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SOYBEAN OIL YIELD AS AFFECTED BY THE GROWING LOCALITY IN AGRO-CLIMATIC DIVERGENT YEARS

SUMMARY

The subject of this study are two-year results of the oil yield of six NS soybean genotypes, 0 and I maturity group (MG) at two growing localities (Rimski Sancevi and Sombor in Serbia). Sombor had higher oil yield than Rimski Sancevi (by 119 kg ha^{-1}, i.e. 15.97%). In the locality of Sombor, in 2010, of the oil yields were statistically significantly higher (1.088 kg ha^{-1}) compared to 2009 (640 kg ha^{-1}), which is higher by 448 kg ha^{-1} or 70% of the average oil yield in 2009. The average oil yield, for all tested genotypes at both locations was 805 kg ha^{-1}, and ranged from 745 kg ha^{-1} (Rimski Sancevi) to 864 kg ha^{-1} (Sombor). At both sites significantly higher oil yield was recorded in 2010 compared to 2009. The highest average oil yield at both sites was achieved growing genotype Sava (840 kg ha^{-1}). Sava had highest oil yield (887 kg ha^{-1}) and Balkan (902 kg ha^{-1}) in locality of Sombor. On average for both genotypes and growing localities I MG had higher average oil yield of 29 kg ha^{-1} (3.67%) than 0 MG genotypes. Realizing the potential for soybean productivity depends on genetic factors, the cultural practice implemented, meteorological conditions and the growing localities.

Keywords: soybean, maturity group - MG, genotype, meteorological conditions, locality, oil yield

INTRODUCTION

Global importance of soybean (Glycine max. (L.) Merr.) is continually growing, with soybean planted areas reaching almost 113 million ha in 2013 (FAO). Areas and yields have had a growing tendency (and hence higher production) in recent years, in our country and abroad. For the production of soybean in addition to high yield, technological quality of grain is also essential (Popovic, 2010; Miladinovic et al., 2008; Popovic et al., 2014; Glamoclija et al., 2015).

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According to these indicators, soybean is the most important industrial plant worldwide, both as a basic source of protein nutrients, and as the most important source of plant oil, Miladinovic et al., 2008. Both protein and oil contents are in part determined by additive gene action, with heritability values ranging from medium to high (Rodrigues et al, 2014). The oil fraction of soybean represents 20% of the seed dry mass and is primarily (95%) used for edible oils. The remaining soybean fractions are used to create a variety of industrial products, such as fatty acids, soaps and biodiesel (http://www.soyatech.com/soy_facts.htm). Soybean oil contents approximately 11, 4, 23, 54, and 8 % palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (18:2) and linolenic (18:3) acid, respectively. The amounts and relative proportions of each fatty acid are important factors, as they affect the flavour, stability, and nutritional value of the oil (Katan et al., 1995). For example, saturated acids have been shown to increase low density lipoprotein (LDL) cholesterol levels as well as the risk for coronary heart disease (Wilson, 2004), and high levels of polyunsaturated fatty acids can cause rancidity and undesirable odours. In particular, oleic acid is less susceptible to oxidation during storage and frying. Therefore, decreasing the levels of saturated (16:0 and 18:0) and polyunsaturated fatty acids (18:2 and 18:3) and increasing the levels of monounsaturated acids (18:1) has been the goal of many studies aimed at improving edible soybean soils (Priolli et al, 2015).

In plant populations, variation in the expression of a quantitative trait is due to both genetic and environmental variability and an interaction between the two. Variation due to genotype by environmental interaction (G x E) that stems from differences in ranking of genotypes among environments reduces heritability and makes it difficult to obtain good estimates of genotypic breeding value. Given that such interactions occur, the plant breeder is faced with decision: which environments should be used for testing and how many are necessary for adequate genotypic evaluation. The two questions are linked because often the number of necessary environments is dependent upon the kind of environments chosen. A related approach to this problem is to study genotype response to environment and in so doing characterize genotypes according to their performance under a given set of environmental conditions (Miladinovic et al, 2008; Popovic et al., 2015).

Environmental variation can be considered as a continuum from predictable to unpredictable (Allard and Bradshaw, 1964). Predictable variation results from those conditions which are controlled in some way (greenhouse, irrigated). Unpredictable variation is usually weather related (Miladinovic et al, 2008; Popovic et al, 2014).

