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EFFECT OF THE METHOD OF PLANT PROTECTION ON THE YIELD, ROOT DEVELOPMENT AND FORMATION OF VEGETATION INDICES OF FABA BEAN CANOPY

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Abstract

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Field studies were carried out in 2006-2008 at the Experimental Station of Prusy, belonging to the University of Agriculture in Kracow. The aim was to determine the yield, vegetation indices of above ground plant parts and characteristic of root system in topsoil. The study covered two methods of plant protection; conventional (CPP – insecticides and fungicides) and ecological (EPP – organic insecticides and fungicides) and two varieties of faba bean: Leo and Nadwiślański. Weather conditions modified the seed yield. The highest yield was obtained in 2007 when the rainfall distribution was similar to the multi-year distribution, while the lowest in 2008, with long-term drought from April to June. Conventional plant protection of faba bean resulted in a seed yield increase of 72.6% comparing to the control, and EPP increased the yield by 26.1%. Nadwiślański cultivar among the tested varieties had the higher yielding potential. The indices of root system (RLD, SRL, RDM and MD) were not significantly dependent on the method of plant protection or cultivar. The declining tendencies for RLD, SRL, RDM indices under the influence of chemicals application and increasing one for MD were noted. Leo cultivar was characterized by higher RLD and SRL values in the 0-30 cm soil layer. The value of assimilation leaf area (LAI) depended on the research years and development stage. Regardless of experimental factors, the greatest assimilation leaf area faba bean achieved between 12 June and 6 July. The method of plant protection had a significant impact on the development of this index only in 2008. After reaching the maximum leaf area, faba bean protected in a conventionally way was characterized by a higher value of leaf area index (LAI) comparing to control and ecological protection (EPP).

Key words: Vicia faba L., organic plant protection, seed yield, yield components, parameters of the root system, LAI, NDVI

Abbreviations: m – meter, cm – centimeter, mm – millimeter, nm – nanometer, t – tone, kg – kilogram, g – gram, mg – milligram, ha – hectare, C – control, CPP – conventional insecticides and fungicides, EPP – organic insecticides and fungicides, RLD - root length density, SRL - specific root length, RDM - root dry matter, MD - mean root diameter, LAI - Leaf Area Index, NDVI - Normalized Difference Vegetation Index, SR - Simple Ratio Index, IRVI – Inverse Ratio Index

Introduction

In 2010 the area under legumes covered almost 76 M ha worldwide, of which broad bean and faba bean occupied over 2.5 M ha [FAOSTAT]. In 2010, the area sown with grain legumes in Poland was 173 thousand ha, of which 129 thousand ha was covered by forage crops (c.a. 75%) (Dmochowska, 2010). They constitute high-protein components for preparation of concentrates. Among these crops, faba bean reveals a high yield forming potential. Low-cost technologies of faba bean cultivation among others assume application of vari-

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ety mixtures, cultivation in mixtures with cereals, decreasing the amount sown, limited application of fungicides and insecticides and in organic farming the necessity to replace herbicides by a mechanical way of insect control. Previous research shows that some ways of cultivation may limit occurrence of diseases (sparse sowing) or pests (cultivation in mixtures with cereals). Low-tannin faba bean varieties bred and entered into the national register (after 2002) have been hardly tested as to their usability for organic farming. Tannins are substances, which lower protein and hydrocarbon digestibility and affect worse taste of forage (Hanczakowski, 2004). However, at the same time they belong to the compounds, which play a role in plant resistance to diseases (Islam et al., 2003). One of key factors which cause fluctuations in faba bean yields is occurrence of harmful enthomofauna (Sądej, 1997), therefore one must pay attention to proper protection against pests and diseases and protection of beneficial enthomofauna, which contributes to reducing mass occurrence of pests (Ropek and Kulig, 2004).

Due to hazard it poses to health and balance in the environment, a positive result of applied plant protection on yield and its components is rarely described in the subject literature (Hassan et al., 2006). Some researchers point to an increase in biometric and physiological parameters among oiliferous plants (Fariduddin et al., 2003, Małolepsza and Urbanek, 2002) and legumes (Hassan et al., 2006) in traditional cultivation. However, Hassan et al., 2006 emphasize that the way of faba bean protection is a crucially important but still inadequately researched yield-forming factor.

The paper aimed to determine yielding of selected faba bean cultivars depending on the method of protection and formation of vegetation indices of canopy, and characterization of the root system in arable soil layer.

Material and Methods

Field experiment

The field experiment was conducted in 2006-2008 at Prusy Experimental Station, property of the University of Agriculture in Krakow (N50°07'10"; E20°05'04"). The two-factor experiment was set up using split-plot method in four replications. The area of harvested plots was 12 m^2. The objects of the first factor were the following plant protection methods: C - control: CPP – conventional insecticides (Karate Zeon 050 CS - lambda-cyhalothrin) and fungicides (Sumilex 500 SC - procymidone, Bravo 500 SC - chlorothalonil); EPP – organic insecticides (Spruzit 04 EC – pyrethrins + piperonyl butoxide) and fungicides (Grevit 200 SL - a.s. extract of grapefruit, Miedzian 50 WP - copper oxychloride). The objects of the second factor were two faba bean cultivars: Leo and Nadwiślański. The extract destroys cytoplasmatic membranes of microorganisms and prevents synthesis of aminoacids decreasing infection by different patogens (Esterio et al., 1992; Wojdyła, 2001).

