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RESPONSE OF CULTIVARS AND BREEDING LINES OF  
TOBACCO (*NICOTIANA TABACUM* L.) UNDER  
NATURAL FIELD INFECTION TO BLUE MOLD  
(*PERONOSPORA TABACINA* ADAM.)

ABSTRACT

Towards the end of June of 1997 a massive outbreak of blue mold caused by *Peronospora tabacina* on the experiment plots of the Institute of Soil Science and Plant Cultivation gave an opportunity to observe and record the response to that disease of 192 different *N. tabacum* genotypes held at the institute's tobacco germplasm collection. Both the date of the onset of the first symptoms and the intensity of the symptoms varied. Symptoms were from very severe (e. g. Virgin Mutant A, Burley White) to none, through severe, moderate, mild. Less than 10% of the accessions scored for blue mold were symptom-free. They belonged to the flue-cured type (15 out of 71) and dark air-cured (5 out of 49). All the remaining entries including orientals and semi-orientals, burleys and cigar tobaccos were affected to some extent. Except the very susceptible Virgin A Mutant systemic symptoms were rare probably because the fungus attacked relatively late in the season when the majority of accessions had already grown out of the most vulnerable stage and were at either budding or flowering.

*Key words:* blue mold, natural field infection, symptoms estimation, tobacco cultivars

INTRODUCTION

The tobacco germplasm collection in Puławy, the largest of its kind in Central Europe, now comprises 750 cultivars of *Nicotiana tabacum* belonging to several different types. The number and diversity of collection items provide an opportunity to screen them for traits potentially useful in breeding. Ca. 200 accessions are subjected each year to field and laboratory evaluation for different traits including resistance to pathogens.

Blue mold is one of the economically most important tobacco diseases in Poland. Annual tobacco crop lost because of blue mold have varied over the years. The disease made its first recognized appearance in 1960 (Bawolska 1962) with devastating effects year in year out until the introduction of resistant cultivars in late 1960's caused a gradual decline

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*Communicated by Edward Arseniuk*

in the disease incidence and severity (Bilbas 1970, Studziński 1969). There was a resurgence of blue mold in early 1970's. It was caused by a new, virulent race of *Peronospora tabacina* (Jankowski 1971, Masiak 1971). Improved management of the disease (new cultivars with improved resistance, chemical control) coupled with weather conditions unfavourable for blue mold resulted in a marked decline of the disease in the 1990's.

A massive outbreak in 1997, the first in several years, was an excellent opportunity to record the symptoms of the disease on 192 accessions grown in the field nursery.

#### MATERIALS AND METHODS

Tobacco accessions were assessed for blue mold symptoms in the field under natural infection. The nursery was located in the flat flood plain of the Vistula river including an alluvial soil. A total of 192 entries from the institute's tobacco germplasm collection were screened. In this number 32 (plus 29 alloplasmics not included in this report) were flue-cured, 36 oriental, 19 burley, 17 cigar wrapper and 49 dark air-cured. The plants were raised in overhead-watered polystyrene trays, transferred to the field in the second half of May and planted at plots of 90 × 45 cm. Standard crop management was applied with fertilization rate varied according to type. No fungicides were applied during the growing season.

The first blue mold symptoms were observed on July 23. The subsequent observations were taken in weekly intervals until August 21. A five-grade scale was used to score the severity of disease symptoms:

- 1 – no symptoms
- 2 - weak symptoms, (small lesions, no sporulation)
- 3 - medium severe symptoms (up to 50% of the leaf surface affected)
- 4 – severe symptoms (more than 50% of the leaf surface affected)
- 5 – severe symptoms including systemic infection

#### RESULTS

##### **Weather conditions in Puławy in 1997**

The spread of blue mold in the growing season is largely dependent on prevailing weather conditions (Studziński 1969). Wind, rainfall, air temperature and high humidity are of particular importance. Table 1 shows the weather records in Puławy from May to September of 1997 and compares them with the long-term means.

