# Row Configuration and Nitrogen Application for Barley/Pea Intercropping

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## Introduction

Cereal and legume species are commonly intercropped for forage production. Total forage production of an intercropping system is dependent largely on competition between species. Interspecies competition for growth resources, such as water and light can result in suppression of growth and biomass accumulation in the less competitive species. Row configurations (arrangements) alter the amount of light making it to lower layers of the crop and affect competition. Differences in rooting depths and nitrogen (N) needs can offset competitive effects.

Intercropping cereal and legume species may increase the use efficiencies of growth factors, such as light (Francis, 1986). The efficiency of an intercropping system can be evaluated by the land equivalent ratio (LER), defined as the total area required under sole cropping to produce the equivalent yields obtained under intercropping (De Wit and Van Den Bergh, 1965). LER values greater than 1.0 indicate an advantage of intercropping over sole crop production of each component.

Intercropping cereal and legume species may also improve nitrogen (N) use efficiency (Francis, 1986). Cereals usually have faster growing or more extensive root systems than legumes and are more competitive for soil inorganic N. This forces the legume to fix N from the atmosphere.

The objectives of this study were to determine the effects of 1) row configuration and 2) fertilizer N on forage yield, protein content, and LER of barley/pea intercropping systems.

## Methods

A 3-yr experiment was conducted at the Western and the Central Agricultural Research Centers under irrigation and dryland, respectively, from 2000-2002. A commercial hay barley cultivar (Haybet) and an experimental selection of Austrian winter pea (MocSelect92) were intercropped with three different intercrop row configurations, and three fertilizer N levels. Intercrop row configurations consisted of: 1) four rows of barley planted adjacent to four rows of pea (4x4); 2) two rows of barley planted adjacent to two rows of pea (2x2); and 3) barley and pea mixed within the same row (mixed). Hay barley seeding rates were 15 seeds/ft$^2$ in the 2x2 and 4x4 configurations and 6 seeds/ft$^2$ in the mixed. Field pea seeding rate was 7 seeds/ft$^2$ in the 2x2 and 4x4 configurations, and 4 seeds/ft$^2$ in the mixed. Seeding rate was calculated based on the total area of mixed stands, and based on the area of only the pure stand of each crop in the 2x2 and 4x4 treatments.

Fertilizer N in the form of ammonium nitrate was spread by hand to each row configuration at the 2-3 leaf stage of barley at three N levels: 0, 60, and 120 lb N/a. The experiment was arranged as a two-factorial randomized complete block (RCB) design with four replications. More information about this study is in Chen et al. (2004).

## Results

Barley biomass production was enhanced in barley/pea mixtures with respect to the individual crops. As the degree of species intermixing increased, barley biomass production increased (mixed > 2x2 > 4x4). Conversely, pea biomass production was suppressed in barley/pea mixtures (mixed < 2x2 < 4x4). Dry pea had the highest biomass production in the 4x4 configuration, followed by the 2x2 configuration, and the lowest production occurred in the mixed configuration. Total forage yield (barley and pea combined) in the mixed treatment was greater than in the 2x2 and 4x4 configurations (Table 1). Barley was the dominant component, producing three times more biomass (4106 to 5806 lb/a) than pea (862 to 1307 lb/a). Fertilizer N enhanced the biomass production of barley and had no significant effect on pea biomass production (Table 1). The total combined forage yield increased with increased N levels.

The responses of protein content to row configuration and fertilizer N were different between the two study sites (Table 2). These differences likely resulted from the difference in production practices (irrigation vs. dryland) and soil depth at the two locations.

Over-application of fertilizer N may result in elevated nitrate content in harvested hay. For example, nitrate measurements for the forage samples from WARC showed 6,600 ppm of NO3-N content at N2 treatment (120 lb N/a) in 2001, which is potentially toxic to cattle (Fjell et al., 1991). Intercropping increased the use efficiency of plant growth resources by 5 to 24% (total LER value ranging from 1.05 to 1.24), with the greatest growth resource use efficiency in the mixed configuration (see Chen et al., 2004).

Fertilizer

Facts

Fertilizer ✔off

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**Summary**

Intercropping barley and pea increased total yield and protein compared to cropping barley alone. Barley is more competitive than pea in barley/pea intercropping systems. Separated row arrangements are advantageous where the desired outcome is a greater pea fraction in the harvested forage, but the mixed arrangement produced a greater total biomass yield and tended to have a higher LER (land equivalent ratio). Fertilizer N is effective in increasing total biomass yield and protein content in barley/pea intercrops, but high N rates may result in potentially toxic levels of nitrate in the forage and a lower LER.

**Fertilizer Facts:**

- Nitrogen fertilizer increased forage yield of barley/pea intercrops.
- Nitrogen fertilizer increased the protein content of the total forage.
- Over-application of N may cause elevated nitrate content in forages (no more than 60 lb N/a are recommended).
- Separate row arrangements had a higher pea biomass proportion and higher protein contents, but the mixed species arrangement had greater total forage production.

**References**

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Table 1. Forage yields of barley and pea and their combined intercrops at WARC and CARC from 2000-2002.

| | WARC Yields | | | CARC Yields | | |
|---|---|---|---|---|---|---|
| Treatment | Barley | Pea | Total | Barley | Pea | Total |
| | lb/a | | | | | |
| 4x4 | 4106c | 1307a | 5413b | 1649c | 971a | 2621b |
| 2x2 | 4581b | 1082b | 5663b | 1904b | 867b | 2770ab |
| Mixed | 5806a | 863c | 6668a | 2328a | 539c | 2867a |
| 0 lb N/a | 3776c | 1226a | 5003c | 1771b | 832a | 2603b |
| 60 lb N/a | 4980b | 1028a | 6008b | 2063a | 773a | 2837a |
| 120 lb N/a | 5736a | 998a | 6735a | 2046a | 773a | 2819a |
| $LSD_{0.05}$ | 412 | 159 | 404 | 196 | 92 | 174 |

Different letters in the same column indicate a significant difference (*P<0.05*). The mean values of row configurations were averaged across the three N levels, and the mean values of N treatments were averaged across the three row configurations. LSD-Least Significant Difference.

Table 2. Protein contents of barley and pea and their combined intercrops at WARC and CARC from 2000-2002.

| | WARC Protein | | | CARC Protein | | |
|---|---|---|---|---|---|---|
| Treatment | Barley | Pea | Total | Barley | Pea | Total |
| | % | | | | | |
| 4x4 | 9.4a | 19.5a | 11.9a | 11.9a | 19.5a | 14.7a |
| 2x2 | 9.6a | 19.2a | 11.4a | 11.7a | 19.3a | 14.0b |
| Mixed | 10.6a | 16.7b | 11.5a | 12.3a | 19.3a | 13.7b |
| 0 lb N/a | 8.8c | 18.1a | 11.2b | 9.4c | 18.1b | 12.4c |
| 60 lb N/a | 9.8b | 18.6a | 11.4b | 12.5b | 18.9b | 14.2b |
| 120 lb N/a | 11.0a | 18.8a | 12.2a | 14.0a | 21.1a | 15.9a |
| $LSD_{0.05}$ | 0.5 | 0.7 | 0.6 | 0.7 | 0.9 | 0.6 |

*Edited by Clain Jones, Extension Soil Fertility Specialist, and Evette Allison, Research Associate*