The aim of this study was to determine the productivity soybean oil yield of varieties in the regions of Sombor and Rimski Sancevi-Novi Sad (Serbia), in agro-climatic divergent years.

MATERIAL AND METHODS

Examination of six genotype productivity soybean oil yield during divergent examination years was on the experimental field of the Institute of Field and Vegetable Crops, Novi Sad, at the Rimski Šančevi and Agriculture Technical Service Sombor, experimental field Toplana; in Serbia, where experiments were performed during 2009 and 2010 on the chernozem meadow soil type. Four soybean varieties from the 0 maturity group (Galina, Valjevka, Becejka and Proteinka) were used as material, as well as two varieties of the I maturity group (Balkan and Sava), which are at the same time the current assortment (Popovic et al., 2012, 2013) in Republic of Serbia, tab.1.

Fields trials were designed as a randomized complete block design (Rimski Sancevi and Sombor) with 3 replications using plots of 10 m2 (Popovic et al., 2012, 2013). Sowing was carried in the first half of April, with micro-experiments planter on 50 cm row spacing. Microbiological preparation NS Nitragin was applied during sowing. Crop density was 500,000 plants per hectare for the 0 maturity group and 450,000 plants per hectare for the I maturity group. Crops were harvested mechanically on September 2009 and 2010 at localities of Rimski Sancevi and Sombor. Yield was measured after harvest and average samples were taken from each trial replicate to determine oil content in grain. Total oil content in grain (Popovic et al., 2012, 2013) was determined by infrared spectroscopy technique on the apparatus PERTEN DA 7000, NIR/VIS Spectro-photometer, employing non-destructive method.

Table 1. Examined varieties*

Ordinal No	Variety	Years of recognition	MG	Flower colors	Hilum colors
1.	Galina	2006	0	White	Colorless
2.	Valjevka	2003	0	Violet	Brown
3.	Becejka	2004	0	Violet	Yellow
4.	Proteinka	2001	0	Violet	Brown
5.	Balkan	1994	I	White	Yellow brown
6.	Sava	2004	I	Violet	Yellow

*The cultivars is developed at the Institute of Field and Vegetable Crops in Novi Sad, Serbia

The data used for the calculation of the oil yield was total grain yield with accounting plot per replication and oil content percentage. Experimental data were analyzed by analytical statistics, using the statistics software package Statistica 12 for Windows. The significance of differences among the mean values of different factors studied in the paper was tested by adapted two-way ANOVA. All evaluations of significance were made on the basis of the LSD test at 5% and 1% significance levels.

RESULTS AND DISCUSSION

Weather conditions

The data from Rimski Sancevi (Novi Sad) meteorological station was used for the analysis of weather conditions. The total amount of precipitation for the studied period was 478 mm and ranged from 271 mm (2009) to 684 mm (2010), Fig. 1. During 2009 average air temperature was 18.41°C, which was 0.51°C higher (Popovic et al., 2012) than the average temperature in 2010, Fig. 1.

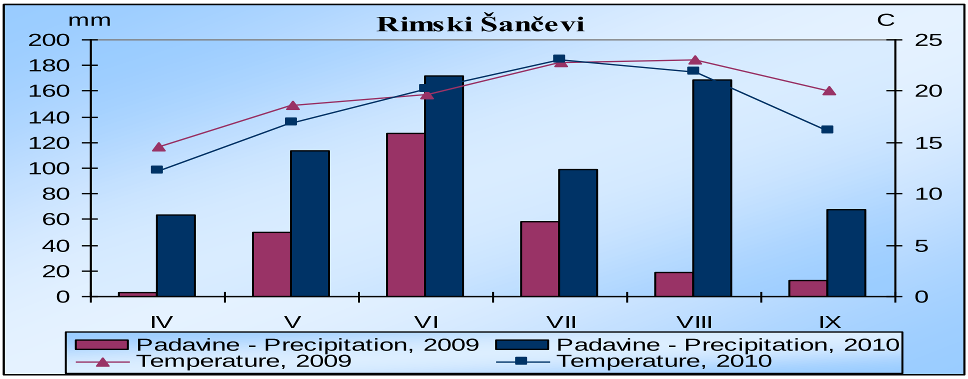


Fig. 1. Average temperature and precipitation, Rimski Sancevi-Novi Sad, Serbia

The data from Sombor meteorological station was used for the analysis of weather conditions. The total amount of precipitation for the studied period was 476 mm and ranged from 258 mm (2009) to 694 mm (2010), Fig. 2. During 2009 average air temperature was 19.45°C, which was 1.4°C higher (Popovic et al., 2013) than the average temperature in 2010, Fig. 2.

