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Effect of Mixed Cropping Lentil with Wheat and Barley at Different Seeding Ratios

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Abstract: This study was conducted in order to investigate yield, yield components and Land Equivalent Ratio (LER) in sole lentil and in wheat and barley mixtures (90% lentil + 10 barley or wheat, 80% lentil + 20% barley or wheat, 70% lentil + 30% barley or wheat) under dry conditions of Van and Erciş locations in 1998-1999. The highest grain yield was obtained from monoculture for lentil, barley and wheat in both locations. Pure stands of lentil, barley and wheat gave grain yields respectively of 380, 1850 and 1910 kg ha⁻¹ in Erciş and 835, 2233 and 1087 kg ha⁻¹ in Van. In both type of mixtures number of pods per plant, plan number per m², Grain yield per plant, number of branches per plant and grain yield of per unit area significantly decreased whereas number of spikes and grain yield of barley and wheat increased depending on the increases in the percentage of cereals. In the mixture of 80% lentil + 20% wheat gave the highest LER value for straw and grain yield as 1.15 and 1.07 in Erciş, respectively. In Van conditions the highest LER value was obtained from 70% lentil + 30% wheat mixtures as 1.04 for straw yield and 1.03 for grain yield.

Key words: Wheat, lentil, barley, mixed cropping, yield, LER

INTRODUCTION

Lentils are grown with mustard, linseed, sugarcane, barley and wheat in different areas of world. Mixed cropping as method crop intensification is commonly practiced in densely populated countries to provide more food. Lentil is the second most important pulse crop of Turkey after chickpea in area and production^[1]. Recent studies suggest that greater yields are obtained from mixed cropping systems than from growing monoculture crops^[2-4]. Mixed cropping of annual cereals and pulse crops is commonly practiced in humid tropic regions because total seed production generally enhanced compared with sole cropping^[5], but cereal-pulse mixtures are seldom sown in upper latitude regions. Robinson^[6] reported that intercropping Spring-sown oat (*Avena sativa* L.) with field pea (*Pisum sativum* L.) produced more forage and total seed than did oat alone in Minnesota; however, oat grain yield was reduced by 20 to 40% depending seeding ratio of crops. Some researchers reported that the highest grain was obtained from sole cropping for barley-lentil, wheat-lentil, mustard-lentil, linseed-lentil mixed cropping systems^[7-12]. Some researchers found that grain yield of barley (*Hordeum vulgare* L.) was not increased and sometimes reduced when mixed cropped with pea^[13].

Lentil was less competitive that intercropped with barley^[14]. Similarly, Ahlawat *et al.*^[15] found that reductions in grain yield of lentil greater than wheat in an irrigated environment.

This experiment was conducted in order to investigate suitable lentil-wheat and lentil-barley mixtures for high yields and mechanical harvesting of lentils.

MATERIALS AND METHODS

This study was conducted under dry conditions of Van and Erciş in 1998-1999. Sazak-91 (lentil), Tir (wheat) and Tokak 157/37 (barley) cultivars were used. Sowing was done with a plot drill in 1.6x6 m plot (9.6 m²) on 10 October (Van) and 11 October (Erciş) 1998. Plots included 8 rows of 20 cm apart, 25 N and 65 kg ha⁻¹ P₂O₅ were applied as ammonium sulphate and triple super phosphate respectively. Monoculture lentil, monoculture wheat and barley and three combinations of lentil-wheat and lentil-barley (90% lentil + 10 barley or wheat, 80% lentil + 20% barley or wheat, 70% lentil + 30% barley or wheat) were included in the study. The experiment was conducted in a randomized complete block design with three replications in two locations. The seed rates of monoculture lentil (Cv. Sazak-91) and both cereals (Cv. Tir and Cv. Tokak 157/37) were 120 and 170 kg ha⁻¹,

Table 1: Soil properties in the experimental site

| Feature | Van | Erciş |
|--------------------|------------------|------------|
| texture | Sandy-loamy-clay | Sandy-loam |
| Organic matter (%) | 0.52 | 0.65 |
| N (%) | 0.02 | 0.03 |
| Phosphorus (ppm) | 5.52 | 10.6 |
| Salt (%) | 0.02 | 0.02 |
| pH | 7.58 | 7.53 |

respectively. Harvest was done, on 10 July (lentil) and 21 July (cereals) 1999 in both locations, excluding one side row from each plot and 50 cm from both ends (1.2x5 m = 6 m²). The data on different yield parameters were collected from 10 randomly selected plants in each plot and those biological yield, grain yield and straw yield were recorded from the whole plot. The LER index^[16] was used to evaluate intercrop efficiencies with respect to sole crops. The LER defines yield as a function of area:

$$LER = I_a / S_a + I_b / S_b$$

Where, I and S refer to inter-crop and sole-crop yield, respectively and the subscripts a and b indicate the component crops in the mixture.

