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Original scientific paper

Control of winter forage pea diseases by pea-oat intercropping under field conditions

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SUMMARY

A field experiment was conducted at the experimental field of the Institute of Field and Vegetable Crops in Novi Sad to investigate the effect of forage winter pea and winter oat intercropping on ascochyta blight and powdery mildew infections. Seeding rations of pea and oat in Treatment 1 (50:50%) and Treatment 2 (75:25%, respectively) reduced ascochyta leaf infection by 32.5% and 12.8%, and powdery mildew infection by 12.3% and 17.5%, respectively, compared to pea monoculture used as a control (Treatment 3). The same seeding rations in Treatment 1 and 2 reduced ascochyta blight on pea plants by 37.2% and 18.3%, respectively. However, there were no significant differences between the treatments in reducing powdery mildew on plants.

The effects of different treatments on the average number of pods per plant, seed per pod, shriveled pods and seed weight were analyzed using Spearman's correlation coefficient. Negative but not statistically significant effects on those measured parameters were registered in Treatments 2 and 3, while Treatment 1 showed positive effects on all parameters except shriveled pods.

According to all data obtained in this research, the intercropping mixture of pea and oat at 50:50% seeding ratio had the best effect on the measured parameters while the intercropping mixture of pea and oat at 75:25% seeding ratio had low to moderate effect in comparison with pea monocrop.

Keywords: Forage pea; Diseases; Intercropping

INTRODUCTION

Pea is the oldest cultivated plant in the world, originating in the Middle East (Zeven & Zhukovsky 1975). Forage pea (*Pisum sativum* L.) is a variety of common pea grown for forage, silage and dry seed for animal feeding. Pea is the third most widely produced grain legume in Serbia (Statistical Office of the Republic of Serbia, 2012) and the second in world grain production (Food and Agriculture Organization, 2012).

Pea production is limited by 29 different fungal diseases (Hagedorn, 1984). Among them, ascochyta blights (*Ascochyta* spp.) and powdery mildew (*Erysiphe pisi* DC) are the most economically important diseases of peas throughout the world (Dixon, 1978; Muehlbauer & Chen, 2007).

Ascochyta blight is caused by a complex of three pathogens of peas: *Ascochyta pisi* Lib., which causes leaf and pod spot; *A. pinodes* (Berk. & Blox.) Jones, (teleomorph: *Mycosphaerella pinodes* (Berk. & Blox.) Vesterg, which causes blight; and *Ascochyta pinodella* (sin. *Phoma medicaginis* var. *pinodella* (L.K. Jones) Boerema, which causes foot rot. Among them, *A. pinodes* is the most damaging pathogen. Average yield losses of pea caused by these pathogens under favorable weather conditions have been estimated at over 50% (Xue et al., 1997; McDonald & Peck, 2009).

Erysiphe pisi, the causal agent of powdery mildew of pea, is a hazardous pea pathogen in warm and dry regions. The pathogen infects all aerial parts (leaves, stems, flowers, pods) of pea plants (Singh, 2000), and can cause significant yield losses (Kumar & Singh, 1981; Davidson et al., 2004).

The most efficient environmentally-friendly method for plant protection is selection and growing of pea cultivars resistant to ascochyta blights and powdery mildew. However, limited success has been made in pea breeding programs for resistance to *Ascochyta* spp. and *E. pisi* (Aghora et al., 2010; Rubiales & Fondevilla, 2012). Many authors agree that one of the solutions could be found in improved intercropping systems (Schoeny, et al., 2010; Fernández-Aparicio et al., 2010; Boudreau, 2013). Components of intercrops are often less damaged by pests and diseases than they are as sole crops, but the effectiveness of avoiding attack that way often varies unpredictably (Trenbath, 1993). Disease infection can be delayed by reducing inoculum spreading, creating a physical barrier and modifying microclimate to make crops less suitable for pathogens to spread in intercropping (Boudreau, 2013).

Several authors have reported other advantages of intercropping as well: better usage of environmental resources, improved soil fertility and nitrogen increase, less pesticides used, improved forage quality, yield stability and uniformity and finally – an increase in overall production (Sumner et al., 1981; Mousavi & Eskandari; 2011, Kadžiulienė et al., 2011).

This study focused on observing the influence of an intercropping mixture (pea with oat) on ascochyta blights and powdery mildew infections. Another aim was to show the effect of different treatments on the average number of pods per plant, shriveled pods per plant, seed per pod, and seed weight.

