

VIRUS DISEASES OF LUPIN,
BROAD BEAN AND RED CLOVER IN POLAND¹

Władysław Błaszczak

Institute of Plant Protection, Academy of Agriculture, Poznań

After the second world war the appearance of a dangerous disease of yellow lupin was observed in several countries. It was narrow-leaf virus disease. In Poland the first information about the occurrence of the disease dates back to the fifties and the through studies of its etiology, ecology and harmfulness were carried out by Książek [15] and Błaszczak [1]. Similar studies were conducted by Corbett in the USA [11] and Zschau [18] in German Democratic Republic. The main cause of the massive manifestation of the narrow-leaf virus disease was the introduction into cultivation of fodder lupin of low alkaloid content which is a good host plant for aphids, vectors of viruses. The disease is caused by bean yellow mosaic virus (BYMV). The affected plants are chlorotic, have narrowed, upward turned leaves, set pods poorly and remain green until autumn. The virus is transmitted with seeds. It was shown that, on the average, about 6% of seeds collected from virus infected plants give seedlings affected by the virus. On the other hand, the virus was isolated from almost all green seeds collected from diseased plants. It disappears from most seeds during ripening and drying [4]. No regularity was found in the distribution of affected seeds on the plant and in the pod [1]. The symptoms of the disease on seedlings grown from virus infected seeds usually appear on the third pair of leaves. The vectors of BYMV on yellow lupin during the vegetative period are aphids, mainly *Aphis craccivora* Koch., and *Acyrtosiphon pisum* Harris. The time of their appearance and the quantity of population as well as the time of sowing of lupin have a decisive influence on the

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spreading of the disease. The 24 h ratio of the virus attack of plants measured after 4 weeks from the time of massive aphids appearance (after incubation period) increases as the time of sowing is delayed and the age of the plants reduced at the moment of the aphid appearance [1].

Narrow-leaf virus disease causes the worst damage in breeding stations and on seed plantations. The infection of growing materials amounts to 50 or even more percent, whereas the infection of seed plantations ranges from several to several dozen percent. The affected plants give a low yield of seeds and the fall depends on the time of disease appearance (Table 1) and may reach even 90%.

Table 1

Influence of infection time of yellow lupin by bean yellow mosaic virus on the growth of plants and seed yield

Phase of plant growth	Weight of the plant (g)	Percentage of seed yielding plants	Yield of seeds/plant				Percentage of virus infected seeds
			number		weight		
			abs.	%	abs.	%	
Flowerstands to 2 cm	4,5	55,0	4,2	11,9	0,6	15,0	12,9
Full blossoming	6,8	85,0	7,2	20,4	0,8	20,0	11,5
Pod setting on the main stem	10,3	97,5	21,2	60,2	2,3	57,5	4,9
Pod setting on secondary stems	12,8	95,0	27,5	78,1	3,1	77,5	3,3
Healthy plants	14,5	100,0	35,2	100,0	4,0	100,0	1,1

Selection of healthy seeds free from virus infection, early sowing, setting seed plantations in isolation from other *Papilionaceus* cultures are recommended as the means of control of narrowleaf virus disease. The attempts to obtain resistant cultivars have been unsuccessful. According to many breeders, early cultivars are less affected by narrow-leaf virus disease than the late ones. In nurseries, it is well worth while controlling aphids and applying negative selection.

Blue lupin, less often yellow lupin, in Poland are also attacked by the cucumber mosaic virus (CMV), which causes lupin browning. In some years this disease also spreads dangerously. Similar browning of blue lupin is caused also by BYMV. A different strain of CMV causes another disease tentatively termed blue lupin witches broom (Fig. 1). The diseased plants do not die; they yield seeds of which considerable proportion (up to 20%) are the carriers of the virus. The investigations on the broad bean viruses which have been conducted in Poland so far aimed at the recognition of viruses attacking broad bean, range of their

