EFFECT OF BEAN YELLOW MOSAIC VIRUS TO PEA UNDER FIELD CONDITIONS

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Viruses often cause severe disturbances in plant growth, which manifest themselves by acute pathological changes and reduce plant crops to a different extent. The harmful effect of viruses on plants depends on many factors existing in the virus-plant-environment system, and it is modified by these factors. Since many years at the Institute of Plant Protection, Academy of Agriculture in Poznań, the occurrence and harmful effect of viruses of *Papilionaceae* are under investigation under greenhouse and field conditions [2-4, 6]. The aim of the present study was to determine the harmful effect of bean yellow mosaic virus on growth and yield of pea under field conditions, depending on the time of plant inoculation.

OUTLINE OF EXPERIMENTS

Studies were performed at the Agricultural Experimental Station in Złotniki, near Poznań, in 1976. Pea cv. Flawanda (original) with good germination power (96%) and mass of 1000 seeds amounting to 312 g was applied. For inoculation the bean yellow mosaic virus — pea strain (BYMV) collected from peas in 1974 at the Plant Breeding Station in Nieznanice was aplied.

On a pea field (about 11 ares), 15 plots (2×1 m) were demarcated. Plants were inoculated in the phase of 5 leavs (5 plots) and in the phase of first flower (5 plots). The remaining 5 plots served as control. Pea was sown after sugar-beet on podsol type of soil. The usual agrotechnical treatments were applied. Prior to sowing mineral fertilization was performed at the level of: 10 kg N, 40 kg P_2O_5 and 60 kg K_2O per 1 ha, in the form of 34% of ammonium saltpetre, 25% of superphospha-

te and 60% of potassium salt, respectively. Sowing was carried out on 7 April. Sowing density was 270 kg/ha the spacing — 25 cm, and soil-covering depth — about 4 cm. In several plots empty spaces occurred and thus in all plots thinning was performed, with 70-80 uniformly distributed plants left in each plot. The inoculum prepared from pea plants with distinct infection symptoms (2-3 weeks after inoculation) was diluted with water (1 : 2). Pea plants were inoculated on May 26th (in the phase of 5 leaves) and on June 14th (in the phase of first flower). On the first date 3 leaves with stipules and on the second date 2 young but well developed leaves were inoculated on each plant. Before inoculation the plants were dusted with carborundum, and after inoculation they were rinsed with water. For inoculation cheesecloth plugs were used. Control plants were „inoculated" with sap from healthy pea plants, diluted with water (1 : 2).

Observations were taken at 3-6 days intervals, and each time the plants with virus infection symptoms were determined. Infected plants were randomly collected, and from them reisolations on test plants were done for verification whether their visual evaluation had been correct.

Owadofos was applied against *Sitona* sp. Pea was harvested on July 20th: after drying the plants were examined individually. The more important elements of growth and seed yield were determined. For the control combination 365 plants were examined, for the first inoculation time (phase of 5 leaves) — 371 plants, and for the second one (phase of first flower) — 22 plants. The seed yield was evaluated statistically.

In the pea vegetation period in 1976, the weather did not promote growth and high yield of pea. Whereas the temperature between May-

Table 1

Air temperature and rainfall during pea vegetation in 1976 (according to the Institute of Meteorology and Water Management in Poznań)

Months	Air temperature °C		Rainfall mm	
	monthly mean	deviation from many-years means	monthly sum	percentage of normal
April	6,9	—0,9	8,8	24,4
May	13,0	—0,1	29,7	64,5
June	16,7	—0,4	13,8	24,2
July	19,0	0,4	109,2	156,0
August	15,9	—1,7	65,3	105,3

-July only slightly differed from the many-years means, a considerable rainfall deficiency, particularly in April and June, greatly limited plant growth and accelerated ripening (Table 1). The more abundant rainfall in July did not help any more, and thus both the vegetative growth and yield of plants were rather poor. The drought prevailing in June may have lowered the efficiency of inoculation; it could, moreover, stimulate the harmful effect of BYMV on plants inoculated in this month.