MATERIAL AND METHODS

The effect of intercropping forage winter pea (*Pisum sativum* L.) and winter oat (*Avena sativa* L.) on disease development under field conditions was examined at the experimental field of the Institute of Field and Vegetable Crops in Novi Sad, using a completely randomized block design with three replications. The plot size for each accession was 9 m^2. Pea and oat were mixed together, and mechanically sown in rows at the same depth in mid-autumn of 2012. The seeding pea-oat intercropping ratios were 50:50% in Treatment 1 and 75:25% in Treatment 2, which were compared with a forage pea monocrop (100%) in Treatment 3.

A total of ten pea plants randomly chosen per plot in three replications per treatment were estimated for disease presence during the pod-fill growth stage. The number of properly developed and shriveled pods, number of seeds and seed weight were analyzed during the spring of 2013.

Disease severity on leaves was individually assessed for ascochyta blight and powdery mildew, according to scale 1 (0-4) as follows: 0 = 0-4% no infection, 1 = 5-9%, 2 = 10-19%, 3 = 20-49% and 4 = over 50% of leaf surface infected (EPPO, 2004). Visual evaluation of whole pea plants from top to bottom was made according to scale 2: 0 = 0-10% of plant surface infected with disease, 1 = 11-20%, 2 = 21-30%, 3 = 31-40%, 4 = 41-50%, 5 = 51-60%, 6= 61-70, 7 = 71-80%, 8 = 81-90%, 9 = 91-100%.

Average disease incidence per treatment was calculated as an average disease percentage according to scale 1 for all estimated leaves, and scale 2 for whole estimated plants. The data showing the average disease incidences on leaves and plants were further analyzed in Statistica 12 using the Kruskal-Wallis test.

Spearman's rank correlation coefficient was used to analyse the effects of different treatments on the average number of pods per plant, shriveled pods per plant, seed per pod, and seed weight.

