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# YIELD OF GRAIN LEGUMES INTERCROPPING WITH CEREALS IN THE FLORINA AREA IN GREECE

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## ABSTRACT

Intercropping of two or more crops in the same area at the same time is an old and commonly used practice that results in the highest overall yield on a given plot, because ofdifferent root growth, height and nutrient requirements of the crops involved. The aim of this study was to determine the possibilities of intercropping grain legumes with cereals for food production for human consumption. The completely randomized design was applied with three replications and the experiment was established in the farm of the Western Macedonia University in Florina (Greece). Particularly, lentils (two varieties) was used as grain legumes, and bread wheat (two varieties) and oat were used as cereals, which were grown individually as well as intercropped with each other in mixed rows in a sowing ratio 50:50. The plots consisted of seven rows five meters long of which the five inner were harvested. A total of 33 experimental plots was installed. The field was fertilized only with base fertilization. During the growing season, the following morphological traits were measured: height and total height, the blooming, as well as the grain yield, the length of spike (cm) and the number of fertile grain/spike. Differences were found between treatments regarding yield as well as the agronomic traits.In most cases the mixtureshad higher yield compared to their respective monocrops.

**Key words:** *intercropping, yield, monocropping.*

## INTRODUCTION

Legumes are important crops because their seed is considered to be high-nutrient food, due to its high content of proteins (30-35%) - proteins of high biological value -, calcium and phosphorus minerals and vitamins, which are considered essential for human'snutrition. Intercropping of most annual legumes with winter cereals is a very common cultivation practice in many countries (Qamar et al. 1999; Clergue et al. 2005). Intercropping of legumes with cereals contributes to the improvement of soil properties, in weed control and in lodging resistance, important trait for some cereals. (Banik et al. 2006; Wang et al. 2012). However, it has been reported that competition of intercropped plants for moisture, light and

inorganic minerals usually results in yield reduction of the mixturescompared to monoculture (Akter et al. 2004; Dusa and Roman 2009; Lithourgidis and Dordas 2010; Menber et al. 2015).Grain legumes, especially lentil, are a food with high nutritional value, which are grown mainly for human consumption and considered an essential part or more specificallythe basis of the Mediterranean diet. Intercroppingcereals withgrain legumes could be an interesting new proposal, whichinvestigates the possibility of intercropping cereals with grain legumes for simultaneous seed harvest, in order to be applied in organic agricultural system.
The research was undertaken to study the behavior of some field crops in intercropping, and to determine the possibilities of intercropping grain legumes with cereals for food production for human consumption under the special climatic conditions of the Florina area.

## MATERIALS AND METHODS

A field experiment was carried out in the farm of the University of Western Macedonia in Florina (Greece), the cultivation season 2019-2020, intercropping Greek varieties of grain legumes with cereals. Particularly, two varieties of lentils (*Lens culinaris*) was used as grain legumes, and two varieties of bread wheat (*Triticum aestivum*) and one variety of oat (*Avena sativa*) were used as cereals, which were grown individually as well as intercropped with each other in mixed rows in a sowing ratio 50:50. Thus 11 different treatments were created and a total of 33 experimental plots was installed. The examined genotypes were sown in early November 2019 in a sandy loam soil. The plots consisted of seven rows five meters long of which the five inner were harvested. The distances between rows were 0.25m. The completely randomized design with three replications was used. The field was fertilized only with base fertilization, so that 80 and 40 kg $ha^{-1}$, Nitrogen and $P_20_5$ respectively were added into the soil. The crop was kept free of weeds by hand hoeing when necessary. During the growing season, the following morphological traits were measured: height and total height, the blooming, as well as the grain yield,the length of spike or panicle (cm) and the number of fertile grain/spike.Specifically, the height of the plants was measuredin early April, and one day before the harvest.Lentils varieties used are reptiles, therefore the measure of the final height did not take place. Data were statistically analyzed and the means were compared according to LSD test at p=0.05.

## RESULTS AND DISCUSSION

Intercropping had significant effects on grain yield. Specifically significant differences were recorded between the examined genotypes in yield (significant differences at p=5%, Table 1). Yield ranged from924Kg/ ha in lentil 2 (second variety) to 11963.24Kg/ha in bread wheat 2 (second variety) intercropped with lentil 2 (Table 1). Both bread wheat varieties produced more yield intercropped with both lentil varieties. The superiority of bread wheat intercropping with lentils was more obvious when the second lentil variety was involved. Intercropping increased the yield of oat as well. These results were in disagreement with those of

other researchers who reported that the yield of sole crops was higher compared to their intercrops (Yagmur and Kaydan 2006, Duşa and Stan 2013). The grain yield of lentil varieties was affected less than the cereals involved in intercropping system. In intercropping with wheat, the lentil 1 yield was smallerthan in sole cropping but this difference was not statistically significant.On the contrary the lentil second variety had higher yield intercropped with cereals (bread wheat or oat). The above results suggest that there was a positive effect of intercropping to the crops involved but this effect was clearerfor the cereals rather than legumes.