RESULTS

EFFECT OF BYMV ON GROWTH OF PEA PLANTS

As a result of pea plant inoculation in the phase of 5 leaves, 93% of plants became infected; already 2 weeks after inoculation pathologic symptoms were observed in 75% of the inoculated plants (Table 2). Infected plants exhibited typical symptoms of socalled pea mosaic [5]. At first they showed vein-clearing in the youngest leaves, and then spotted mosaic, chlorosis and yellowing of leaves — yellow mosaic (Fig. 1). As concerns the plants inoculated in the phase of 1st flower, only 6% of them became infected. They were evaluated for the last time 19 days after inoculation; later it was impossible because of general yellowing and aging of plants.

Table 2

Susceptibility of pea cv. Flawanda in two phases of growth to bean yellow mosaic virus under field conditions

Plant inoculation		No. of inoculated plants	Percentage of infected plants after:
Date	growth phase		14 and 28 days since inoculation
I	5 leaves	386	75 93
II	1st flower	367	0 6*

* After 19 days since inoculation.

Table 3

Effect of infection date of pea cv. Flawanda by bean yellow mosaic virus on plant growth

Growth phase of inoculated plants	Means for 1 plant				No. of podbearing stems
	height		weight		
	cm	%	g	%	
Control	41,8	100	12,2	100	1,6
5 leaves	36,5	87	7,9	65	1,3
1st flower	37,9	90	8,6	70	1,5