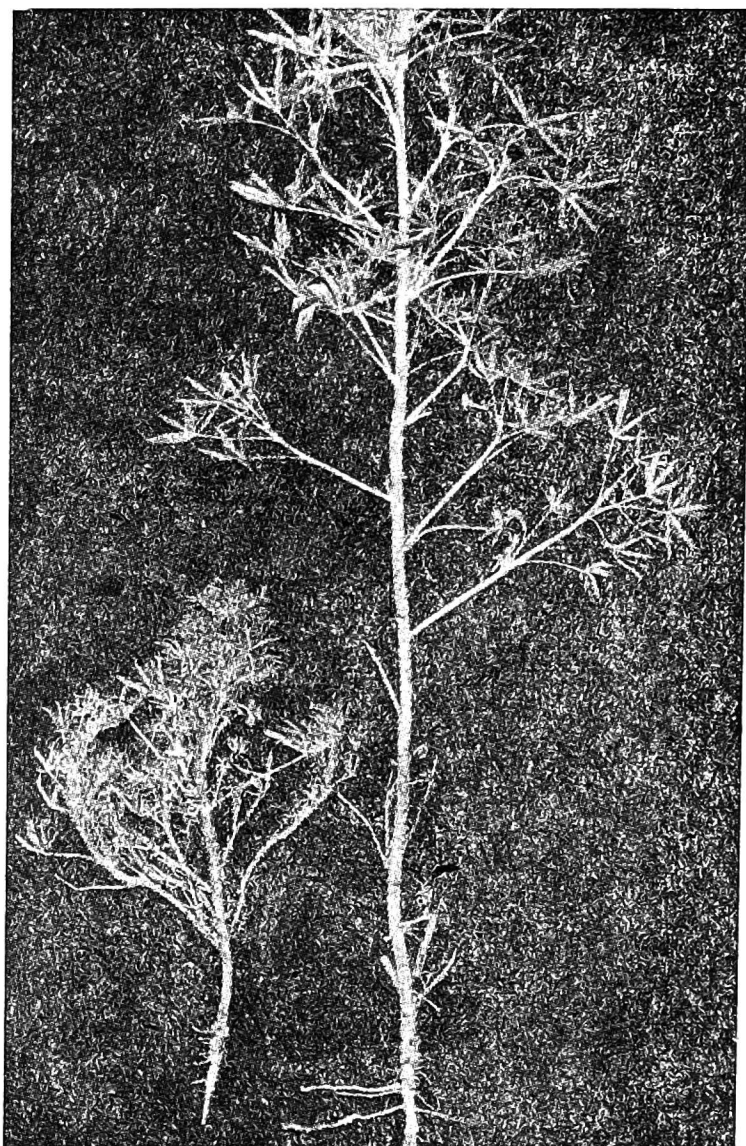


Fig. 1. Blue lupin plants: left — infected by blue lupin witches broom disease (CMV); right — healthy plant

occurrence, harmfulness and searching the ways of control the diseases caused by them.

In 1966 six isolates of viruses were gained from broad bean plants taken from a breeding station, 4 of which were identified as bean yellow mosaic virus — pea strain, 1 as broad bean true mosaic virus (BBTMV) and 1 as pea enation mosaic virus (PEMV). In the following years infections ranging from several to several dozen percent were observed on broad bean plantations. In 1974 seven isolates of viruses were obtained from broad bean, 3 of which were bean yellow mosaic virus, 2 broad bean true mosaic virus, 1 lucerne mosaic virus (LMV) and 1 cucumber mosaic virus [9]. In 1976 22 isolates were distinguished. BYMV and PEMV prevailed again. Leaf roll was also observed. This suggests that the most common viruses attacking broad bean in Poland are: bean yellow mosaic virus, pea enation mosaic virus, broad bean true mosaic virus and leaf roll virus. It is most probable that broad bean stain mo-

saic virus (BBSMV) and broad bean wilt virus also occur. The occurrence of virus diseases of broad bean is quite popular in Czechoslovakia [16] and German Democratic Republic [13, 17]. BYMV causes a typical yellow mosaic on broad bean (Fig. 2), PEMV characteristic ena-