Soil samples from two locations were analyzed at the laboratories of Erzurum Village Affairs Research Institute (Table 1). The experimental soil was sandy-loam-clay and slightly alkaline. During the growing season total precipitation (1 November to 1 August) was 249.7 mm in Van and 276.0 mm in Erciş and monthly rainfall and maximum, minimum and average temperatures are shown in Table 2.

RESULTS AND DISCUSSION

Yield and yield component of lentil: The effect of mixed cropping treatments were significant on number of plant/m², Grain yield/plant, number of branches/plant, number of pods/plant, plant height, biological yield, grain yield and straw yield in Van. From these components number branches/plant, grain yield/plant, plant height and number of pods/plant were not affected by lentil-wheat mixtures but number of pods per plant not affected by lentil-barley mixtures in Erciş. The highest grain yield was obtained from sole lentil crops in Van and Erciş as 835 and 380, respectively (Table 3 and 4). Sole crop was followed by 342 kg ha⁻¹ from 100% lentil + 10% barley mixtures and 268 kg ha⁻¹ from 100% lentil + 10% wheat mixtures. The lowest grain yield was obtained by 134 and 148 kg ha⁻¹ from 100% lentil +30% barley and wheat mixtures, respectively (Table 3 and 4).

Yield and yield components of cereals: The effect of mixed cropping was significant on the number of spikes/m², plant height, biological yield, grain yield and straw yield in both locations for wheat-lentil mixture. But plant height

Table 2: Meteorological data at the experimental site including vegetation period (1998-1999)

| Months | Van | | | | Erciş | | | |
|----------|--------------------|--------------------|--------------------|---------------|--------------------|--------------------|--------------------|---------------|
| | Maximum temp. (°C) | Minimum temp. (°C) | Average temp. (°C) | Rainfall (mm) | Maximum temp. (°C) | Minimum temp. (°C) | Average temp. (°C) | Rainfall (mm) |
| November | 14.0 | 4.8 | 8.8 | 14.9 | 14.6 | 1.5 | 6.6 | 24.5 |
| December | 8.0 | -0.4 | 3.0 | 57.5 | 7.4 | -2.5 | 1.4 | 48.0 |
| January | 5.1 | -2.8 | 0.3 | 8.1 | 5.5 | -5.8 | -1.5 | 3.7 |
| February | 5.4 | -3.3 | 0.4 | 24.9 | 4.9 | -6.4 | -1.7 | 36.6 |
| March | 7.4 | -1.5 | 2.6 | 45.9 | 8.3 | -3.2 | 1.7 | 50.0 |
| April | 12.8 | 3.6 | 8.4 | 49.2 | 14.5 | 2.2 | 7.7 | 64.6 |
| May | 19.6 | 8.6 | 14.9 | 41.8 | 21.3 | 6.3 | 13.9 | 33.0 |
| June | 24.9 | 13.9 | 20.0 | 7.4 | 27.0 | 11.7 | 19.3 | 4.3 |
| July | 27.3 | 16.6 | 22.2 | - | 31.0 | 15.1 | 22.9 | 11.3 |