Sowing date in the subsequent years was conditioned by the weather course and for the years 2006-2008 fell respectively on: 19 April, 29 March and 1 April. Before sowing the seeds of Faba bean inoculated with a bacterial vaccine "Nitragina™". The insecticides were applied once on the following dates: 13.06.2006, 08.06.2007 and 02.06.2008, whereas fungicides were applied twice, respectively: Grevit or Sumilex (27.06.2006, 20.06.2007, 23.06.2008) and Miedzian or Bravo (10.07.2006, 09.07.2007, 03.07.2008). The plants were harvested on 4 September 2006, 22 August 2007 and on 6 August 2008.

Faba bean was cultivated on the suite after spring wheat. Fertilization dosed - 35.2 kg P per hectare as ground phosphate rock and 99.6 kg K as potassium sulphate were applied before sowing. Faba bean was sown at row spacing of 50 cm. No herbicides were applied (2x mechanical tending).

Characteristics of soil conditions

Experiment with faba bean cultivation was conducted on degraded chernozem developed from loess. The soil reaction before the experiment fluctuated in individual years within pH range from 5.7 to 6.6. Soil arable layer abundance in essential components was as follows: 0.13% of total N, 0.9 - 1.1% of C-org, medium to very high content of available phosphorus forms (13.0 - 24.7 mg/100g soil) and low to medium content of potassium (11.0 - 15.7 mg/100g soil), with high concentrations of magnesium (9.9 - 14 mg/100g soil).

Climatic conditions

Precipitation distribution in the years 2006-2008 was presented on Figure 1. In 2006, the highest precipitation deficit occurred at green pod stage (in July). On the other hand, August was a very wet month, which resulted in delayed maturing. In 2007, a clear deficiency of rainfall was noted in April, but in that period, plants were using water resources, which remained in soil after winter. Precipitation distribution in this vegetation season was the most beneficial for growth and yielding of faba bean in comparison with the other years. In 2008, the dry period started in the third decade of April (emergencies) and lasted until the third decade of June (flowering start). The most serious water deficit was registered during the period from the second decade of May until the second decade of June.

Biometric measurements

Prior to the harvest, a sample of plants was collected from 0.25 m^2 of each plot to conduct biometric measurements.

Yield structure components were estimated (the number of plants per unit area, the number of pods per plant, number of seeds per pod, a thousand seeds weight) and the other morphological features of plants (number of node per plant, length of steam with pods, plant height). Seed moisture content was measured after harvest.

Vegetation indices of the canopy

In 2006-2008 assimilation area (LAI) was measured at the main development stages by means of SunScan Canopy Analysis System (Delta T) and NDVI, SR and IRVI (Green Seeker by Ntech). The wavelength bands are in the visible (RED 660 nm) and infrared (NIR, 770 nm) regions of the spectrum. Vegetation indices were computed according to the following formulas:

NDVI = (NIR-RED)/(NIR+RED)
SR = NIR/RED
IRVI = RED/NIR

Root system

Soil samples with roots were collected from the 0-30 cm soil layer by means of a root sampler (made by Ejikelkamp – purchased for the project). The cut cylinder was 7 cm in diameter and 10 cm high. Single samples were rinsed in and automatic, hydraulic-pneumatic root flusher (Smucker et al, 1982). Rinsed roots were transferred onto filter paper to remove the excess of water. Subsequently the roots were placed on the scanner surface (Epson Perfection 4870 Photo) and scanned in the light filtering in 600 dpi definition. Obtained images were saved in tif format. The root images were analyzed using the APHELION v.3.2. image analysis system using the command stream saved as macro command. In result, root length in mm was obtained for their various fractions separated based on thickness: >2, 1-2, 0.5-1, 0.2-0.5, 0.1-0.2, <0.1 mm. After scanning, the roots were dried at 105°C in order to determine root dry matter (RDM). The following indices were calculated based on obtained results:

root length density RLD=L/V
where: L = root length (cm); V – volume of tested sample (cm^3)

specific root length SRL = L/RDM
where: RDM – root dry matter
mean root diameter (MD) computed as weighted mean root diameter.

Statistical analyses

Statistical analyses were conduced by means of Statistica 10.0 programme using two ways ANOVA and Tukey's test. Moreover, analysis of correlation and regression was used to estimate the interrelations between the tested features.

Results

The weather conditions modified seed crop yield and the highest mean yield of faba bean was obtained in 2007, the year characterized by precipitation distribution similar to the multiannual period, whereas the lowest yield was harvested in 2008 with long lasting drought in April-June period. Application of traditional plant protection caused increase in seed yield by 72% in comparison with the control, while EPP application increased faba bean yielding level by 26.1% (Table 1). Among the studied cultivars, Nadwiślański cultivar produced the largest yield. The difference, in comparison with the low tannin Leo cultivar was not statistically confirmed. Figure 2 shows the interaction of the protection methods and conditions in respective years in seed yield formation. The most beneficial EPP effect on faba bean yielding was registered in the year with unfavourable course of the weather conditions and high pressure of diseases and pests (2008).