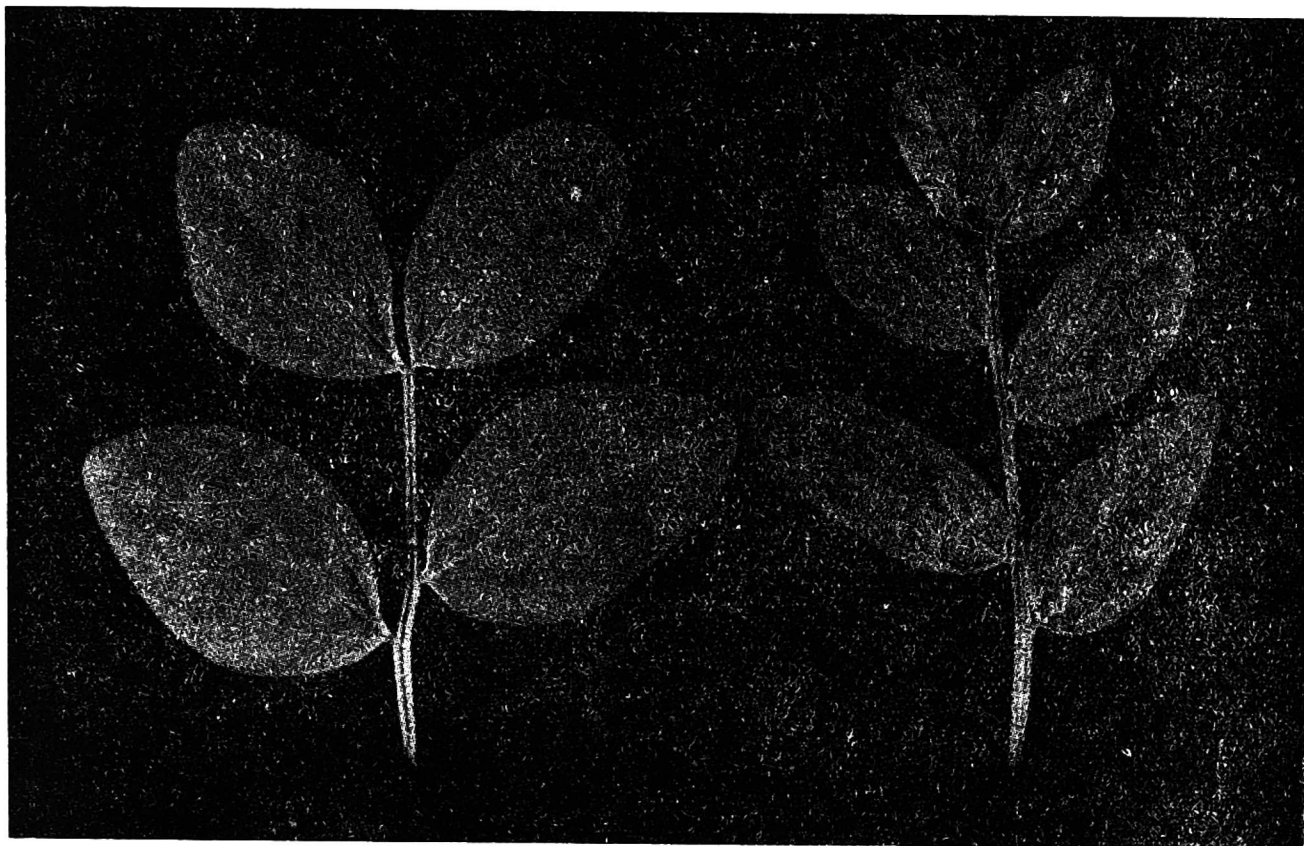


Fig. 2. Leaves of horse bean; right — infected by BYMV, left — leaf of healthy plant