Both in June and in July the prevailing winds were northerly and north-westerly. In June southerly and south-easterly winds were also frequent. In 1997, the monthly air temperatures were close to long-term averages, only in July it was lower by 1°C. Monthly rainfall sums and air humidity in 1997 were well above the long-term average espe-

cially in July. Rainfall in August was below the long-term average but relatively high air humidity persisted until September.

Table 1.  
Weather in Pulawy in the growing season of 1997 and the long-term means

Month	Average temperature [°C]		Average humidity [%]		Average rainfall [mm]	
	Long-term	1997	Long-term	1997	Long-term	1997
May	14.6	14.6	64.6	68.0	55.1	58.6
June	17.3	17.3	64.8	71.0	58.7	91.7
July	19.4	18.4	61.8	79.0	43.6	150.1
August	18.9	18.7	66.0	73.0	70.1	57.7
September	12.9	12.9	83.2	80.0	93.2	59.9

### Blue mold infection

Blue mold first appeared on July 23 when the plants were at budding or beginning of flowering. Blue mold infection became most severe toward the end of July (Fig. 1). The resurgence of the disease in the second half of August was of lesser intensity and caused only mild lesions on the upper leaves of most accessions. First symptoms of blue mold were recorded following ca. three weeks of intensive rainfall which was accompanied by relative air humidity reaching almost 80% and average diurnal air temperature of ca. 18°C. Absence of rainfall in the second and third week of August and the resultant fall in relative humidity to ca. 65% checked the further progress of the disease and no plants were killed.

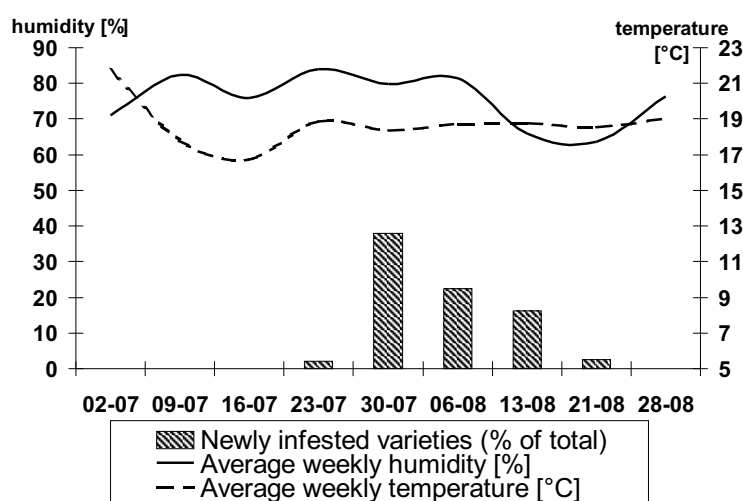


Fig. 1. Rate of spread of blue mold across the tobacco varieties in the field nursery in Pulawy in 1999

Table 2 lists the blue mold scorings across different tobacco types. Within the flue-cured type there was the highest number of accessions that showed high degree of resistance to blue mold. When the group was further subdivided into foreign and domestically bred accessions it was shown that the majority of fully resistant cultivars were local. Only dark air-cured (broad-leaved) cultivars were recorded as the other group where a few symptomless entries were found. Although no symptomless accessions were found in the burley group more than half of them responded to infection only with mild symptoms. Within the oriental and cigar groups the most of accessions were medium or highly susceptible to the pathogen.