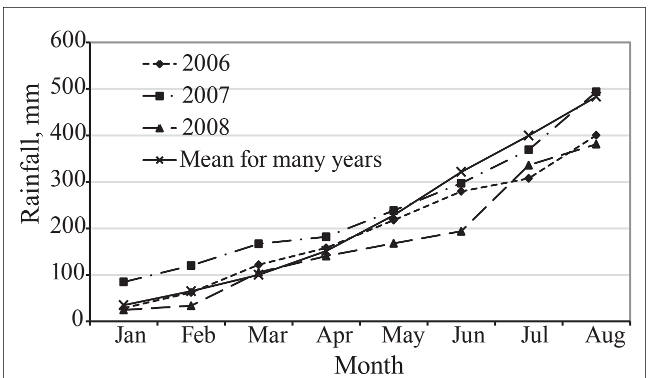

Fig. 1. Cumulative sum of rainfall in 2006-2008 and for many years

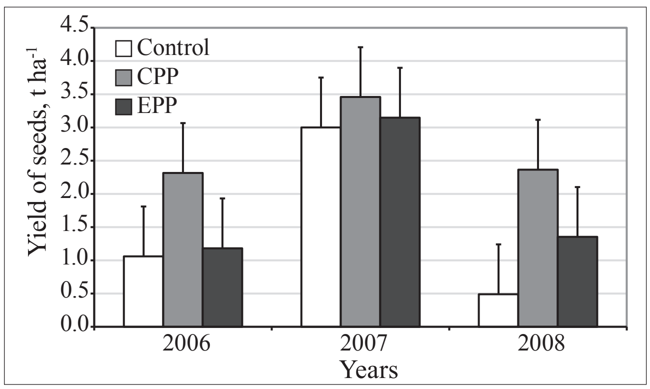

Fig. 2. Interaction of years and plant protection methods in faba bean yielding formation

Mean plant density was 43.3 pcs. per m^2. Among the tested cultivars, the higher density characterized Nadwiślański c.v. (Table 1). The number of pods per plant significantly depended on the studied factors and years; its mean value was 7.96. In result of CPP application, a marked increase in the number of pods was noted – by 44% in comparison with the control and by 41.9% in result of EPP application. Leo c.v. formed a bigger number of pods. Mean number of seeds per faba bean pod during the discussed experimental period was 2.39. The plants from CPP treatments developed on average 27.4% more seeds per pod than those from EPP objects.

Mean thousand seeds weight was 337 g. Yielding potential connected with this feature was especially poorly used in 2006 and 2008, which was caused by drought in July 2006 and considerable pressure of diseases and pests (particularly *Aphis fabae* and *Botrytis fabae*) in 2008. Seeds from CPP objects were characterized by 21.2% higher MTN value than on the control and by 20.8% higher than on EPP treatments. Leo c.v. was characterized by a lower number of seeds per pod and lower MTN in relation to Nadwiślański cultivar. Both the conditions in respective years and protection means significantly affected morphological features of plants – plant height, number of pod levels and length of fruiting part. Strong biotic (diseases and pests) and abiotic (drought) in 2008 stress caused a considerable decline in the above-mentioned morphological features. On the other hand, the most beneficial values of these features were noted on CPP treatments, slightly poorer on EPP and definitely the lowest on unprotected objects (Table 1).

The indices of root system: RLD, SRL, RDM and MD were not significantly dependant on the plant protection method or cultivar, however a declining tendency for RLD, SRL and RDM indices, but increase in MD value was noted under the influence of chemicals application (Table 2). Leo c.v. was characterized by higher RLD and SRL values in the 0-30 cm soil layer. In the subsequent soil layers, 0-10, 10-20 and 20-30 cm, RLD value was decreasing insignificantly, whereas RDM and MD value significantly. On the other hand, SRL value was increasing visibly.

With increasing depth of the root system, the number of root nodules was decreasing notably, irrespective of plant protection method. In the 0-10 and 20-20 cm layers a tendency for producing a lower number of root nodules was observed following the application of plant protection in comparison with the control (Figure 3).

The highest RLD index value was observed for the roots with 0.2-0.5 and 0.1-0.2 mm diameters, and subsequently for 0.5-1 mm (Figure 4a). Application of plant protection (CPP and EPP) caused a marked decrease in RLD value for the root classes with 0.1-0.2 and 0.2-0.5 mm diameters (Figure 4b).

Table 1
Statistical characteristics of agronomic and morphological traits of faba bean, depending on the studied factors