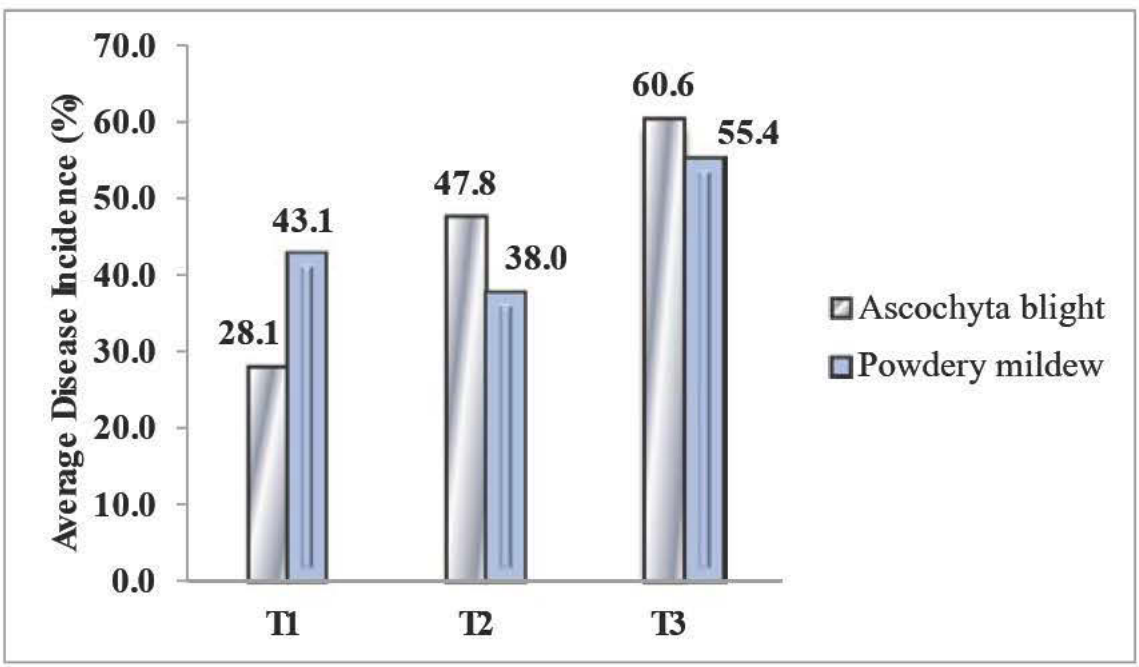
RESULTS AND DISCUSSION

The results in Figure 1 show a general reduction in ascochyta leaf blight and powdery mildew incidence by both intercrop mixtures. Seeding ratios of pea and oat in Treatment 1 (50:50%) and Treatment 2 (75:25%) significantly ($p < 0.05$) reduced ascochyta blight and powdery mildew infections (Figure 1). The average disease incidences on leaves in the pea monocrop, which was used as the control (Treatment 3), were high for both asochyta blight (above 60%) and powdery mildew (55%). Ascochyta average disease incidences in Treatment 1 and Treatment 2 were reduced by 32.5% and 12.8% respectively, compared to pea monocrop. Modified microclimate within the intercrop canopy and particularly a reduction in leaf wetness has an impact on conidia dispersal of the pathogens (Schoeny at al., 2010). Kinane and Lyngkjaer (2005) reported that an intercropping mixture (50:50%) reduced ascochyta blight by 40%. A study carried out by Fernández-Aparicio et al. (2010) showed that the 50:50% ratio of pea and oat had a low to moderate effect of reduction (14-45%) on *A. pinodes*.

Powdery mildew average disease incidences on leaves in Treatment 1 and Treatment 2 decreased by up to 12.3% and 17.5%, respectively, compared to pea monocrop (Figure1). This may be attributed to a changed host crop density and creating a physical barrier with non-host plants. This is the first report on a reduction in pea powdery mildew on leaves by the intercropping system.

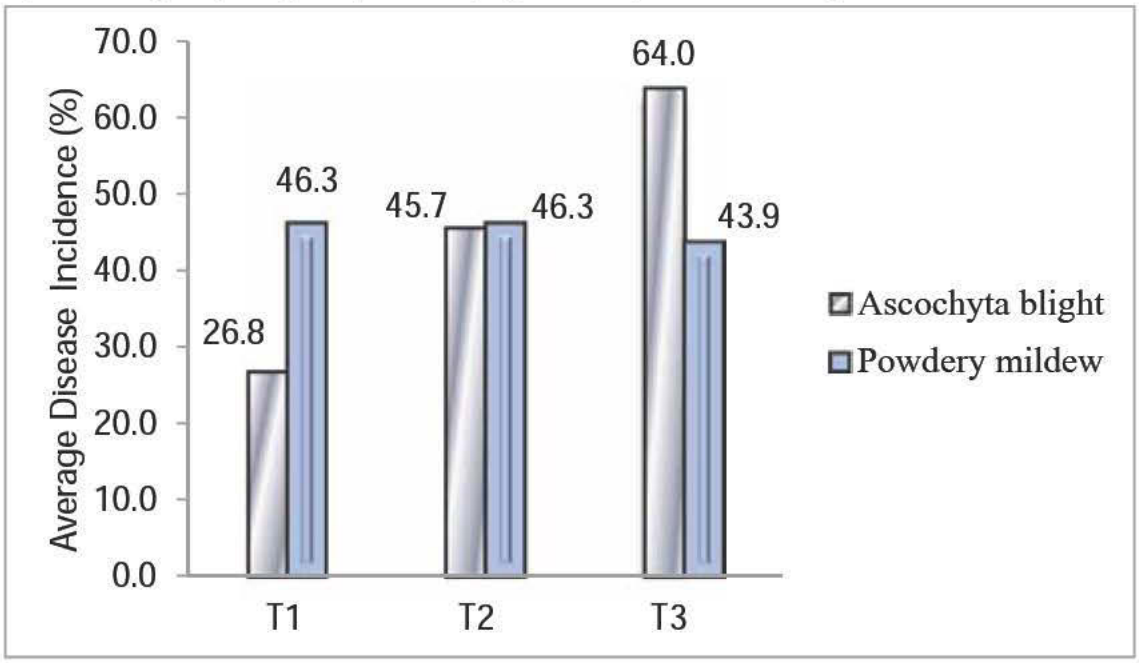
According to the results (Figure 2), the highest ascochyta blight average disease incidence on plants was observed in the forage pea monocrop in Tretament 3 (64%), while powdery mildew average disease incidence on plants was above 46% in both Treatment 1 and Treatment 2. However, there was no significant difference ($p<0.05$) between the powdery mildew average incidence in treatments and forage pea monocrop. Ascochyta blight average incidence was significantly reduced ($p<0.05$) by 37.2% (Treatment 1) and 18.3% (Treatment 2) compared to the monocrop. Schoeny at al. (2010) reported that ascochyta blight severity on stems was substantially reduced in a pea-cereal intercrop compared to a pea monocrop, in which the epidemic was moderate to severe. During our research disease was not noticed on oat. Similar intercropping results have been reported for a pea-barley mixture, which reduced net blotch (*Pyrenophora teres*), leaf rust (*Puccinia triticina*) and powdery mildew (*Blumeria graminis* f. sp. *hordei)* in every intercrop treatment compared to barley monocrop (Kinane & Lyngkjær, 2002).

