodesia during the year 1930. Rhodesia Agric. Journ., XXVIII, 4, pp. 384-389. 1931.

HOPKINS J. C. F. - Report of Branch of Botany and Plant Pathology for the year ending 31st December 1947. Rhodesia Agric. Journ., XLV, 4, pp. 330-342, 1948.

HOPKINS J. C. F. - Tobacco diseases with special reference to Africa. The Commonwealth Mycol. Inst. Kew., Surrey, pp. 93-98; 118-119, 1956.

JACZEWSKI A. A. - Cle de poche pour la determination des champignons. Partie II. Oidium. (en Russe). Lab. Mycol. A. A. Jaczewski- Inst. Et. d'Agric. Exp., Leningrad, 626 pp., 1927.

LEVYKH P. M. - Influence de la temperature et de l'humidite de l'air sur l'infection du tabac par l'oidium (Oidium tabacci Thuem.) (en Russe). Inst. de Rech. A.I. Mikoyan sur l'Ind. du tabac et tab. indien, Rostoff sur Don, Publ. 114, pp. 97-111, 1940.

LUCACCI G. & D'ARMINI M. - Lotta contro l'oidio del Tabacco con prodotti solforati a dosa ridotta. Tabacco, Roma, LVII, 651, pp. 354-357, 1953.

MARCELLI E. - Osservazioni preliminari sulla specializzazione del' "Oidio" del Tabacco. Notiz. Malatt. Piante, 6, pp. 21-24, 1949.

MARCELLI E. - Prove sulla suscettibilita all' "Oidio" di diverse specie e razze di Tabacco. Notiz. Malatt. Piante, 6, pp. 330-332, 1950.

MARCELLI E. - Ulteriori osservazioni sulla specilizzazione del'"Oidio" del Tabacco. Tabacco, Roma, LIV, 615, pp. 330-332, 1950.

MARCELLI E. - Ultimi risultati nella lotta contro l'oidio del Tabacco. (Erysiphe cichoracearum). Tabacco, Roma, LVI, 641, pp. 370-374, 1952.

MARCELLI E. Un nuovo prodotto per la lotta contro l'oidio del Tabacco : il Karathane. Prime esperienze li lotta in serra ed in campo. Tabacco, Roma, LXI, 684, pp. 262-269, 1957.

McKEEN C. D. - Observations on the occurance and control of powdery mildew on greenhouse Cucumbers in Ontario. Plant Dis. Reptr., XXXVIII, 12, pp. 860-863, 1954.

MOORE E. S. - Diseases of Virginian Tobacco in South Africa. Journ. Dep. Agric. S. Africa, XII, 5, pp. 428-433, 1926.

MOORE E. S. & RETIEF D. F. - Mildew or white rust of Tobacco, Farming in S. Africa, XI, 118, p. 31, 1936.

MOORE E. S. & RETIEF D. F. - Mildew or white rust of Tobacco. Farming in S. Africa, XIII, 2 pp. 1938.

MOROZOFF A. F., ZELENINA I. N. & KOZMINA O. A - Effets des maladies sur le poids et la qualité des semences (en Russe). Pl. Prot. Leningrad, 10, pp. 148-149, 1936.

NEVELING C. H. - Annual Report of the Secretary for Agriculture for the year ended 31 August, 1933. Farming in S. Africa, XXIX, 334, 124 p., 1934.

NEVELING C. H. - Report of the Secretary for Agriculture for the year ended 31 August, 1934. Farming in S. Africa, XXX, 348, 124 pp., 1955.

ORCHARD O. B. - The control of Cucumber mildew. Eighteenth ann. Rep. Cheshunt Exp. & Res. Stat., 1932, p. 48, 1933.

PALM B. T. - Een Gevaar voor de tabakscultuur in Deli. Bull. Deliproefst. Medan-Sumatra, XIV, 9 pp., 1921.

PUTTERILL V. A. - Plant Diseases in the Western Cap Province IX. Journ. Dep. Agric. S. Africa, VII, 2, pp. 131-134, 1923.

RETIEF D. F. - Preparation, sowing and care of Tobacco seed-beds. Farming in S. Africa, XXVI, p. 304, 1951.

ROGER L. - Phytopathologie des pays chauds. P. Lechevalier ed., Paris, t. II, pp. 1576-1596, 1953.

ROSSOUW D. J. - The control of powdery mildew in Tobacco. Farming in S. Africa, XXXII, 11, 11. 27-28, 1957.

SALMON E. S. - A Monograph of the Erysiphaceae. Mem. Torrey bot. Club, IX, pp. 1-292, 1900.