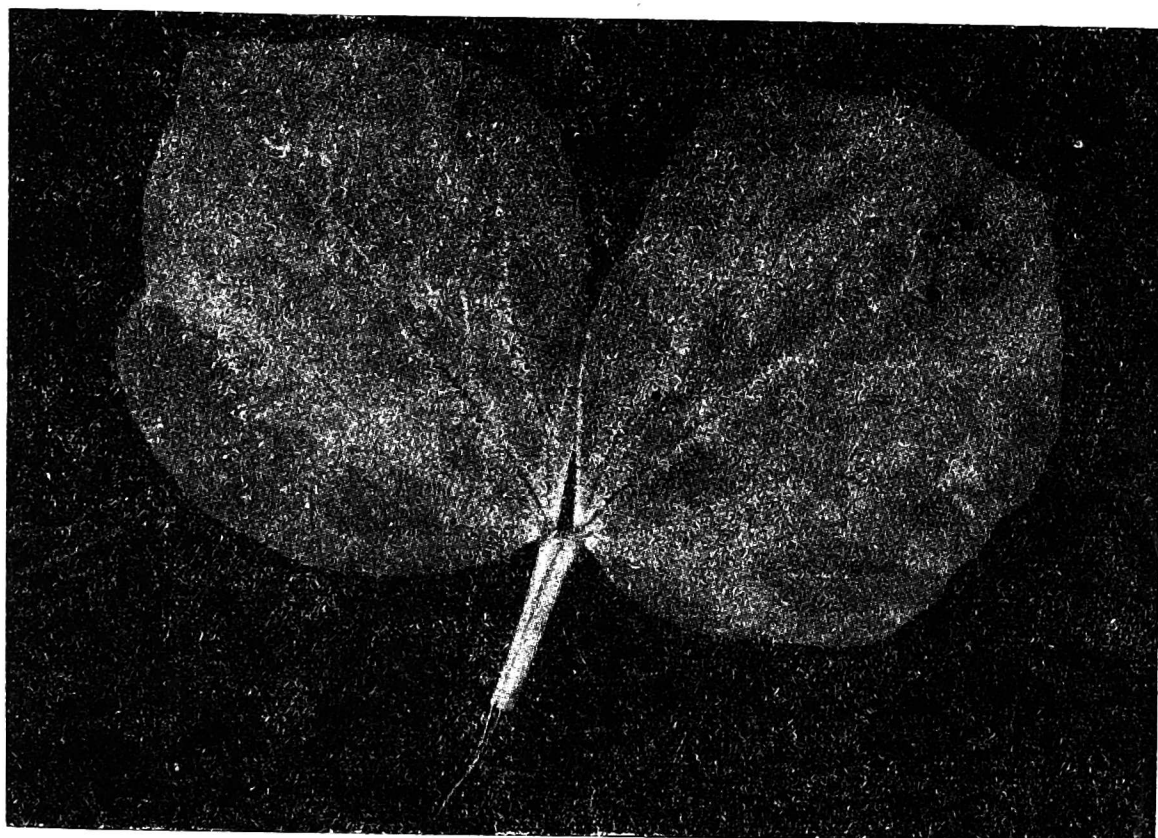


Fig. 3. Leaf of horse bean with the symptoms caused by BBTMV

tions, BBTMV distinct mosaic spots and blisters (Fig. 3). Pathological changes may assume a more complex picture in cases of frequent mixed infections.

Damages caused by broad bean virus diseases are considerable. Two years' field experiments were carried out testing BBTMV harmfulness depending on the time of inoculation [3] Broad bean cv. Nadwiślański was inoculated at the stages of 2-3 leaves, flowering and pod setting. Infection of younger plants caused greater delay of growth and a higher fall of plant weight. The decrease of seed yield in plants inoculated at the stage of 2-3 leaves amounted to 30%. Seeds coming from affected plants showed less energy and germination power. A considerable percentage of seeds was attacked by fungi (Table 2). The time of inocula-

Table 2

Influence of inoculation time of horse bean cv. Nadwiślański with BBTMV on growth of plant and seed yield

Growth phases of inoculated plants	Weight (%)*		Germination power (%)	Percentage of seeds infected by fungi
	plants	seeds		
2-3 leaves	54,7	69,6	79,0	21,0
Blossoming	88,7	71,7	83,5	14,5
Pod setting	87,8	96,8	87,0	13,5
Healthy plants	100,0	100,0	91,5	2,5

* In relation to healthy plants.

tion of plants had a serious influence on the number of affected seeds. Depending on the time of inoculation plants yielded respectively 2.4, 3.2, and 0.8% of virus affected seeds. Plants considered symptomatically healthy gave 0.3% of seeds infected by BBTMV.

