

## The effect of drought on the development and yielding of two different varieties of the fodder broad bean (*Vicia faba minor*)

Janusz PODLEŚNY

Institute of Soil Science and Plant Cultivation, Puławy, Poland

**Abstract.** A factorial experiment was performed in the fodder broad bean to analyse effects of soil drought on the development and yield components of two varieties of different morphotype: 'Nadwiślański' (traditional) and 'Tim' (determinate growth habit). Plants were grown in Mitscherlich's pots under three different soil moistures: 70%, 50% and 30% of field water capacity. The soil water shortage contributed to a considerable depression in the developmental characteristics and yield traits of both varieties. Under all conditions, the variety 'Nadwiślański' yielded more seeds than did 'Tim'. The traditional variety was more resistant to drought than the new 'Tim'.

**Key words:** broad bean, development, drought, growth type, yielding.

The broad bean has the greatest water requirements among all leguminous crops that are cultivated in Poland (DZIERŻYC 1989). In this species, a low water availability is one of the major yield-limiting factors. The requirements are known to increase at the imbibition of seed and decrease after pod setting and seed filling. However, the highest requirements of the fodder broad bean for water occur during the flowering and pod setting stages (JASIŃSKA, KOTECKI 1993). A shortage of soil water at this growth stage causes shedding of flowers before fertilization. In consequence, stressed plants form less pods and the pods are irregularly distributed on the stem.

Presently, varieties representing two different morphotypes of the fodder broad bean, i.e. traditional and with determinate growth habit, are cultivated in Po-

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Correspondence: J. PODLEŚNY, Institute of Soil Science and Plant Cultivation, 24-100 Puławy, ul. Czartoryskich 8, Poland, e-mail: jp@iung.pulawy.pl

land. It is well known that the two morphotypes have different requirements for the cultivation regime. It is a result of a changed plant habit and differences in the course of plant development. This means that the mentioned forms of the fodder broad bean could also have different requirements for soil water. The major aim of the present study was to evaluate the influence of soil drought on the development and yielding of the two fodder broad bean morphotypes and to compare their sensitivity to water shortage in the soil.

The study was performed in climatic chambers (Heraus Ltd.) at the Institute of Soil Science and Plant Cultivation in Puławy. The factorial experiment was arranged as a randomized design with two varieties of different morphotype, three soil moisture levels and four pot-replications. The following varieties were studied: 'Nadwiślański' (traditional) and 'Tim' (determinate growth habit). Plants were grown in Mitscherlich's pots that contained 7 kg of a moderately compacted soil. In each pot, ten seeds were sown. After emergence, the seedlings were thinned to five per pot. The three different soil moisture levels, i.e. 70%, 50% and 30% of field water capacity (FWC), were maintained constant during plant growth. Thermal conditions in the climatic chambers were similar to conditions which occur in the field. Detailed observations of the growth and development of plants were made. The dynamics of plant growth was estimated by frequent measurements of plant height. Measurements of other plant characters were done at the flowering stage. The fresh and dry matter of particular plant organs were determined after harvest. The roots sluiced on the bolter at the aim separate from the soil. The Tukey's confidence intervals (at  $\alpha = 0.05$ ) were used to compare means.

At 70% and 50% FWC, both broad bean varieties emerged uniformly after 16 days from sowing. Soil water content had no effect on the rate of appearance first leaves. Less uniform and retarded emergences in comparison to objects with higher soil moisture were observed only in the pots containing the least amount of water (30% FWC). However, the soil moisture levels showed significant influence on the subsequent plant development (Table 1). Particularly significant differences were observed in plant height. In general, plants of the variety 'Tim' were shorter than those of 'Nadwiślański'. The simulated drought significantly affected plant growth, but these drought-induced effects on the growth and development of plants were more visible in 'Tim' than in 'Nadwiślański'. This observation confirms the common opinion that cultivars of determinate growth are more sensitive to unfavourable environmental factors than traditional ones. In the study, drought-stressed plants of both varieties started to flower a few days earlier than did plants better supplied with water (50% and 70% FWC). An earlier flowering of stressed plants, caused by mutual competition for water, was also observed by PODLEŚNY (1994) in pea.