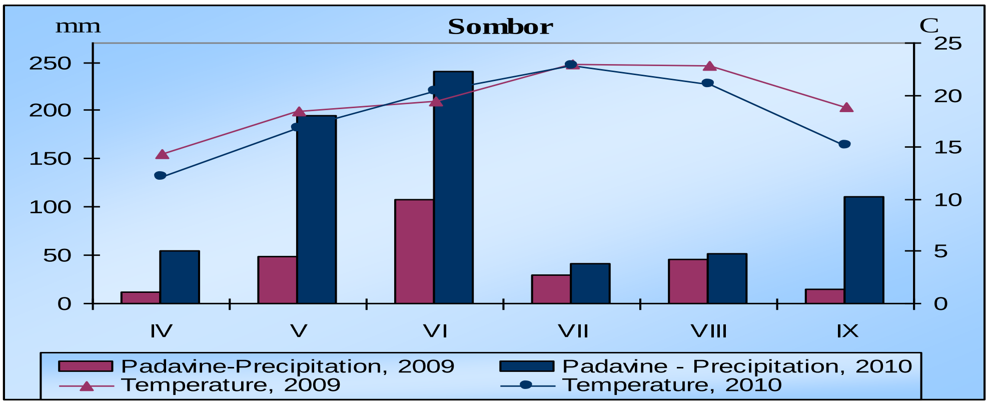


Fig. 2. Average temperature and precipitation, Sombor, Serbia

In contrast to 2009, monthly precipitation distribution during the humid 2010 was more favorable and it reflected on soybean plants up growth and contributed to the achievement of higher oil yields.

Oil yield in soybean grain

Year and genotype had a statistically significant effect on the oil yield (p <0.01) at locality Rimski Sancevi. The oil yield average of all genotypes of soybean in 2009-2010, amounted to 745 kg ha^{-1}. The highest average of oil yield had genotype Sava (792 kg ha^{-1}), followed by genotypes Valjevka (780 kg ha^{-1}) and Becejka (753 kg ha^{-1}), Tab. 2.

Tab. 2. Oil yield in soybean grain (kg ha^{-1}), Rimski Sancevi and Sombor, Serbia

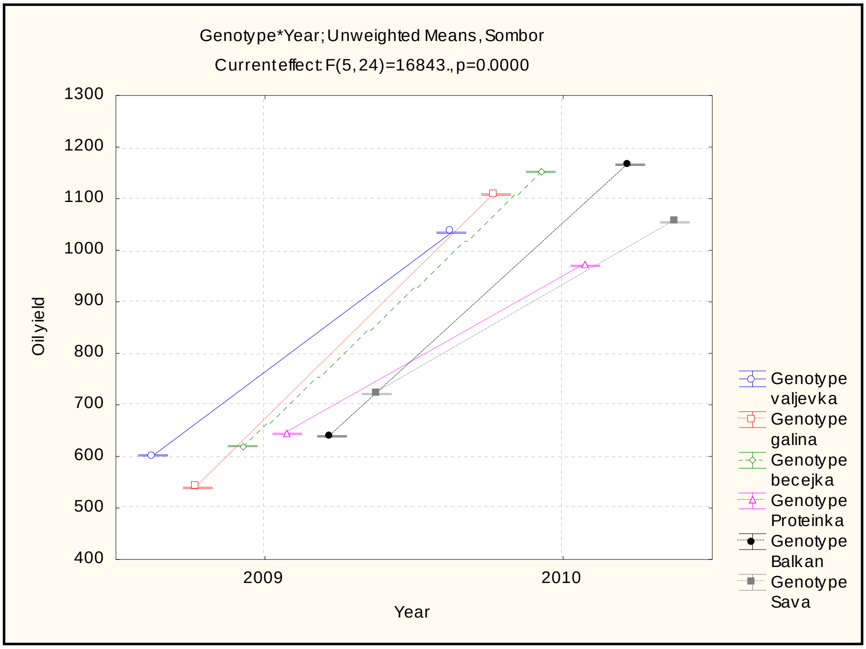
Genotype	MG	Rimski Sancevi, Novi Sad			Sombor		
		2009	2010	$\overline{X}$	2009	2010	$\overline{X}$
Galina	0	667	792	730	539	1.108	823
Valjevka	0	748	811	780	602	1.034	818
Bečejka	0	730	777	753	620	1.152	886
Proteinka	0	681	769	725	644	970	807
Average 0 MG		707	788	748	601	1.066	833
Balkan	I	608	784	696	639	1.166	902
Sava	I	749	834	792	721	1.054	887
Average I MG		678	809	744	680	1.110	895
Average		697	794	745	640	1.088	864