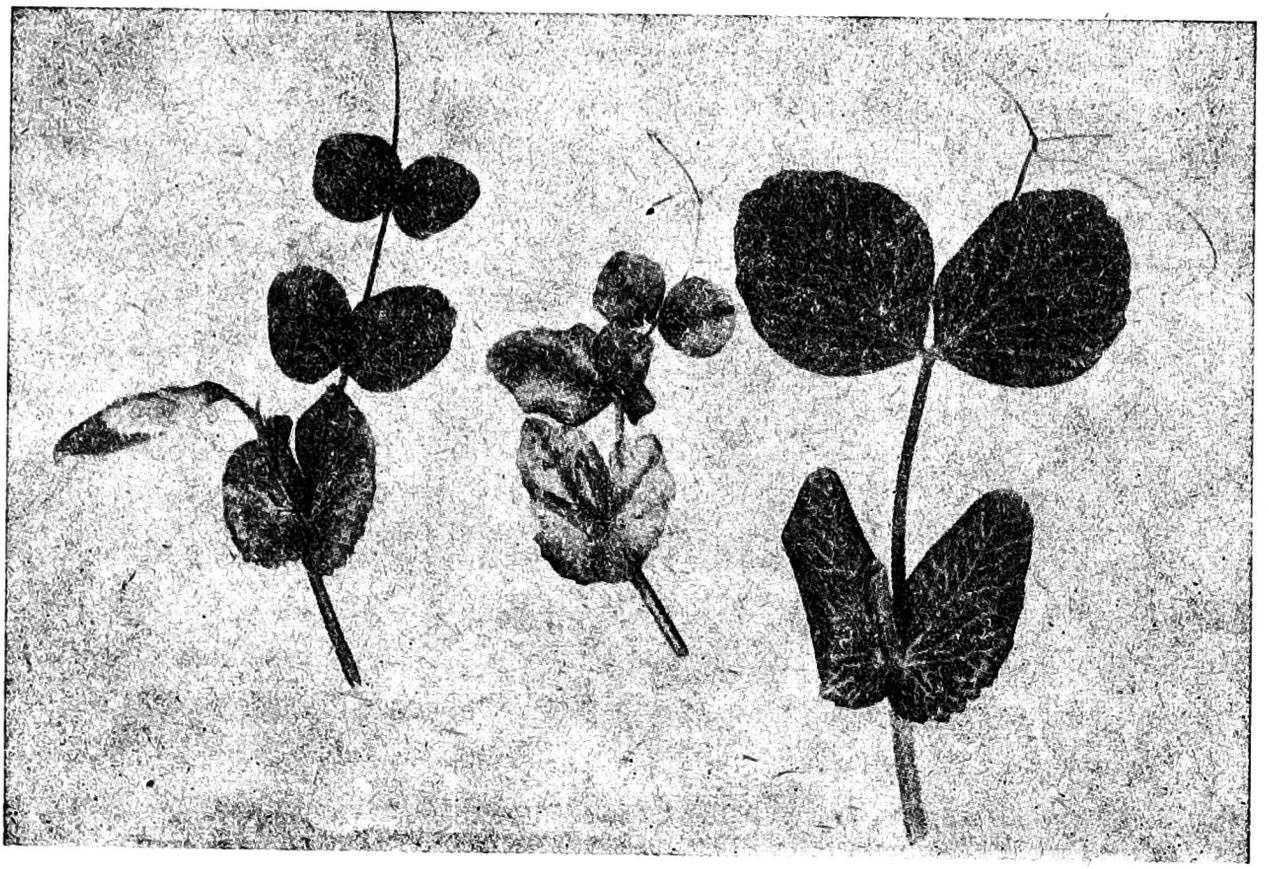

Fig. 1. Typical symptoms of pea mosaic induced by bean yellow mosaic virus — pea strain, in pea cv. Sześciotygodniowy

Fig. 2. Plants of pea cv. Flawanda with symptoms of mosaic and mild dwarf — from left and right. In the center — healthy plant

BYMV — infected plants grew less intensively (Fig. 2) and thus their weight was by 30-35% lower than that of healthy plants (Table 3): as expected, these decreases were slightly greater in plants inoculated in the phase of 5 leaves. Similar differences concerning the mean number of pod-bearing stems per plant were found.

EFFECT OF BYMV ON SEED YIELD QUALITY

Infected plants set fewer pods (Table 4), though the differences were not very great. On the other hand, the number of seeds was greatly reduced. Plants inoculated in the phase of 5 leaves produced 32% of seeds less than controls. Plants inoculated in the phase of 1st flower developed even fewer seeds. Likewise, the drop in weight of seeds collected from plants inoculated in the phase of 5 leaves and in the phase of first flower was 46 and 54%, respectively. These differences in the number and weight of seeds between plants inoculated on the first date (5 leaves) and second date (1st flower) were insignificant, whereas they were significant when compared with the control combination.

Table 4

Effect of infection date of pea cv. Flawanda by bean yellow mosaic virus on seed yield

Growth phase of inoculated plants	Means for 1 plant				
	no. of pods	no. of seeds		weight of seeds	
		absolute	%	g	%
Control	6,8	24,3	100	6,7	100
5 leaves	5,5	16,5	68	3,6	54
1st leaf	5,7	13,9	57	3,1	46
LSD		5,6		1,3	

Pea cv. Flawanda infected by BYMV produced seeds with lower weight of 1000 seeds and reduced germination power (Table 5). The reduction of the weight of 1000 seeds averaged about 20%. Seeds collected from plants inoculated in the phase of 5 leaves exhibited lower germination power (13%) and 14% of these seeds were infected by fungi (*Ascochyta* sp., *Botrytis* sp. and other).

Pea enation mosaic virus also occurred in the experimental plot. The virus was identified on test plants. Ascochytosis (*Ascochyta* sp.) occurred on 3.3% of plants. As of pests, only *Sitona lineatus* and *Lesperyesia nigricana* were observed. The last one was feeding on 6% of the analyzed plants.

Table 5

Effect of infection time of pea cv. Flawanda by bean yellow mosaic virus on seed quality

Growth phase of inoculated plants	Weight of 1000 seeds (g)	Germination power (%)	Percentage of fungi infected seeds
Control	257	99	1
5 leaves	213	86	14
1st leaf	206	94	6

DISCUSSION OF RESULTS

Bean yellow mosaic virus, especially its pea strain, occurs widely on many species of *Papilionaceae* [5] and often causes great losses. Plantations of red clover and horse bean are most often infected by BYMV both in Poland and many other countries [4, 6]. The BYMV isolate applied in the present experiments markedly reduced the vegetative growth and yield of pea plants. In another study it has been found that in three greenhouse-grown pea cultivars within 3 weeks after inoculation the plant height was reduced by 14-21%, and in field pea cv. Kosieczyńska inoculated in the phase of 3 leaves the yield of air-dried matter was lower by 49%; the seed yield was lower by more than 60%, and the weight of 1000 seeds decreased by about 30%. When the plants were inoculated in the phase of flower buds, seed yield has dropped by 40%, and the weight of 1000 seeds — by about 21% [3]. Thus, the mean decrease in yield of field pea seeds derived from both inoculation times has been 50%, and approached the mean drop in the seed yield of pea cv. Flawanda, found in the present study under field conditions. The reduction of the weight of 1000 pea seeds (18%) was also similar. According to Kvičala, the weight of BYMV — infected pea plants grown in greenhouse has decreased within 5 weeks after inoculation by 18.6 and 40.9%, depending on the time of experiment [7]. Pea cv. Łagiewnicki has been found to react more intensively to BYMV; under greenhouse conditions the weight of infected plants at harvest was by about 67% lower as compared with healthy plants. The number of pods has decreased by more than a half, and the number of seeds — by 76%. The differences were highly significant [2].