Table 3: The effect of lentil + cereal mixtures yield and components of lentil in Van conditions

| Seeding ratio | Plant population/m ² | Grain yield per plant (g) | Number of branches/plant | Number of pods/plant | Plant height (cm) | Biological yield (kg ha ⁻¹) | Grain yield (kg ha ⁻¹) | Straw yield (kg ha ⁻¹) |
|-------------------------------|---------------------------------|---------------------------|--------------------------|----------------------|-------------------|---|------------------------------------|------------------------------------|
| Lentil+Wheat mixtures | | | | | | | | |
| %100 L | 233.3a* | 0.58a | 3.8a | 9.8a | 23.8b | 2332a | 835a | 1497a |
| %90 L + %10 W | 161.7b | 0.15b | 1.8b | 5.2b | 24.1b | 808b | 268b | 540c |
| %80 L + %20 W | 150.0b | 0.19b | 1.6b | 5.3b | 23.3b | 810b | 225b | 585c |
| %70 L + %30 W | 126.7b | 0.16b | 1.3c | 5.3b | 27.5a | 888b | 200b | 688b |
| %100 W | - | - | - | - | - | - | - | - |
| Lentil+Barley mixtures | | | | | | | | |
| %100 L | 233.3a* | 0.58a | 3.8a | 9.8a | 23.8b | 2332a | 835a | 1497a |
| %90 L +%10 B | 180.0b | 0.24b | 2.2b | 7.0b | 22.0b | 855b | 342b | 513b |
| %80 L +%20 B | 160.0b | 0.28b | 2.3b | 5.0b | 23.5ab | 642b | 170b | 472c |
| %70 L +%30 B | 105.0c | 0.29b | 2.2b | 6.0b | 27.2a | 408b | 150b | 258d |
| %100 B | - | - | - | - | - | - | - | - |

* Values followed by the same letter in a column are statistically similar at 1% level according to Duncan's Multiple Range Test.
L: Lentil, W: Wheat, B: Barley

Table 4: The effect of lentil-cereal mixtures yield and components of lentil in Erciř conditions

| Seeding ratio | Plant population/m ² | Grain yield per plant (g) | Number of branches/plant | Number of pods/plant | Plant height (cm) | Biological yield (kg ha ⁻¹) | Grain yield (kg ha ⁻¹) | Straw yield (kg ha ⁻¹) |
|------------------------|---------------------------------|---------------------------|--------------------------|----------------------|-------------------|---|------------------------------------|------------------------------------|
| Lentil+Wheat mixtures | | | | | | | | |
| %100 L | 248.3a | 0.35 | 2.5 | 6.6 | 22.1 | 1186a | 380a | 806a |
| %90 L + %10 W | 200.3b | 0.26 | 2.0 | 3.8 | 19.5 | 816b | 249b | 567b |
| %80 L + %20 W | 180.7c | 0.25 | 2.2 | 4.5 | 20.9 | 684bc | 213b | 471c |
| %70 L + %30 W | 117.3d | 0.25 | 2.1 | 4.1 | 22.7 | 492c | 134c | 358d |
| %100 W | - | - | - | - | - | - | - | - |
| Lentil+Barley mixtures | | | | | | | | |
| %100 L | 248.3a | 0.35 | 2.5 | 6.6 | 22.1 | 1186a | 380a | 806a |
| %90 L + %10 W | 207.7b | 0.46 | 1.8 | 4.1b | 18.4 | 540b | 182b | 358b |
| %80 L + %20 W | 180.0c | 0.15 | 2.0 | 4.1b | 21.4 | 500b | 188b | 312c |
| %70 L + %30 W | 101.3d | 0.20 | 2.1 | 5.2b | 21.2 | 504b | 148b | 356b |
| %100 W | - | - | - | - | - | - | - | - |

* Values followed by the same letter(s) in a column are statistically similar at 1% level according to Duncan's Multiple Range Test.
L: Lentil, W: Wheat, B: Barley

Table 5: The effect of lentil + cereal mixtures yield and components of cereals in two locations