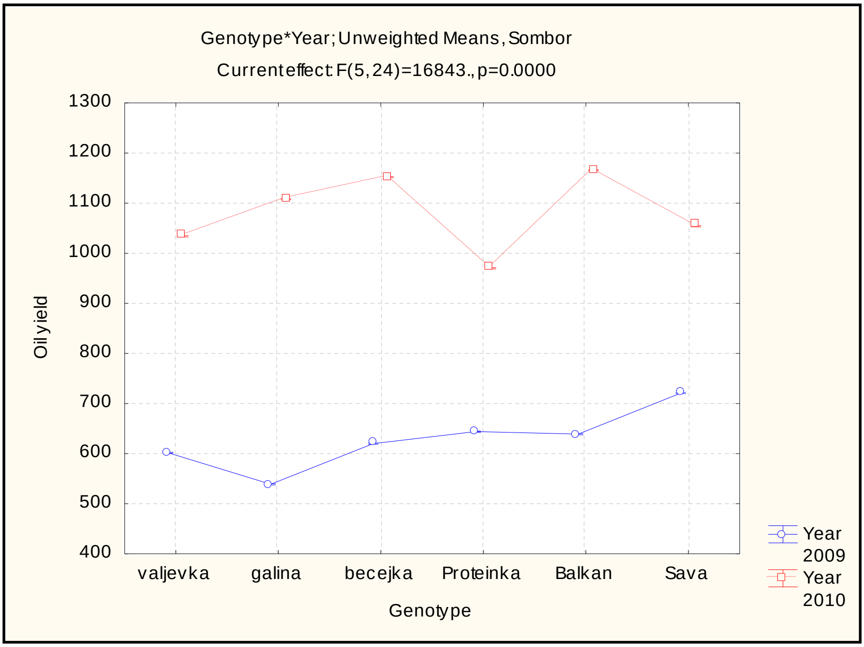
Paramete r	Locality	Rimski Sancevi, Novi Sad		Sombor	
LSD test		5%	1%	5%	1%
Year		30	40	69	94
Genotype		52	70	120	163
Interaction		73	99	170	230

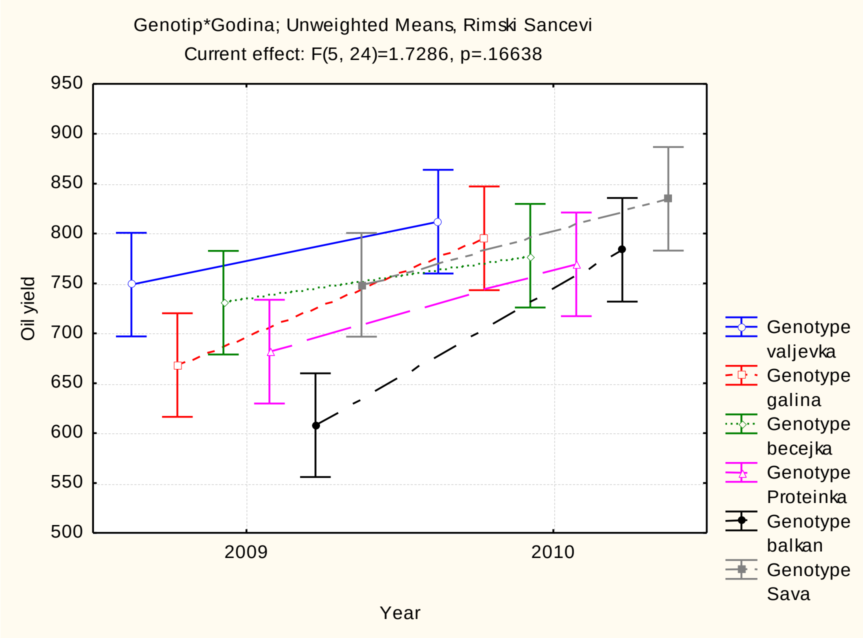
Genotype Sava, at locality Rimski Sancevi, had significantly higher oil yield, statistically, compared to genotypes Galina, Proteinka and Balkan. Statistically significantly higher oil yield, had genotype Valjevka compared to genotypes Proteinka and the Balkan as well as genotype Becejka in relation to genotype Balkan. In 2010, of the oil yields were statistically very significantly higher (794 kg ha-1) compared to 2009 (697 kg ha-1), which is higher by 97 kg ha-1 or 13.92% compared to 2009, Tab. 2.