Figure 1. Ascochyta blight and powdery mildew on pea leaves as compared between seeding ratios



Legend: T1 – Treatment 1 (50:50% pea/oat); T2 – Treatment 2 (75:25% pea/oat); Treatment 3 (100% pea)
(Kruskal-Wallis test, $p < 0.05$)

Figure 2. Ascochyta blight and powdery mildew on pea plants as compared between seeding ratios



Legend: T1 – Treatment 1 (50:50% pea/oat); T2 – Treatment 2 (75:25% pea/oat); Treatment 3 (100% pea)
(Kruskal-Wallis test, p <0.05)

Table 1. Correlation coefficients between different treatments and average number of pods, shriveled pods per plant, seeds per pod and seed weight

	Average number of pods per plant	Average number of shriveled pods per plant	Average number of seeds per pod	Average seed weight per plant
Treatment 1 (50:50% pea/oat)	0.192	-0.320	0.151	0.302
Treatment 2 (75:25% pea/oat)	-0.147	-0.074	-0.045	-0.222
Treatment 3 (100% pea)	-0.206	-0.239	-0.142	-0.236

Legend: Significant at * 0.05;** significant at 0.01 (Spearman's rank correlation coefficient)

Correlation coefficients (Table 1) for the number of pods (0.192), seeds (0.151) and seed weight (0.302) per pea plant were nonsignificantly but positively correlated in Treatment 1, while negative correlation was noticed only for the number of shriveled pods (-0.320). In Treatment 2, negative correlations were found for the number of pods (-0.147), seeds (-0.045) seed weight (-0.222) and number of shriveled pods (-0.074) per pea plant. In Treatment 3, negative correlations were detected for all measured parameters as well – the number of pods (-0.206), seeds (-0.142), seed weight (-0.236) and number of shriveled pods (-0.239), per pea plant.

According to all data obtained in this research, the intercropping mixture of pea and oat at 50:50% seeding ratio had the best effect on the measured parameters, while their intercropping mixture at the respective 75:25% seeding ratio had low to moderate effect compared to pea monocrop.

CONCLUSIONS

This research showed that intercropping mixtures of pea and oat (at 50:50% and 75:25% seeding ratio) had low to moderate effect in reducing ascochyta blights and powdery mildew of pea. The higher proportion of oat in the mixture led to a reduction in ascochyta blight and powdery mildew infections of leaves and stems of pea

plants. The data obtained in this research also showed that the intercropping mixture of pea and oat at 50:50% seeding ratio was positively correlated with the number of pods, seeds and seed weight per pea plant. A negative correlation with these parameters was observed in the pea monocrop and intercropping mixture of pea and oat at 75:25% seeding ratio.

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Smanjenje bolesti ozimog stočnog graška u združenoj setvi u polju

REZIME

Poljski ogled je postavljen na oglednom polju Instituta za ratarstvo i povrtarstvo u Novom Sadu kako bi se istražio uticaj smeše ozimog stočnog graška i ozimog ovsa na pojavu antraknoze i pepelnice. Smeše graška i ovsa u Tretmanu 1 (50:50%) i Tretmanu 2 (75:25%) smanjile su antraknozu lista za 32.5% i 12.8%, a pepelnicu za 12.3% i 17.5% u odnosu na monokulturu graška, koja je uzeta za kontrolu (Tretman 3). Navedene smeše u Tretmanima 1 i 2 su smanjile pojavu antraknoze celih biljaka za 37.2% i 18.3%. Međutim, između tretmana nije uočena značajnija razlika u pojavi pepelnice na celoj biljci graška.

Uticaj tretmana na prosečan broj mahuna po biljci, šturih mahuna po biljci, zrna po mahuni i mase semena analizirani su Spearman-ovim koeficijentom korelacije. Negativne ali ne statistički značajne korelacije sa merenim parametrima su registrovane u Tretmanima 2 i 3, dok je Tretman 1 imao pozitivan efekat na merene parametre sa izuzetkom šturih mahuna.

Prema dobijenim rezultatima u sprovedenom istraživanju, združena setva ozimog stočnog graška i ozimog ovsa u smeši 50:50% je imala najbolji efekat na istraživane parametre dok je združeni usev graška i ovsa u smeši 75:25% imao slab do srednji uticaj u poređenju sa kontrolom, odnosno monokulturom graška.

Ključne reči: Stočni grašak; bolesti; združena setva