| Seeding ratio | Van | | | | | Erciř | | | | |
|------------------------|----------------------------------|-------------------|---|------------------------------------|------------------------------------|----------------------------------|-------------------|---|------------------------------------|------------------------------------|
| | Number of spikes /m ² | Plant height (cm) | Biological yield (kg ha ⁻¹) | Grain yield (kg ha ⁻¹) | Straw yield (kg ha ⁻¹) | Number of spikes /m ² | Plant height (cm) | Biological yield (kg ha ⁻¹) | Grain yield (kg ha ⁻¹) | Straw yield (kg ha ⁻¹) |
| Lentil+Wheat mixtures | | | | | | | | | | |
| %100 L | - | - | - | - | - | - | - | - | - | - |
| %90 L + %10 W | 139.0b* | 67.5a | 936d | 290d | 646d | 129.3d | 66.1b | 1850d | 570d | 1280d |
| %80 L + %20 W | 161.7ab | 67.1a | 1427c | 483c | 944c | 185.3c | 69.6b | 3127c | 972c | 2155c |
| %70 L + %30 W | 186.0a | 64.2ab | 2660b | 860b | 1800b | 217.7b | 74.5b | 3340b | 1023b | 2317b |
| %100 W | 187.3a | 53.3b | 4192a | 1087a | 3107a | 406.7a | 92.0a | 5680a | 1910a | 3770a |
| Lentil+Barley mixtures | | | | | | | | | | |
| %100 L | - | - | - | - | - | - | - | - | - | - |
| %90 L + %10 B | 122.7c* | 53.8 | 1813d | 603c | 1150d | 211.0d | 66.4 | 1897d | 653c | 1244d |
| %80 L + %20 B | 234.3b | 56.8 | 2357c | 840c | 1517c | 273.7c | 66.5 | 2177c | 657c | 1520c |
| %70 L + %30 B | 232.7b | 62.4 | 3353b | 1173b | 2180b | 349.3b | 57.3 | 3177b | 1199b | 1978b |
| %100 B | 546.0a | 57.1 | 5740a | 2233a | 3507a | 520.3a | 61.4 | 4844a | 1850a | 2994a |

* Values followed by the same letter(s) in a column are statistically similar at 1% level according to Duncan's Multiple Range Test.
L: Lentil, W: Wheat, B: Barley

Table 6: Relative yields and LER analysis of different seeding ratios

| Seeding ratio | Location | | | | | | | | | | | |
|-----------------------|----------------------|--------|------|----------------------|--------|------|----------------------|--------|------|----------------------|--------|------|
| | Van | | | | | | Erciř | | | | | |
| | Relative grain yield | | | Relative straw yield | | | Relative grain yield | | | Relative straw yield | | |
| | Lentil | Barley | LER | Lentil | Barley | LER | Lentil | Barley | LER | Lentil | Barley | LER |
| Lentil-Barley mixture | | | | | | | | | | | | |
| %100 L | 1.00 | - | 1.00 | 1.00 | - | 1.00 | 1.00 | - | 1.00 | 1.00 | - | 1.00 |
| %90 L + %10 B | 0.41 | 0.30 | 0.71 | 0.34 | 0.33 | 0.67 | 0.48 | 0.35 | 0.83 | 0.44 | 0.42 | 0.86 |
| %80 L + %20 B | 0.41 | 0.38 | 0.79 | 0.32 | 0.43 | 0.75 | 0.49 | 0.36 | 0.85 | 0.39 | 0.51 | 0.89 |
| %70 L + %30 B | 0.20 | 0.53 | 0.73 | 0.17 | 0.62 | 0.79 | 0.39 | 0.65 | 1.04 | 0.44 | 0.66 | 1.10 |
| %100 B | - | 1.00 | 1.00 | - | 1.00 | 1.00 | - | 1.00 | 1.00 | - | 1.00 | 1.00 |
| Lentil-Wheat mixture | | | | | | | | | | | | |
| Seeding ratio | Lentil | Wheat | LER | Lentil | Wheat | LER | Lentil | Wheat | LER | Lentil | Wheat | LER |
| %100 L | 1.00 | - | 1.00 | 1.00 | - | 1.00 | 1.00 | - | 1.00 | 1.00 | - | 1.00 |
| %90 L + %10 W | 0.32 | 0.26 | 0.58 | 0.36 | 0.21 | 0.57 | 0.66 | 0.25 | 0.91 | 0.70 | 0.34 | 1.04 |
| %80 L + %20 W | 0.27 | 0.43 | 0.70 | 0.39 | 0.30 | 0.69 | 0.56 | 0.51 | 1.07 | 0.58 | 0.57 | 1.15 |
| %70 L + %30 W | 0.24 | 0.79 | 1.03 | 0.46 | 0.58 | 1.04 | 0.35 | 0.54 | 0.89 | 0.44 | 0.61 | 1.05 |
| %100 W | - | 1.00 | 1.00 | - | 1.00 | 1.00 | - | 1.00 | 1.00 | - | 1.00 | 1.00 |

L: Lentil, W: Wheat, B: Barley

was not affected significantly from lentil-barley mixtures in both areas. The highest wheat and barley grain yields were obtained from sole crops of wheat and barley as 1087, 2233 kg ha⁻¹ (Van) and 1910, 1850 kg ha⁻¹ (Erciř), respectively (Table 5). The lowest grain yield was obtained by 90% lentil + 10% wheat mixture as 290 and

603 kg ha⁻¹ by 90% lentil + 10% barley mixture in Van and Erciř, respectively (Table 5).