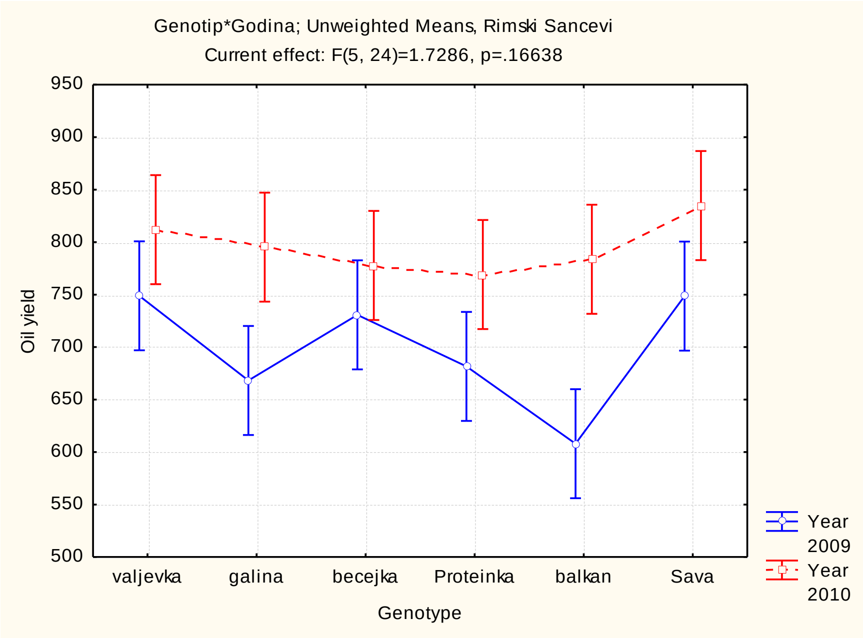
In the locality Sombor, year had statistically significant effect on the oil yield (p <0.01). In 2010, of the oil yields were statistically significantly higher (1.088 kg ha^{-1}) compared to 2009 (640 kg ha^{-1}), which is higher by 448 kg ha^{-1} or 70% of the average oil yield in 2009. The oil yield average for all soybean genotypes in 2009-2010 amounted to 864 kg ha^{-1}. The highest average oil yield genotype Balkan (902 kg ha^{-1}) followed by genotype Sava (887 kg ha^{-1}) and Becejka (886 kg ha^{-1}), Table 2, Fig. 3. In the locality of Sombor genotype and interaction genotype x years had statistically significant effect on the oil yield, Table 2, graph. 3.

Figure 3-6. Year and genotype effects in oil yield in soybean (kg ha^{-1}), Sombor and Rimski Sancevi









If we compare locations of growing, it is evident that the location of Sombor the oil yield was higher for 119 kg ha-1, or 15.98% compared to location of Rimski Sancevi, Novi Sad, Table 2, Graph. 3.

At both locations the highest average oil yield had is genotype Sava (840 kg ha-1). Genotype Sava had highest average oil yield at locality of Sombor, while highest average of oil yield had genotype Balkan (902 kg ha-1) at the locality Sombor, Table 2, Graph. 3.

On average for both localities, genotypes of the maturity group I had higher average oil yield of 29 kg ha-1 respectively to 3.80% compared to genotype maturity group 0, Table 2.

The soybean production involves more factors that individually and in interaction, cause the success of the production of soybean cultivars. In addition to genetic factors, a large impact on the variability of the studied traits of soybean cultivars were and agro-ecological factors and locality. Highly significant year x genotype interaction shows that there are differences in the expression of the traits studied in soybean. Similar results were reviews Vidic et al. (2010) and the Popovic et al., 2012, 2014 and 2015.