Table 1. The grain yield, the height after tillering and the final height of intercropping crops and monocropping

| Genotype | Grain yield Kg/ ha (for cereals) | Grain yield Kg/ha (for lentil) | Height after tillering (for cereals) (for lentil) | | Final height (for cereals) |
|---|---|---|---|---|---|
| Bread wheat 1 | 5111.27e | | 44.03 | | 75.60cd |
| Oat | 4028.20f | | 38.40 | | 89.63b |
| Bread wheat 2 | 5293.77e | | 44.76 | | 64.80e |
| Lentil 1 | | 1436.53h | | 27.20 | |
| Lentil 2 | | 914.46i | | 27.37 | |
| Bread wheat 1+ Lentil 1 | 8484.64d | 1221.92h | 47.03 | 31.57 | 78.23c |
| Bread wheat 2+ Lentil 1 | 11963.24b | 1151.02h | 48.90 | 31.53 | 63.60e |
| Bread wheat 2+ Lentil 2 | 14170.4a | 2652.58g | 45.53 | 31.73 | 68.23de |
| Bread wheat 1+ Lentil 2 | 10387.52c | 1563.7h | 45.33 | 31.73 | 82.60bc |
| Oat+ Lentil 1 | 8592.56d | 2988.06fg | 39.40 | 26.17 | 100.63a |
| Oat+ Lentil 2 | 5847.12e | 1983gh | 39.23 | 28.03 | 98.67a |

Means in columns followed by different letters are significantly different at $p<0.05$ by LSD test.

The height after tillering ranged from 38.4 in sole oat to 48.9 in bread wheat 2 when intercropped with lentil 1 (Table 1). Regarding the final height the differences were significant (Table 1). The final height ranged from 63.6 in bread wheat 2 intercropping with lentil 1 to 100.63 in oat intercropped with lentil 2, followed by the oat intercropped with the other lentil' s variety. The final height of both varieties of bread wheat was not affected by the intercropping. On the contrary the final height of oat intercropping with lentil was higher compared to the sole crop.

Table 2. Blooming, length of spike, number of fertile grains/spike,fertile grains /pod of intercropping crops and monocropping

| GENOTYPE | Blooming (days to heading) for cereal | Blooming (days to heading)for lentil | Length of spike, or panicle (cm) | Number of fertile grains/spike grains/panicle | Number of fertile grains/ pod |
|---|---|---|---|---|---|
| Bread wheat 1 | 181a | | 7.14 | 22.87ab | |
| Oat | 182a | | 16.36 | 17.5b | |
| Bread wheat 2 | 183a | | 8.43 | 22.3ab | |
| Lentil 1 | | 176b | | | 1.67ab |
| Lentil 2 | | 177b | | | 1.33ab |
| Bread wheat 1+ Lentil 1 | 181a | 177b | 7.92 | 22.57ab | 1b |
| Bread wheat 2+ Lentil 1 | 180a | 178b | 8.37 | 20.77b | 1.33ab |
| Bread wheat 2+ Lentil 2 | 180a | 175b | 8.66 | 21.93ab | 2a |
| Bread wheat 1+ Lentil 2 | 182a | 176b | 8.17 | 27.97a | 1.33ab |
| Oat+ Lentil 1 | 180a | 177b | 17.58 | 23.5ab | 1b |
| Oat+ Lentil 2 | 181a | 176b | 17.72 | 22.97ab | 1.33ab |

Means in columns followed by different letters, are significantly different at $p<0.05$ by LSD test.

The highest number of fertile grains/spike was found in bread wheat (first variety) intercropped with lentil 2 (27.97) (Table 2). The number of fertile grains/panicle was also higher in oat intercropping with both varieties of lentil (Table 2). These results were in disagreement with the ones of Dusa and Stan (2013) who reported that the number of fertile grains/panicle was lower in intercropping, especially for the oat plants intercropped with lentil. The smallest number of fertile grains/pod was produced when lentil variety 2was intercropped with bread wheat 1, whereas the greatest number was recorded when lentil variety 2 was intercropped with bread wheat 2.The above results suggest that the behavior of intercropped species is influenced by the genotype of species involved in the intercropping system.

## CONCLUSIONS

It was concluded that concerning the grain yield the mixture bread wheat 2 + lentil 2 is more productive followed by the mixture of bread wheat 2 with the other lentil variety. Concerning the mixture oat +lentil, intercropping increased the yield of oat, especially when the first variety of lentil was involved. A first estimate of these results leads to the conclusion that the genotype of species involved in the intercropping system plays an important role in the behavior of intercropped species. However further research, including different spatial arrangement of the individual crops and different cultivars, is needed to confirm the results of the present study.

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