Item	Yield of seeds, t·ha^{-1}	Plant density, pcs.·m^{-2}	Pods per plant, pcs.	Seeds per pod, pcs.	Weight of 1000 seeds, g	Plant height, cm	Node per plant, pcs.	Length of steam with pods, cm
Years								
2006	1.63±0.68*	39.7±5.99	10.49±1.94	2.98±0.54	350±45.5	91.5±11.44	6.02±1.12	26.8±5.65
2007	3.20±0.40	44.7±6.93	7.97±2.71	2.33±0.28	388±63.0	91.1±10.26	5.84±1.79	26.7±7.58
2008	1.40±1.04	44.6±6.96	5.98±2.75	1.99±0.62	277±49.3	71.7±7.47	3.19±2.02	10.8±5.58
$LSD_{(\alpha=0,05)}$	0.371	NS	1.548	0.315	27.0	4.41	0.9468	4.063
Way of plant protection								
Control	1.57±1.20	42.7±7.63	6.15±3.08	2.12±0.72	306±73.4	78.3±12.63	3.76±2.47	17.1±9.52
CPP	2.71±0.79	42.6±6.62	8.88±2.60	2.70±0.58	371±69.6	90.0±13.88	5.55±1.93	23.8±9.87
EPP	1.98±1.07	44.6±6.78	8.73±2.93	2.30±0.46	331±58.1	83.8±11.59	5.41±1.61	22.2±9.64
$LSD_{(\alpha=0,05)}$	0.369	NS	1.539	0.313	26.9	4.39	0.941008	4.051
Cultivars								
Leo	1.97±1.09	41.2±7.49	8.68±2.97	2.31±0.58	324±55.9	80.3±13.06	5.21±2.59	21.3±11.41
Nadwiślański	2.26±1.14	45.3±5.77	7.24±3.07	2.47±0.68	351±82.9	88.3±12.85	4.66±1.59	21.2±8.31
$LSD_{(\alpha=0,05)}$	NS	3.41	1.255	NS	21.9	3.58	NS	NS
Mean	2.11	43.3	7.96	2.39	337	84.3	4.93	21.2

* Values are means±SD (n=4), NS – not significant difference, CPP- insecticides and fungicides; EPP – organic insecticides and fungicides

A significant decline in this index value was observed in the 0-10 cm layer in effect of plant protection (Figure 4c). Leo c.v. was characterized by clearly higher values of RLD index for the roots with 0.1-0.2 and 0.2-0.5 mm diameters (Figure 4d).

The value of assimilation leaf area (LAI) depended on research years and their development stage (Figure 5). Regardless of experimental factors, the greatest assimilation leaf area faba bean achieved between 12 June and 6 July. In 2007, the faba bean was characterized by a greater assimilation leaf area than in 2006 and 2008. Method of plant protection had a significant impact on the development of this index only in 2008. After reaching the maximum leaf is aconventionally protected faba bean was characterized by a higher value of leaf area index (LAI) comparing to control and ecological protection (EPP). Assimilation leaf area of faba bean varieties remained at a similar level in 2006 and 2008 while in 2007 a significantly higher assimilation leaf area was noticed in Nadwislanski variety on the 163rd day of the year (Figure 5). The conducted study found no significant differences in the NDVI index between compared varieties of faba bean. However, at the end of growing season (starting from the 171st day a year) slightly higher values of NDVI were observed in traditional Nadwislanski variety. Methods of plant protection significantly modified leaf area indices at the end of growing season (the 190th day the year). The use of conventional plant protection efficiently extended the physiological processes and as a consequence significantly higher value of NDVI was achieved (Figure 6). The correlation analysis showed strong relations between the assimilation leaf area and NDVI, SR and IRV indices (Figure 7).

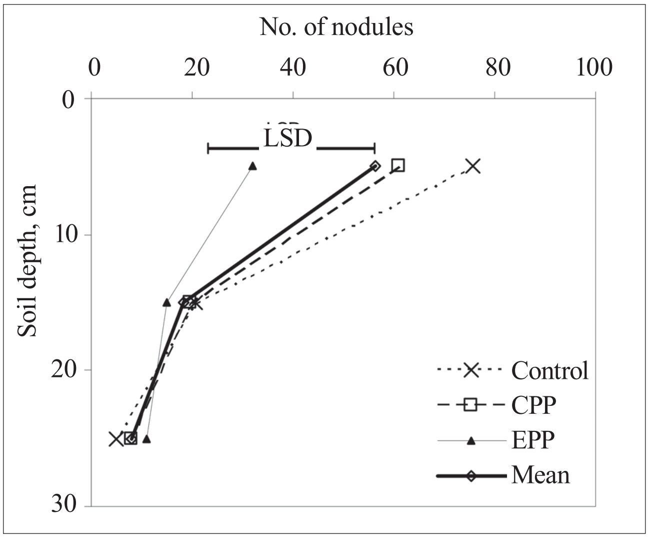

Fig. 3. Total root nodules in the individual layers of the soil

Discussion

Yield and yield structure

Application of full protection against diseases and pests contributes to increase in faba bean seed yields. Higher yielding level of so protected faba bean should be in the first place

Table 2
The parameters of faba bean root system in the soil layer 0-30 cm in 2006

Treatments	RLD, cm cm^{-3}	SRL, cm g^{-1}	RDM, g cm^{-1}	MD, mm
Way of plant protection				
Control	1.083+0.242*	1540+477	0.00160+0.00091	0.494+0.062
CPP	0.673+0.133	1115+376	0.00124+0.00054	0.579+0.093
EPP	0.761+0.113	1316+396	0.00115+0.00044	0.533+0.066
$LSD_{(\alpha=0,05)}$	NS	NS	NS	NS
Cultivar				
Leo	0.907+0.121	1695+352	0.00082+0.00021	0.461+0.041
Nadwiślański	0.771+0.170	952+262	0.00184+0.00067	0.609+0.066
$LSD_{(\alpha=0,05)}$	NS	NS	NS	NS
Soil layer, cm				
0-10	1.027+0.248	417+104	0.00294+0.00073	0.685+0.055
10-20	0.873+0.124	1297+230	0.00076+0.00011	0.510+0.080
20-30	0.618+0.115	2257+375	0.00030+0.00006	0.411+0.025
$LSD_{(\alpha=0,05)}$	NS	995.6	0.00158	0.2103
Mean	0.839+0.103	1324+231	0.00133+0.00036	0.535+0.042