The used soil moisture levels were found to alter also other morphological characters of the broad bean. In both varieties, plants have grown under limited

**Table 1.** Means for some morphological and productive characters of fodder broad bean grown at different soil moisture

Variety	Soil moisture %	Pods per plant	Leaves per plant	Seeds per plant	Plant height cm	Length of stem with pods	Leaf area $10^{-2}m^2/plant$	Dry matter			Weight ratio of aboveground parts to roots
								of stem per plant	of leaves per plant	of roots per plant	
Nadwiślański	30	4.2	9.3	8.9	57.2	31.7	1.0249	2.4	2.9	0.9	5.89
	50	5.6	10.5	12.2	64.2	32.8	1.2217	3.0	3.7	1.1	6.09
	70	6.4	11.8	14.1	69.6	36.9	1.3993	3.4	4.1	1.3	5.77
Tim	30	3.8	7.6	8.0	50.8	21.2	0.8333	2.1	2.8	0.6	8.17
	50	4.7	9.0	10.4	53.7	28.5	0.9654	2.3	3.0	0.7	7.57
	70	6.3	10.5	13.8	61.4	31.3	1.1472	2.7	3.5	0.8	7.75
LSD ( $\alpha = 0.05$ ) for interaction											
		0.44	0.36	1.1	2.24	0.70	0.21	0.33	0.22	0.12	0.24
		0.21	0.84	0.8	3.41	4.20	0.14	0.20	0.24	0.31	1.12

soil moisture (30% and 50% FWC) formed significantly less leaves than did plants grown under optimal conditions (70% FWC). This reduction in 'Nadwiślański' was 26.9% and 12.4%, whereas in 'Tim' 38.2% and 18.4%, respectively. The soil drought also affected some characters associated with yield formation. Under this condition, the number of pods per plant and number of seeds per plant were significantly reduced.

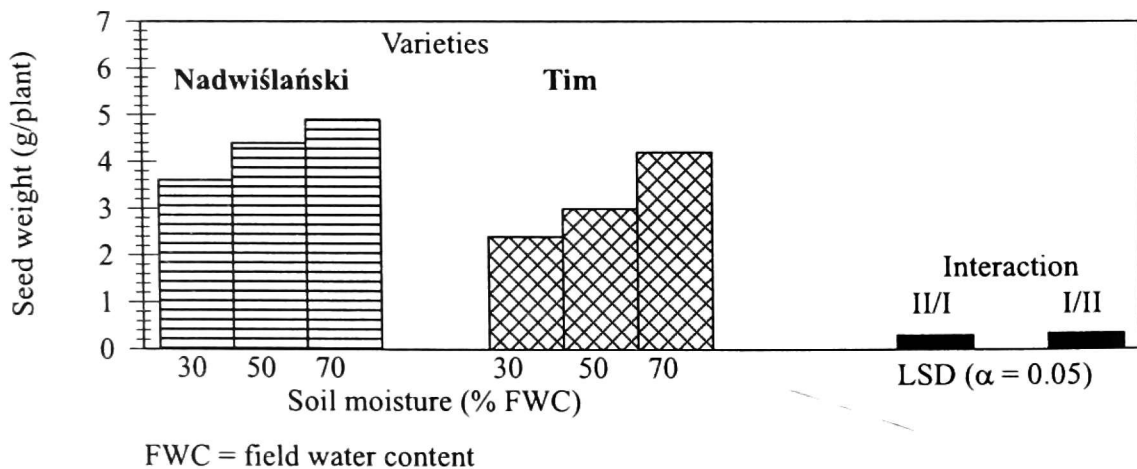


Fig. 1. Seed weight of fodder broad bean 'Nadwiślański' and 'Tim' growing at different soil moisture

Similar effects were found in the white lupine (PODLEŚNY 1999). The length of stem with pods was reduced. The deficit of soil water did limit the mean leaf area per plant. In soybean, HOOGENBOOM et al. (1987), RANDALL and SINCLAIR (1988), SAMESHIMA et al. (1995) and SARKAR (1994) also found negative influence of drought stress on the formation of leaf blades.

Differentiated conditions of soil moisture affected dry matter yield of other plant organs and seed yield (Figure 1). Plants that were cultivated at the highest soil moisture (70% FWC) gave the highest yield. 'Nadwiślański' yielded better than 'Tim' irrespective of soil moisture. On average, 'Nadwiślański' yielded about 4.3 g seeds per plant, while 'Tim' only 3.2 g seeds per plant. Soil moisture had a significant influence on seed yield. On average, the yield of 4.6 g/plant at 70% FWC was reduced to 3.7 g/plant at 50% FWC and to 3.0 g/plant at 30% FWC. However, the seed yield of 'Tim' was more reduced by drought than that of 'Nadwiślański'. The higher sensitivity of 'Tim' to drought may be a result of its weaker root system and an unfavourable weight ratio of aboveground parts to roots. According to GRZESIAK et al. (1996, 1998) those plants which produce larger root systems and have a lower weight ratio of aboveground parts to roots are more resistant to drought.

It can be concluded that a limited water content of the soil strongly reduced the development and yield capacity of fodder broad bean. The 'Nadwiślański' variety (traditional) was more drought-resistant than the new 'Tim' variety of determinate growth.

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