In another field experiment the influence of BBTMV, BYMV and PEMV on the growth and yield of broad bean seeds was determined [6]. All viruses caused severe diseases and decreased, to a considerable degree, both the quantity and the quality of seeds (Table 3). The fall in the seed yield of plants affected by BBTMV amounted up to 60% and in the case of BYMV and PEMV to more than 80%. As the results of infection the weight of 1000 seeds fell by 13-30%, germination power by 18-33% and the number of seeds attacked by fungi and bacteria was about 2-3 times higher (Table 4) than in seeds collected from healthy plants.

Table 3

Influence of BBTMV, BYMV and PEMV on seed yield of horse bean cv. Nadwiślański

Viruses	Number of seeds		Weight of seeds	
	abs.	%	abs.	%
Healthy plants	37,9	100	18,4	100
BBTMV	16,7	44	7,5	41
BYMV	7,6	20	3,5	19
PEMV	8,8	21	3,1	17

Table 4

The influence of BBTMV, BYMV and PEMV on the quality of seeds of horse bean cv. Nadwiślański

Viruses	Weight of 1000 seeds	Germination power		Percentage of seed infected by fungi and bacteria
		%	index	
Healthy plants	547	88,5	100,0	9,5
BBTMV	476	72,5	81,9	18,0
BYMV	440	70,0	79,5	17,5
PEMV	359	59,5	67,2	29,0

In order to reduce the appearance and harmfulness of broad bean virus diseases it is advisable, according to many authors, to sow broad bean far from sources of infection and to use seeds which are healthy and free from viruses [10]. According to our observation the infection of broad bean seeds by viruses may vary considerably in different years. No sources of resistance of broad bean against particular viruses have been found so far. The removal of diseased plants from breeding materials may also be advisable. Fritzsche [13] applied aphids control on large acreages and achieved 40-55% decrease in broad bean infection by BYMV, and Cockbain [10] successfully controlled mature forms of *Apion vcrax* and *Sitona lineata* by application of Aldicarb into soil and reduced the spreading of BBTMV and BBSMV.

Detailed investigations on red clover viruses were carried out by Kowalska [14], Błaszczak [12], Błaszczak et al. [8] 227 isolates of viruses were obtained from over 400 diseased plants collected from 150 plantations (Table 5). Bean yellow mosaic virus proved to be the most common. Its two strains, bean and pea constituted 59.5% of all isolates tested. Red clover necrotic mosaic virus (RCNMV) occurred numerously though it was found mainly in the piedmont. Other viruses like white

Table 5
Viruses found on red clover plantations in South-west
Poland in 1965-1968

Viruses	Number of identified isolates	
	abs.	%
BYMV	71	31,3
BYMV (pea strain)	64	28,2
RCNMV	65	28,6
WCMV	18	7,9
RCVMV	6	2,6
LMV	3	1,3
Total	227	99,9