* Values are means ± SE (n=4), NS – not significant difference, CPP- insecticides and fungicides; EPP – organic insecticides and fungicides, RLD - root length density, RDM - root dry matter, SRL - specific root length, MD - mean root diameter

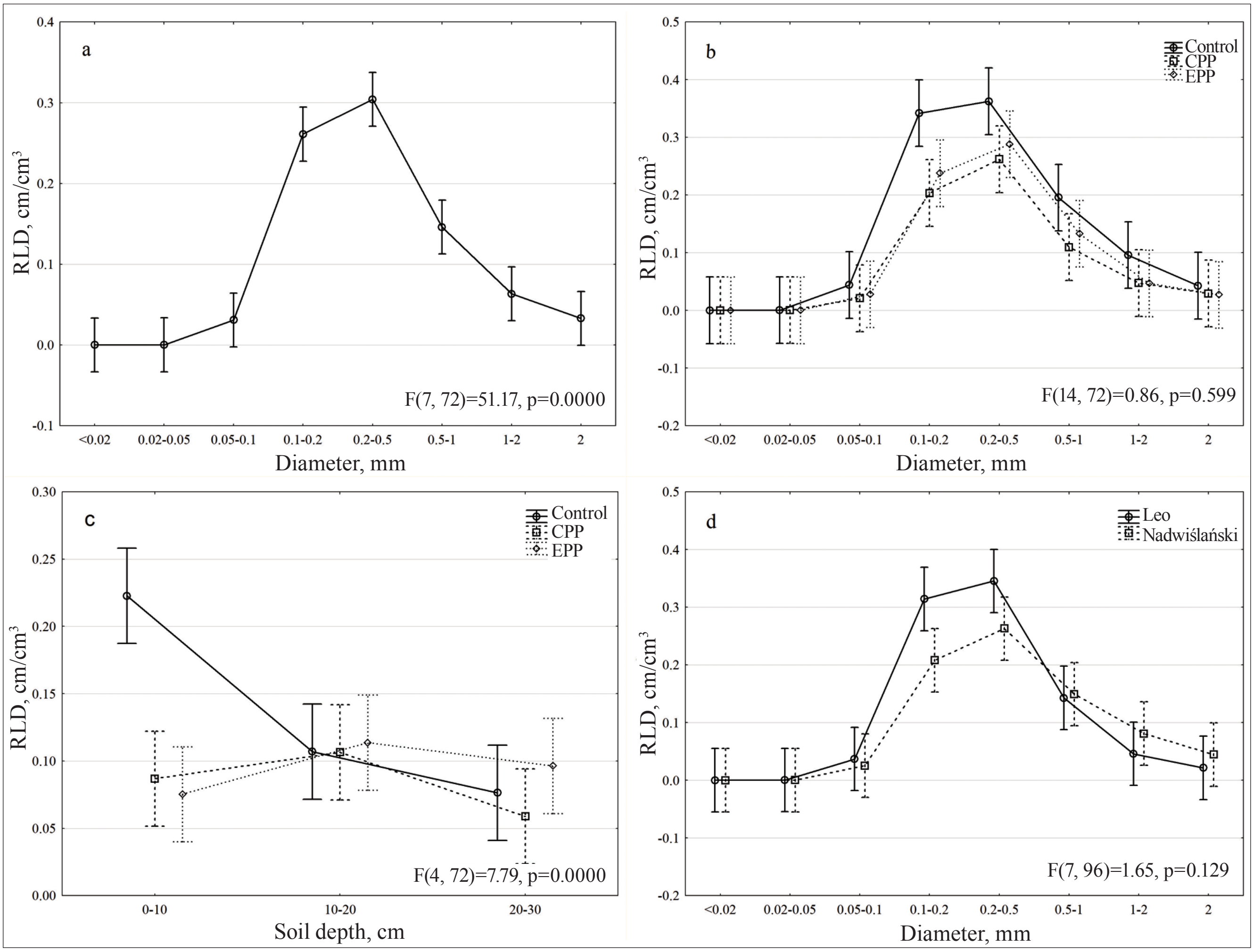

Fig. 4. Formation of the RLD, depending on roots diameter and soil depth

connected with an effective reduction of *Botrytis fabae, Alternaria* and *Aphis fabae* occurrence. More intensive plant protection also beneficently affected the elements of yield structure (number of pods, seeds, a thousand seed weight per plant and ripeness of seeds) forming faba bean level of yielding (Księżak and Kuś, 2005). Seed yield is closely dependant on biomass accumulation (Agung and McDonald, 1998). Therefore, in the system where plant protection means are not necessary, plant vigour plays a crucial role in yield structure forming. Poulain et al. (1986) and Tuttobense and Vagliasindi (1995) report that sowing density forms the yield structure elements due to inter species competition. Increase in canopy density negatively influences the number of produced nodules, resulting in a reduction of pod number per shoot. The number of seeds per pod and genotype most probably determines seed weight. However, as reported by Lopez-Bellido et al. (2005) inter-species diversification of this feature depends also on the site conditions. According to Pilbeam et al. (1990), seed yield is formed by the years x sowing density x cultivar interaction. However, as the author demonstrates, the crop yield is more strongly determined by the environment, which is connected with a considerable but unpredictable diversification of years, despite applied proper protection against pests and diseases. The number of pods per 1m^2 is a feature closely correlated with seed yield. If any disturbances of plant growth and development occur due to environmental conditions, considerable differences in the number of formed pods become visible (Stützel and Aufhammer, 1992). Pocsai (1985) reports that seed weight is conditioned genetically, although to a lesser extent than the number of seeds per pod. According to McEwen 1973, seed weight is also conditioned environmentally. Faba bean is an attractive nutrient for many