CONCLUSIONS

Based on two-year examination of the oil yield for six NS soybean genotypes on two growing localities may be the following conclusions:

•Year and genotype had a statistically significant effect on the oil yield at locality Rimski Sancevi. The average oil yield of all genotypes of soybean in 2009-2010. amounted to 745 kg ha-1. The highest average oil yield had genotype Sava (792 kg ha^{-1}). In 2010, of the oil yields (794 kg ha^{-1}) were statistically significantly higher compared to 2009 (697 kg ha^{-1}), which is higher by 97 kg ha^{-1} or 13.92% compared to 2009.

•In the locality of Sombor, year had statistically significant effect on the oil yield. The average oil yield of all genotypes of soybean in 2009-2010. amounted to 864 kg ha^{-1}. The highest average oil yield had genotype Balkan (902 kg ha^{-1}), followed by genotype Sava (887 kg ha-1) and Becejka (886 kg ha-1). In 2010, of the oil yields were statistically significantly higher (1.088 kg ha^{-1}) compared to 2009 (640 kg ha^{-1}), which is higher by 448 kg ha^{-1} or 70% of the average oil yield in 2009.

•If we compare the locations, it is evident that the location of Sombor the oil yield was higher for 119 kg ha-1, or 15.97% compared to location of Rimski Sancevi, Novi Sad.

•The soybean production involves more factors that individually and in interactions, cause success of the production of soybean cultivars. In addition to genetic factors, a large impact on the variability of the studied trait of soybean cultivars had agro-ecological factors and the growing locality.

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REFERENCES

Akça İ, Tuncer C. 2005.Biological Control and Morphological Studies on Nut Weevil (Curculio nucum L. Col., Curculionidae).Acta Hort. (ISHS), 686; 413-419.

Anonymous 2011. Food and Agriculture Organization of the United Nations, Statistical Database. http://faostat.fao.org (accessed September 05, 2013).

Anonymous 2013. Türkiye İstatistik Kurumu.www.tuik.gov.tr (accessed September 05, 2013).

Belisario A, Santori A. 2009. Gray Necrosis of Hazelnut Fruit: A Fungal Disease Causing Fruit Drop. Acta Hort. (ISHS) 845:501-506.

Karaca G, Erper İ. 2001. First Report of *Pestalotiopsis* guepinii causing twig blight on hazelnut and walnut in Turkey.PlantPathology, 50; 415.

Maharachchikumbura S, Guo L, Chukcatirote E, Bahkali A, Hyde K. 2011. *Pestalotiopsis* – morphology, phylogeny, biochemistry and diversity. Fungal Diversity 50:167-187.

Mirhosseini-Moghaddam SA, Taherzadeh MR. 2007. Isolated fungi from hazelnut, their damage and economic importance in Guilan province. Internet Resource: http://rifr-ac.org/Last/english/journals/forest_abstract.aspx?id=1000810 (accessed September 23, 2013).

Santori A, Vitale S, Luongo L, and Belisario A. 2010. First Report of Fusarium lateritium as the Agent of Nut Gray Necrosis on Hazelnut in Italy. Plant Dis., 94(4), 484.

Sezer A, Dolar FS. 2012. Colletotrichum acutatum, A New Pathogen of Hazelnut. Journal of Phytopathology, 160(7-8):428-430. http://dx.doi.org/10.1111/j.1439-0434.2012.01910.x

Sutton BC. 1980. The Coelomycetes. Fungi Imperfecti with Pycnidia, Acervuli and Stromata. Commonwealth Mycological Institute, Kew, Surrey, England: 696 p.

Tanrıvermiş H, Gönenç S, and Terzioğlu SB. 2006. Türkiye'de FındıkÜretiminin Sosyo-EkonomikYapısı Tamamlayıcı Gelir Kaynaklarını Geliştirilebilme Olanakları ve Etkilerinin Değerlendirilmesi (Socio-Economic Structure of Hazelnut Production in Turkey, The Possibilities of Development for Supplementary Income Resources and Impact Assessment), 3. Milli Fındık Şurası, s. 125-144, Giresun.

Xi K, Morrall RAA, Baker RJ and Verma PR. 1990. Relationship between incidence and severity of blackleg disease of rapeseed. Canadian Journal of Plant Pathology, 12:164-169.

Yürüt HA, Erkal Ü, and Gürer M. 1994. Hazelnut Diseases in Bolu, Düzce and Bartın. 9th Congress of the Mediterranean Phytopathological Union, Kuşadası, Aydın, Türkiye: Turkish Phytopathological Society Publications No: 7, pp. 417-419.