The highest grain yield produced by sole cereals could result from higher population/unit area. In the mixed cultures increased the inter- and intra-crop competition reduced yields per plant^[10].

The highest LER for grain was obtained by 80% lentil + 20% wheat mixture and 70% lentil + 30% barley mixtures as 1.07 and 1.04, respectively in Erciş (Table 6). The highest LER for straw was obtained from the mixtures that the highest grain LER was obtained as 1.15 and 1.10 (Table 6).

In conclusion, mixed cropping of lentils with wheat and barley did not present promising results in Van region, but sowing 70+30% lentil-barley and 80+20% lentil-wheat mixtures in Erciş conditions produced higher yields.

REFERENCES

1. Anonymous, 1997. The Summary of Agricultural Statistics. State Statistics Institute, Ankara.
2. De, R., R.S. Gupta, R.P. Singh, M. Pal, S.N. Singh, R.N. Sharma and S.K. Kaushik, 1978. Interplanting maize sorghum and pearl millet with short duration grain legumes. *Indian J. Agric. Sci.*, 48: 132-140.
3. Singh, S.P., 1979. Intercropping studies in sorghum. In: Proceedings of the International Workshop Intercropping, 10-13 January, ICRISAT, Hyderabad, India, pp: 22-24.
4. Willey, R.W., 1979. Intercropping its research needs. Part 1. Competition and yield advantage. *Field Crops Abst.*, 32:1-13.
5. Rao, M.R., T.J. Rego and R.W. Willey, 1987. Response of cereal to nitrogen in sole cropping and intercropping with different legumes. *Plant Soil*, 101: 167-177.
6. Robinson, R.G., 1960. Oat-pea or oat-vetch mixtures for forage or seed. *Agron. J.*, 52: 546-549.
7. Islam, M.N., R.K. Paul and R.U. Coudhury, 1991. Effect of mixed cropping lentil with barley at different seeding rates. *Lens Newsllett.*, 18: 24-26.
8. Aktar, M.S., A.M. Shamsuddin, Nazrul Islam and A.R.M.S. Rahman, 1993. Effect of mixed cropping lentil and mustard at various seeding ratios. *Lens*, 20: 36-39.
9. Aktar, M.S., A.M.M.S. Haque and A.R.M.S. Rahman, 1993. Effect of mixed cropping lentil and linseed at various seeding ratios. *Lens*, 20: 39-42.
10. Zaman, S.M., 1989. Effect of mixed cropping lentil and wheat at varying seeding ratios. *Lens*, 16: 16-18.
11. Carr, P.M., J.C. Gardner, B.G. Schatz, S.W. Zwinger and S.J. Guldan, 1995. Grain yield and weed biomass of a wheat-lentil intercrop. *Agron. J.*, 87: 574-579.
12. Kantar, F., A. Öztürk, E. Elkoca. 1998. Yield and yield components in lentil+cereal mixtures, *J. Agril. Univ. Erzurum*, 29: 187-197 (In Turkish).
13. Izaurrelde, R.C., N.G. Juma and W.B. McGill, 1990. Plant and nitrogen yield of barley-field pea inter-crop in cryoboreal-subhumid central Alberta. *Agron. J.*, 82: 295-301.
14. Gangasaran, G. and G. Giri, 1985. Intercropping of mustard with chickpea, lentil and barley in dry land. *Indian J. Agron.*, 30: 244-250.
15. Ahlawa, I.P.S., A. Singh and R.P. Sharma, 1985. Water and nitrogen management in wheat lentil intercropping system under late-sown conditions. *J. Agric. Sci. (Camb.)*, 105: 697-701.
16. Vandermeer, J., 1989. *The Ecology of Intercropping*. Cambridge University Press, Cambridge.
17. Anonymous, 1999. Records of Van Meteorological Regional Administration.