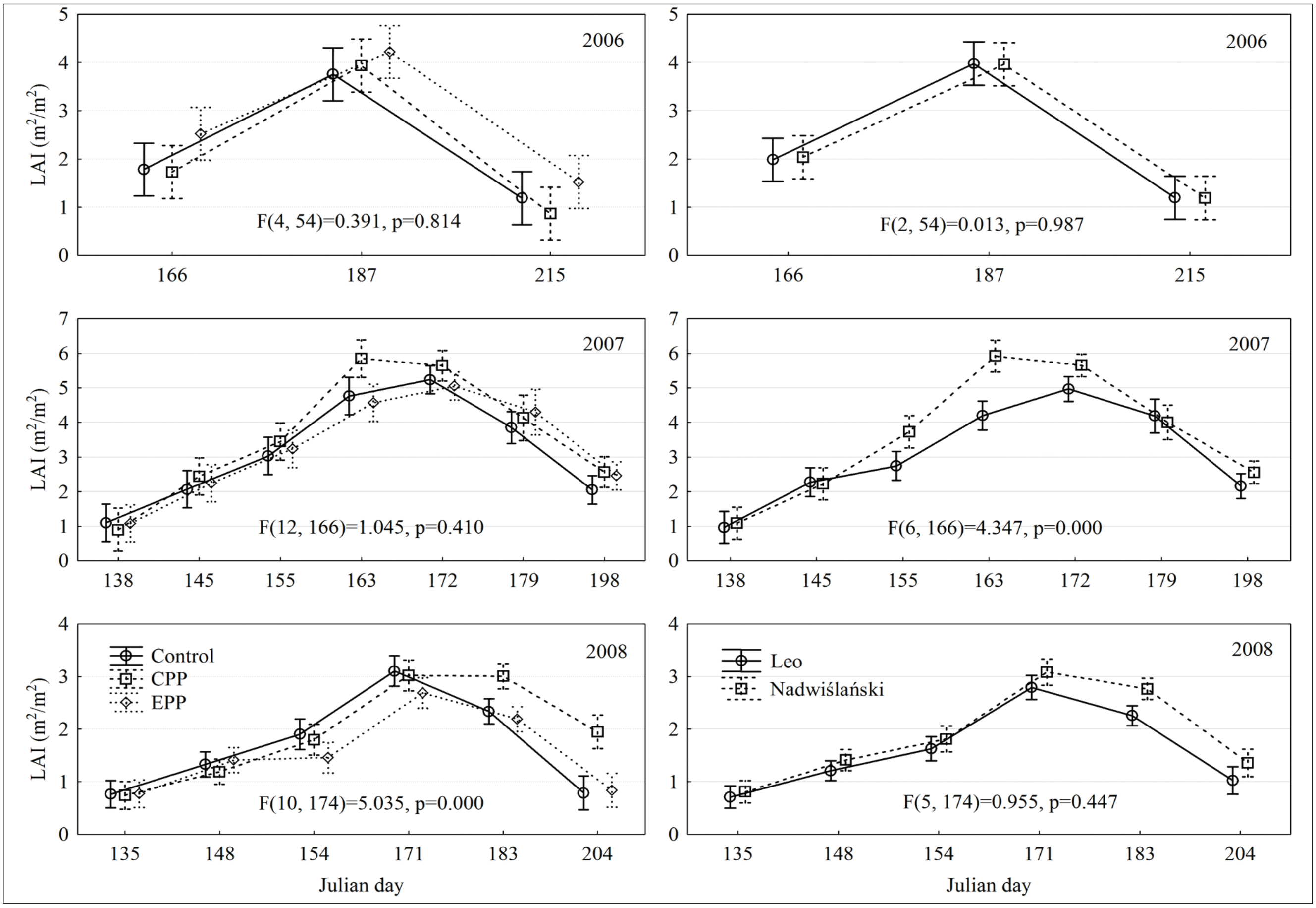

Fig. 5. Formation of faba bean conopy surface depending on plant protection method or cultivar