Table 2.  
Severity of blue mold symptoms in the field nursery of the tobacco germplasm collection in Puławy across different tobacco groups

Type	No. of screened varieties	Number of varieties showing blue mold symptoms:					% of resistant and mildly affected varieties
		None score: 1	Mild score: 2	Medium severe score: 3	Severe score: 4	Very severe score: 5	
Flue-cured	42	15	8	12	6	1	54.8
Domestic	20	12	2	4	2	0	
Foreign	22	3	6	8	4	1	
Oriental	36	0	3	27	6	0	8.3
Burley	19	0	11	6	1	1	57.9
Cigar	17	0	0	12	3	2	0
Dark air-cured	49	6	4	21	18	0	20

The accessions which showed no blue mold symptoms under conditions of heavy field infection are listed in Table 3. Among the flue-cured accessions the first three are Australian acquired in the early 60's to be used as sources of resistance in the breeding programmes. The majority of entries bred in Poland probably share the common source of resistance to blue mold originally derived from Australian sources. The exceptions are PC 2-1 Mutant and SKZ Prim which were selected as resistant mutations.

The most susceptible entries which scored 5 on the susceptibility scale were: Virgin A Mutant (VAM), Burley White, Parfum d'Italie and Wisconsin Havana 142. Of these Virgin A Mutant became infected systemically. The relatively low number of entries that showed very severe including systemic symptoms may have been due to the fact that the disease attacked relatively late in the season when the most of accessions had already grown out of the most vulnerable stage and were at either budding or flowering.

Table 3.  
**Varieties and breeding lines in the Puławy tobacco germplasm collection that showed no symptoms of blue mold under heavy field infection of 1997**

Flue-cured group		Dark air-cured group	
Accession	Origin	Accession	Origin
1. F85	Australia	1. Kentucky 5-49	Italy
2. F86	Australia	2. Koszycki	Poland (CLPT)
3. F87	Australia	3. Mocny Puławski	Poland (IUNG)
4. Lechia "A"	Poland (IUNG)	4. PC 2-1 Mutant	Poland (IUNG)
5. Lechia "B"	Poland (IUNG)	5. SKZ Prim	Poland (IUNG)
6. LHSE-70	Poland (LWTP)		
7. Łukowianka 1	Poland (local selection)		
8. Taset 8			
9. Taset 9	Poland (IUNG)		
10. TB-566	Poland (IUNG)		
11. TG 24222	Poland (IUNG)		
12. Virginia 278	Poland (IUNG)		
13. Virginia 340	Poland (IUNG)		
14. Wisana	Poland (ODUHT)		

## DISCUSSION

Since outbreaks of blue mold have not been frequent over the last few years it is difficult to do a systematic assessment of the whole collection. The last survey of this kind was made by Masiak (1974) who took records of blue mold symptoms in 468 accessions back in 1972. That investigator did not find fully resistant accessions. However, since then the Puławy germplasm collection has been enlarged by several hundred new accessions.

The prevalence of resistance to blue mold or high tolerance of it encountered in the flue-cured and burley groups probably reflects the fact that the main effort of breeders aimed towards pathogens resistance, including blue mold resistance, has been focussed on these two groups, as economically the most important (Di Muro *et al.* 1992, Rufty and Wernsman 1993). It also results from the fact that although no specific tobacco genotypes are given preference as collection items, accessions with such important usable traits as resistance to *P. tabacina* are primarily sought by breeders and most cultivars and breeding lines are passed to the collection from breeding projects.

## CONCLUSIONS

1. A massive 1997 outbreak of blue mold on the tobacco germplasm collection field in Puławy in which ca. 90% of collection entries were affected to some extent was favoured by heavy rains and high relative air humidity in June and July. The peak in the disease incidence occurred towards the end of July.
2. Under heavy field infection 192 tobacco genotypes showed a full range of symptoms that were from very severe (e. g. Virgin Mutant A, Burley White) to severe, moderate, mild and absence of symptoms.
3. The symptomless types qualified as resistant included 14 flue-cured accessions and 5 dark air-cured accessions.
4. The highest number of mildly susceptible entries were found among burley accessions.
5. Only 4 entries (less than 2% of the total) showed very severe symptoms and within that group only one (Virgin A Mutant) became infected systemically.

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