SCARAMUZZI G. - Dati preliminari di lotta contro l'oidio del Tabacco in prove de serra. Notiz. malatt. Piante, 1, pp. 37-41, 1949.

SCARAMUZZI G. & CIFFERI - Un metodo di valutazione della difesa antioidica sulle foglie di Tabacco. Notiz Malatt. Piante, 1, pp. 9-11, 1949.

SCHMITT J. A. - The host specialization and morphology of the powdery mildew, Erysiphe cichoracearum DC. ex Merat, from Zinnia, Phlox, an cucurbits. Diss. Abstr., XIV, 4, p. 587, 1954.

SCHMITT J. A. - The status of the name Erysiphe cichoracearum DC. Mycologia, XLVII, 3, pp. 422-424, 1955.

SCHWARZ M. B. - Meeldauw van Tabak en Physalis minima. Indische Culturen. (Teysmannia), XI, 9, pp. 238-239, 1926.

SECHET M. - Compte rendu d'essais de traitements contre l'oidium du tabac a l'aide du Karathane. Non publie, 1956.

SEMPIO C. & LUCACCI G. - Lotta contro l'oidio del Tabacco. Tabacco, Roma, LVII, 643, pp. 45-55, 1953.

STEPHEN R. C. - Research into diseases of Tobacco. Rhod. Tobacco, IV, pp. 26-27, 1954.

TERNOVSKY M. F. _ Methodes de selection de varietes de tabac resistant a la mosaique du tabac et a l'oidium (en Russe). Inst. de Rech. pan Soviet. A. I. Mikoyan sur l'ind. du tabac et tab. indien (VITIM), Krasnodar, Publ. 143, pp. 126-141, 1941.

TERNOVSKY M. F. - Resistance a l'oidium chez les hybrides vegetatifs du tabac (en Russe). C. R. Acad. Sci. U.R.S.S., LXXX, p. 437, 1951.

TERNOVSKY M. F. - Utilisation de varieties sauvages de tabac dans la selection en vue de la resistance aux maladies (en Russe). J. Sci. Agric., Moscow, III, 1, pp. 137-139, 1938.

THUNG T. H. - Phytopathologische waarnemingen. Meded. Proefst. Vorstenl Tabak, 81, pp. 25-37, 1935.

THUNG T. H. - Phytopathologische waarnemingen. Meded. Proefst. Vorstent. Taback, 82, pp. 27-35, 1936.

THUNG T. H. - Phytopathologische waarnemingen. Meded. Proefst. Vorstenl. Tabak., 84, pp. 25-42, 1937.

THUNG T. H. - Phytopathologische waarnemingen. Meded. Proefst. Vorstenl. Tabak, 85, pp. 25-39, 1938.

THUNG T. H. - Phytopathologische waarnemingen. Meded. Proefst. Vorstenl. Tabak, 87, pp. 23-46, 1939.

THUNG T. H. - Phytopathologische waarnemingen. Meded. Proefst. Vorstenl. Tabak; 88, pp. 24-28, 1940.

UOZUMI T. & YOSHII H. - Quelques observations sur les oidiums affectant les cucurbitacees (en Japonais). Ann. Soc. Phytopath. Japan. XVI, 3-4, pp. 123-126, 1932.

VENKATARAYAN S. V. - Report on work done in the Mycological Section during the year 1935-1936. Adm. Rep. Agric. Dep. Mysore, 1935-36, pp. 51-55, 1937.

VIDALI A. - Esperienze di lotta contre l'oidio del Tabacco (Erysiphe cichoracearum) effectuate in campo a mezzo di carbonato di litio. Tabacco, Roma, LVI, pp. 16-20, 1952.

VIDALI A. & CIFERRI R. - Esperienze di lotta contre l'oidio del Tabacco (Erysiphe cichoracearum) a mezzo di tiosulfato e sali di litio. Tabacco, Roma, LV, 620, pp. 93-102, 1951.

VIENNOT BOURGIN G. - Les Champignons parasites des Plantes cultivees, Masson et Cie ed., Paris, T.I., pp. 257-264, 268-270, 1949.

p

FIGURE CAPTIONS

Figure 1. Sample of tobacco mildew from Tananariva (collected by G. Bouriquet); 1 = formation of oidia; 2 = oidia; 3 = Pychide (?) Cicinnobolus Cesatii developed in the conidio phore of the oidium.

Figure 2. Oidium of tobacco; aspect of the felting formed by asexual fructifications of the fungus.

(FIGURES NOT INCLUDED IN THIS TRANSLATION)