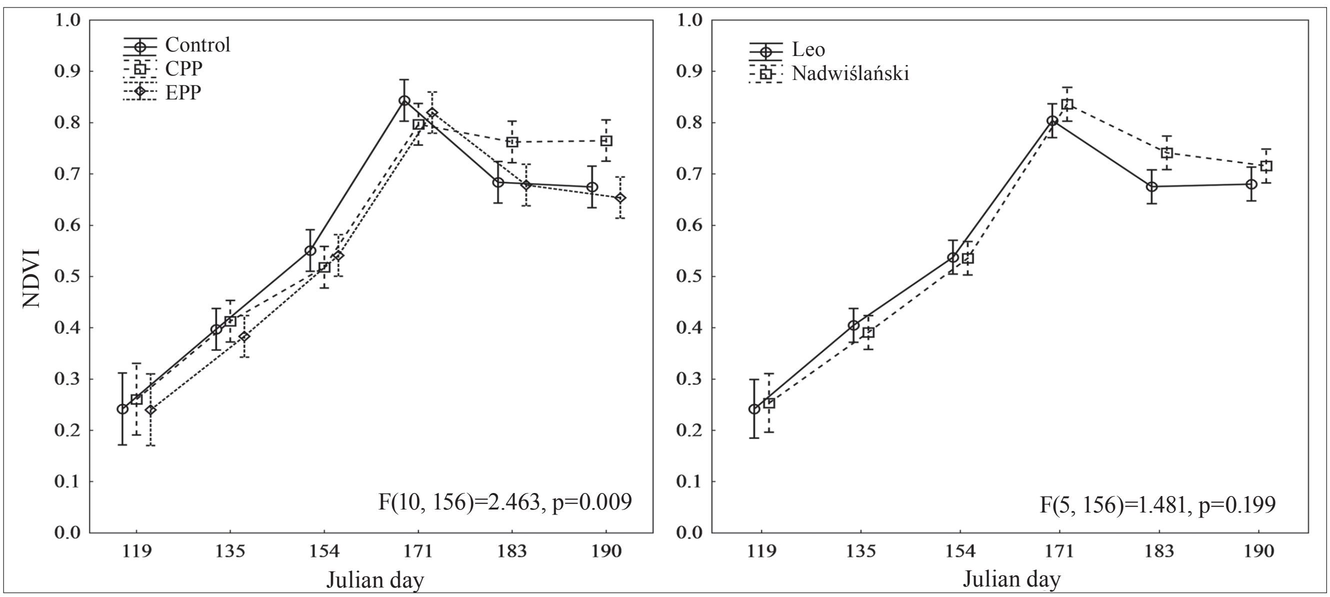

Fig. 6. Formation of NDVI index of faba bean depending on plant protection method or cultivar (year 2008)

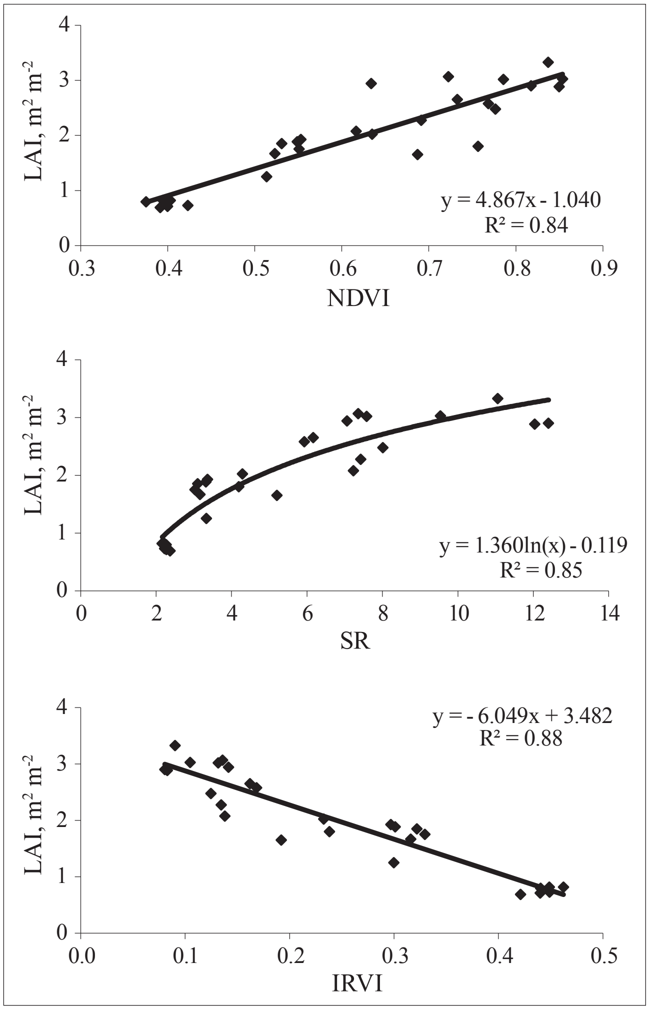

Fig. 7. Relationship among NDVI, SR, IRVI and LAI (year 2008)

insects (Koltowski, 1996; Osborne et al., 1997; Nuessly et al., 2004; Manning, 2006). Late harvesting period contributes to an appearance of creeping thistle (*Cirsium* spp.) at the flowering stage. This weed is attractive for numerous insects. A week after flowering stage, intensive plant infestation by insects happens, which negatively affects pod forming (Rebek et al., 2005; Köpke and Nemecek, 2010). Legume yielding depends on agrotechnical measures and plant protection. Many research works demonstrated that application of insecticides and fungicides increases considerably faba bean seed yield (Nadolnik et al., 2001; Kulig et al., 2006). Common occurrence of pathogenic agents with diversified sensitivity to fungicides causes that chemical limiting the pathogen complex is not easy, but becomes cost-effective when properly chosen (Kulig et al., 2006). Properly conducted measures of fungicide spraying against the most serious fungal pathogens contribute to a significant increase in yield, whereas chemical diseases control should be applied particularly in cultivation of faba bean with determined growth (Nadolnik et al., 2001).