In a study on spreading of BYMV in pea plants cv. Łagiewnicki depending on age of inoculated plants and leaves, Błaszczak has found no increased plant-age-dependent resistance to infection [1]. In the present study, most plants of pea cv. Flawanda, inoculated in the phase

of 1st flower, were not infected by BYMV. This may point either to the occurrence of age dependent resistance to BYMV infection, or to low efficiency of inoculation, resulting from other factors, e.g. environmental ones. From the standpoint of epidemiology, the problem of occurrence of age-dependent resistance to infection by viruses in pea seems to be very important and calls for closer investigations.

CONCLUSIONS

1. Bean yellow mosaic virus — pea strain — infects pea cv. Flawanda. The infected plants grow slower, and produce less air-dried matter and a lower seed yield. The weight of 1000 seeds, their health and germination power are lowered.

2. Differences in growth and seed yield between plants inoculated in the phases of 5 leaves and 1st flower were insignificant.

3. Plants inoculated in the phase of 1st flower became infected in only 6%. It remains unclear whether this was due to agedepend resistance to infection or to the factors limiting the efficiency of inoculation.

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ВРЕДНОСТЬ ВИРУСА ЖЕЛТОЙ МОЗАИКИ ФАСОЛИ ПО ОТНОШЕНИЮ К ГОРОХУ В ПОЛЕВЫХ УСЛОВИЯХ

Резюме

В 1978 году в Сельскохозяйственном опытном учреждении Злотники возле Познани был проведен полевой опыт по вредности вируса желтой мозаики фасоли на горохе сорта флаванда, в зависимости от срока заражения. Горох инокулирован в фазе пяти листьев и первого цветка. Установлено количество больных растений. После уборки растения были индивидуально обработаны. Продолжающаяся в июне засуха не благоприятствовала вегетации гороха.

Симптомы поражения на инокулированном горохе в фазе 5 листьев (386 растений) появились через 2 недели на 75%, по истечении 4 недель — на 93% растений. В случае же инокуляции растений в фазе 1-го цветка (367 растений) по прошествии 19 дней было обнаружено только 6% больных растений. Масса больных растений уменьшилась на 30-39%, число семян на 32-43%, а масса семян на 46-54%, причем снижение урожая семян больных растений было существенным. Также качество семян подверглось снижению.

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SZKODLIWOŚĆ WIRUSA ŻÓŁTEJ MOZAIKI FASOLI WOBEC GROCHU W WARUNKACH POLOWYCH

Streszczenie

W roku 1976 w Rolniczym Zakładzie Doświadczalnym Złotniki k. Poznania przeprowadzono doświadczenie polowe nad szkodliwością wirusa żółtej mozaiki fasoli na grochu odm. Flawanda, w zależności od terminu zakażania. Groch inokulowano w fazie pięciu liści i pierwszego kwiatu. Ustalono liczbę roślin chorych. Po zbiorze rośliny opracowano indywidualnie. Utrzymująca się susza w czerwcu nie sprzyjała wegetacji grochu.

Objawy porażenia na grochu inokulowanym w fazie 5 liści (386 roślin) wystąpiły po 2 tygodniach na 75%, a po 4 tygodniach na 93% roślin. Natomiast w przypadku inokulacji roślin w fazie 1 kwiatu (367 roślin) po 19 dniach ujawniono tylko 6% roślin chorych. Masa roślin chorych zmniejszyła się o 30-35%, liczba nasion o 32-43%, a masa nasion o 46-54%, przy czym obniżki plonu nasion roślin chorych były istotne. Również jakość nasion uległa obniżeniu.

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