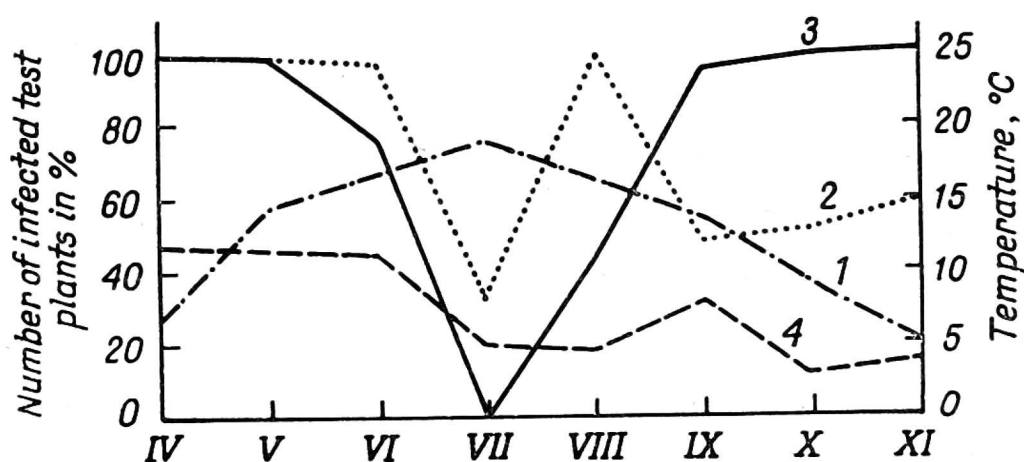


Fig. 4. Effect of isolation of three viruses from red clover in the period of time from April to November; 1 — temperature, 2 — WCMV, 3 — RCNMV, 4 — BYMV

clover mosaic virus (WCMV), red clover vein mosaic virus (RCVMV) and LMV occurred less often or sporadically.

The symptoms of the attack of viruses on clover are seen best in spring and autumn, whereas in full summer are difficult to notice. Similarly, it has been noticed that isolation of viruses are most effective in spring and autumn [7] and poor in full summer (Fig. 4). The infection of large red clover plantations was very small whereas small clover fields or breeding materials in breeding stations were affected very considerably. As expected, the infection of red clover by viruses increased with the age of culture (Fig. 5).

A number of preliminary experiments were conducted on harmfulness of viruses against red clover. In greenhouse conditions 2 BYMV isolates diminished green mass of red clover cv. Hrubieszowska by 39 and 42%. Crimson clover infected by mild isolate of BYMV pea strain gave green mass yield by 40% smaller. The diseased plants formed fewer and worse inflorescences [5]. In another experiment [12] the green

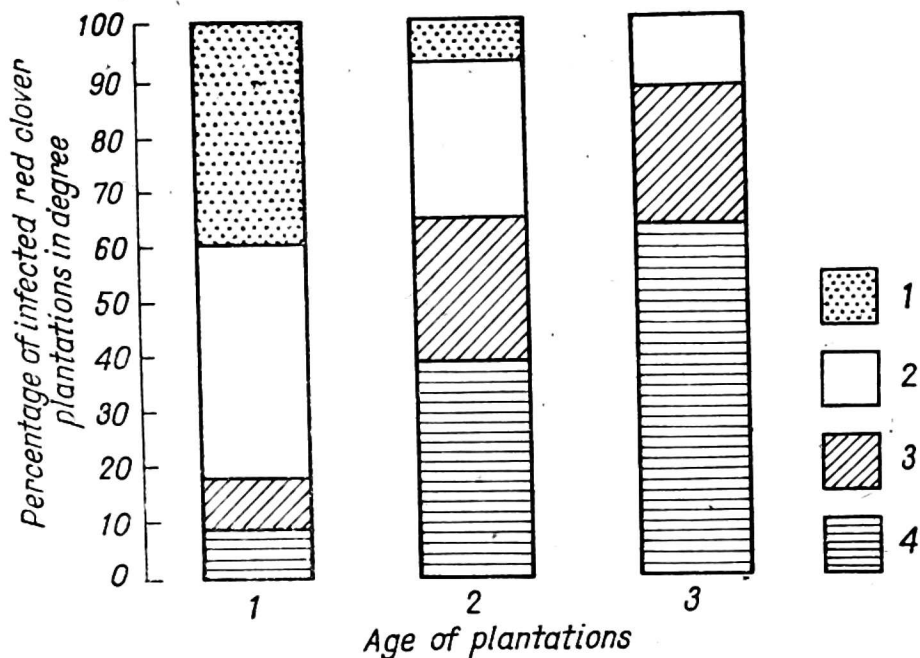


Fig. 5. Occurrence of virus diseases on red clover in 1965-1967 in south — west Poland depending on the age of plantations; 1 — no infection, 2 — 1st infection degree, 3 — 2nd infection degree, 4 — 3rd infection degree

mass yield of red clover affected by BYMV was by 20% smaller in the first mowing and by 40% in the second. In the search to find sources of resistance of red clover against BYMV one breeding line „Strugi 104” was found which showed a high degree of immunity but all other cultivars tested proved to be susceptible to it. Similarly 19 other cultivars of red clover showed full susceptibility to WCMV.