Root system

Hassan et al. (2006) demonstrated that low concentration of chemical preparations (with low toxicity for people) markedly raises the amount of fresh and dry matter of shoot and root weight. Gerwitz and Page (1974) and Manschadi et al. (1998) described mathematically root distribution in the soil profile, whose amount diminishes with depth. Root elongation is constant during the period of growth and development under conditions optimal for the plant or depends on the soil temperature and amount of assimilates supplied by the shoots (Porter et al., 1986; Narda and Curry, 1981). It may be deducted that a change of site conditions caused by biotic stress leads to disturbances of growth and development of roots. Manschadi et al. (1998) observed similar dependencies, stating that, irrespectively of the soil profile level, RLD is the function of shoot growth; daily increment of root length is proportional to biomass increase and placement in the arable layer. The author reports that as much as between 57 and 66% of root mass is in the layer below 15 cm, whereas under conditions of stress the values were reached in the layer below 30 cm. While analyzing RLD value for faba bean in the upper layer (0-15 cm) under changeable site conditions, Manschadi et al. (1998) did not find any diversification of the index, assuming its mean value within the range of 2.2–3.0 cm cm^{-3}, whereas in the lower layer (15-30 cm) its value decreased to 1.2–1.5 cm cm^{-3}. Root system supports the plant and is responsible for taking up water and nutrients from the substratum. Yu and Zhang (1979) stated that in sandy soil the main root might penetrate the substratum to between 100 and 120 cm. Such trend continues until budding stage in which the length of shoots is similar to the main root length. Faba bean forms lateral roots from the main root at a seedling stage. Lateral roots make up 60% of the total root weight, whereas at the stage of shoot forming – 80-90%. According to Yu and Zhang (1981), some lateral branches grow horizontally (45 cm) close to the earth surface before they change the direction to vertical. Faba bean root nodules, particularly among the intensively nitrogen fixing cultivars are placed mainly in the upper soil layer. There is a hypothesis that considerable diversification of SRL value in various species results from diversified root diameters (Pregitzer et al., 2002) because SRL is inversely proportional to root diameter.

Vegetative indices of canopy

According to Poulain et al. (1986), development of LAI depends mainly on the site conditions and canopy density. Maximum LAI is always bigger at greater plant density (Singh et al., 1988; Quaglietta-Chiaranda et al., 1995; Loss et al., 1998). Maximum LAI is obtainable at the flowering stage until pods setting stage. Thompson (1983) concluded that greater canopy density ensures higher seed yield, under condition that LAI value during flowering period is low. According to the same author, there are other agents affecting LAI value, among others the genotype and water resources in the soil. NDVI index assumes values between - 1 and 1. If NDVI index exceeds 6, it is assumed that the plants are in good condition and are not exposed to stressors. The higher the reflection in infrared and lower in the red band light, the greener are the plants and the higher the value of this index (Wang et al., 2004). High values are connected with photosynthetic activity of plants (Rouse, 1973; Gamon et al., 1995; di Bella et al., 2004). NDVI is well correlated with other values, such as: biomass, LAI, APAR, or primary production, determining the state of plants (Carlson and Ripley, 1997). Considerable density of canopy increases photosynthesis process and reduces respiration process (Poulain et al., 1986). The canopy infected by *O. crenata* and therefore its total biomass become reduced. During the seed filling translocation of assimilates occurs in the infected plants – from shoots and leaves to *O. crenata*. During full maturity, a rapid decline in the biomass amount occurs (Grenz et al., 2005). The number of pods was considerably reduced in infected plants. Grenz et al. (2005) report that the yield decreased on average by 25-71%. Pest infestation more contributed to the reduction of the number of pods and slight reduction of 1000 seeds weight than the number of seeds in compared genotypes. Shortening of seed filling period in result of plant infection by pathogens, directly contributed to the reduction of 1000 seeds weight (Grenz et al., 2005). The results correspond to the research conducted by Loss and Siddique, 1997. Disturbance of seed maturation process is instrumental in greater losses in yielding in comparison with a strong reduction of assimilants in the seed filling process (Munier-Joulain et al., 1998). Polish experiments demonstrate that chemical measures significantly limit diseases and pests occurrence (Lipa, 2003; Tyburski and Żakowska-Biemans, 2007). The best results are obtained when full fungicide and insecticide protection is applied (Nadolnik et al., 2001; Dłużniewska et al., 2007). Organic preparations, insecticides and fungicides markedly reduce the occurrence of fungal diseases, still their effect is markedly weaker than traditional means (Dłużniewska et al., 2008). Faba bean seeds containing trace amounts of tannins germinated by 12% more poorly, irrespective of the harvest year and by about 10% more poorly emerged in the field and generally revealed a lower vigour than the seeds with high content of these compounds. Healthiness of low-tannin seeds was worse than high-tannin seeds. Seed yield was higher for no-tannin than for high-tannin forms, however it was not statistically proven (Kolasińska and Wiewióra, 2002). Hassan et al. (2006) and Fariduddin et al. (2003) revealed a marked effect of chlorophyll amount in leaves dependant on the degree of plant infection. Application of chemicals of low toxicity for people (salicylic acid in 0.7mM preparation) markedly influenced chlorophyll level in leaves. Total chlorophyll quantity significantly stimulated formation of pigment, which improved total effectiveness of photosynthesis process.

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