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Владыслав Блащак

ВИРУСНЫЕ БОЛЕЗНИ ЛЮПИНА, КОНСКИХ БОБОВ И КЛЕВЕРА КРАСНОГО В ПОЛЬШЕ

Резюме

В статье рассматриваются важнейшие результаты исследований виросов указанных видов культурных растений, прододимых в Польше в период последних 18 лет. Самой грозной болезнью люпина желтого является узколистность, вызываемая ВУМВ. Она создает наивысшую угрозу для этой культуры. Люпин узколистный поражается бурением, вызываемым как СМВ так и ВУМВ. Установлен также новый тип болезни люпина узколистного, т.наз. метельчатость, вызываемую особым штаммом СМВ.

Угроза со стороны виросов является высокой также для конских бобов. К вирусам поражающим наиболее часто конские бобы принадлежат ВУМВ, РЕМВ, ВВТМВ и вирус скручивания дистьев. Редко появляется АМВ, а также, как кажется ВБСМВ и ВВВВ. Установлена очень высокая вредность ВУМВ, РЕМВ и ВВТМВ, причем снижение урожая растений было тем сильнее, чем

раньше происходило поражение растений. Из растений пораженных вирусами собирают худшие семена, пораженные в сильной степени грибами и бактериями.

Среди вирусов появляющихся на клевере красном преобладают BYMV и RCNMV. Другие вирусы, такие как WCMV, RCVMV и AMV, появляются реже. Наиболее сильно поражаются небольшие плантации клевера красного, используемые в течение 3 лет. Симптомы вирусной болезни на клевере красном наиболее заметны весной и осенью и в этот период можно наиболее легко изолировать вирусы из больных растений. BYMV приводит к значительным снижениям урожая зеленой массы и оказывает неблагоприятное влияние на зимовку растений.

Władysław Błaszczak

CHOROBY WIRUSOWE ŁUBINU, BOBIKU I KONICZYNY CZERWONEJ W POLSCE

Streszczenie

W opracowaniu przedstawiono ważniejsze wyniki badań nad wirozami wymienionych gatunków roślin przeprowadzone w Polsce w okresie ostatnich 18 lat. Najgroźniejszą chorobą łubinu żółtego jest wąskolistność powodowana przez BYMV. Stanowi ona największe zagrożenie dla tej rośliny. Łubin wąskolistny atakowany bywa przez brunatnienie, wywoływane zarówno przez CMV jak i przez BYMV. Stwierdzono też nowy typ choroby łubinu wąskolistnego tzw. miotlastość wywoływaną przez odrębny szczep CMV.

Zagrożenie bobiku przez wirozy jest również duże. Do wirusów najczęściej spotykanych na bobiku należą BYMV i PEMV, BBTMV i liściozwój. Rzadko występuje AMV i prawdopodobnie BBSMV i BBWV. Stwierdzono bardzo dużą szkodliwość BYMV, PEMV i BBTMV przy czym obniżki plonu nasion były tym większe im wcześniej rośliny podlegały porażeniu. Z roślin zaatakowanych przez wirusy zbiera się nasiona gorsze, w znacznym stopniu porażone przez grzyby i bakterie.

Wśród wirusów występujących na koniczynie czerwonej dominuje BYMV oraz RCNMV. Inne wirusy jak WCMV, RCVMV, AMV występują rzadziej. Najsilniej porażane bywają małe plantacje koniczyny czerwonej, użytkowane przez 3 lata. Objawy chorób wirusowych na koniczynie czerwonej są najlepiej widoczne wiosną i jesienią i w tym też czasie najłatwiej można izolować wirusy z roślin chorych. BYMV wywołuje wyraźne obniżki plonu masy zielonej i ujemnie wpływa na zimowanie roślin.