# 14.0 Effect of applied urea and agrotain treated urea in soybean and flax intercrop

***Project duration***: 2017 - 2019
***Collaborators:*** WADO

### *Objectives*

1. Determine yield obtained from soybean and flax intercropped in paired rows
2. Determine the precision spread of urea on soybean yield and nodulation with and without agrotain inhibitors
3. Determine the effects of fertilizer and crop type (interaction) in soybean-flax intercrop on yield and nodulation

### *Background*

Intercropping is an agricultural system that has been embraced worldwide as a result of its benefits that include: greater yields, less diseases, insect pests and weed pressure, soil and moisture conservation and improving soil nutrient status without the need for more synthetic fertilizers than in sole cropping systems (Szumigalski and Van Acker, 2005). Although there might be challenges in harvesting mixed crops, there has been an increase in acres under intercropping in Western Canada as a result of benefits associated with it. Any intercropping system involving soybean usually results in nitrogen credits for the succeeding crop and this in turn results in reduction in fertilizer costs and higher gross returns.

Most intercropping systems involve a legume and non-legume crop so as to maximize symbiotic benefits from both crops. In most cases, legume-cereal intercrops result in increased dry matter production and grain yield more than sole crops. When there is a limitation in fertilizer nitrogen, biological nitrogen fixation becomes the major source of nitrogen in mixed cropping systems involving a legume crop (Fujita et al., 1992). The use of legumes that are tolerant to nitrate and whose biological nitrogen fixation is less affected by application of combined nitrogen, may increase the amount of N available for the other component crop without affecting nodulation of the legume itself. When applying nitrogen to legumes, it is important to consider factors such as the source, rate, timing and placement depth, termed the 4R strategy for successful management of nutrients. Research conducted by Takahashi et al. (2012) suggested that deep placement of coated urea at seeding did not depress nodulation resulting in improved soybean growth and increase in seed yield while top dressing with the same fertilizer inhibited nodule activity after R3 stage, and subsequently resulted in low seed yield. In a related study by Laboski

(2006), Agrotain was shown to effectively reduce the conversion of surface applied urea or urea ammonium nitrate to ammonium resulting in increased grain yield due to reduced nitrogen losses. This study therefore seeks to determine the influence of soybean and flax intercrop and whether agrotain inhibitor has any influence on nodulation and seed yield between the component crops.

### *Materials and Methods*

The trial was initiated at Melita in South western Manitoba in 2018 and continued in 2019. The treatments were established on oat stubble on Waskada loam soil under no till system. The trial included 3 crop types (soybean, flax and soy-flax intercrop) and 3 fertilizer types (0 lb N, 60 lb Agrotain N and 60 lb Urea N). These were laid out as randomized complete block design with 9 treatments replicated 3 times. Seeding was done on the 10$^{th}$ of May at a depth of 1" and treatments were applied as indicated in Table 14a.

**Table 14a. Treatment description for Soybean-flax intercrop in 2019**

| Treatment[a] | Crop | Application rate (lb ac$^{-1}$) |
|---|---|---|
| 1 | Soybean | No N-check |
| 2 | Soybean | 60 Agrotain N |
| 3 | Soybean | 60 Urea N |
| 4 | Flax | No N-check |
| 5 | Flax | 60 Agrotain N |
| 6 | Flax | 60 Urea N |
| 7 | Soybean and Flax | No N-check |
| 8 | Soybean and Flax | 60 Agrotain N |
| 9 | Soybean and Flax | 60 Urea N |

[a]**Treatments 7 through 9 involved 2 soybean rows in the middle and 2 flax rows on either side of the soybean rows**

All soybean seeds were treated with granular BASF inoculant before seeding and granular fertilizer blend was side banded at a rate of 8-35-40-7-2Zn (N-P-K-S) lb ac$^{-1}$ during seeding. Preemergence weed control was done by the application of 0.1 L ac$^{-1}$ Authority, 0.75 L ac$^{-1}$ Roundup and 0.015L ac$^{-1}$ Aim soon after seeding. A second chemical weed control application was done at 5 weeks post emergence with 0.12 L ac$^{-1}$ Select + 0.5% v/v Amigo adjuvant for the control of grasses. There was moderate to high cutworm pressure during the early seedling stages, which warranted the application of Lorsban insecticide at a rate of 0.033 L ac$^{-1}$. Data collected included: nodule counts (n=10), light interception above and below the canopy, soil moisture content, above ground biomass yield, days to maturity, grain yield and moisture content at harvest. Land equivalence ratio for each cropping system was calculated in Excel before being subjected to statistical analysis. The data were subjected to factorial ANOVA Minitab 18 statistical package for determination of treatment differences. Separation of treatment means was done by using Fisher's LSD at the 5% level of significance.

**Nodule sampling in Soy-flax trial on July 8th 2019, Melita**

### *Results and Discussion*

Cropping system had a significant influence on yield and other agronomic components of soybean and flax. Yield from soybean monocrop was significantly ($P<0.001$) higher than obtained from an intercrop with flax. Soybean LER ($P<0.001$), height ($P=0.029$) and oil content ($P<0.001$) were also significantly greater in monocrop compared to the intercrop. On the other hand, protein content of soybean was significantly lower ($P<0.001$) in monocrop (39.1%) compared to the intercrop, which had 40% on dry matter basis. Soybean kernel weight based on 100g sample was significantly ($P=0.036$) greater in the intercrop (19.6g) compared to soybean monocrop (19.0g). Similar to soybean, flax monocrop obtained significantly ($P<0.001$) higher yield (1407kg $ha^{-1}$) compared to the intercrop (901kg $ha^{-1}$). Land equivalence ratio of flax was significant ($P<0.001$) with monocrop having 1.04 while the intercrop had 0.67. Total yield from soybean monocrop and soybean-flax intercrop was significantly higher ($P<0.001$) than total yield from flax monocrop but there were no significant differences in TLER for the three cropping systems. Fertility had no significant influence on all agronomic parameters except on flax LER. Agrotain and 0N application resulted in significantly ($P=0.042$) higher LER compared to Urea application in flax. None of the crop-fertility interactions significantly influenced agronomic components of flax or soybeans in 2019 (Table 14b).

Results from this research show that cropping system is the only factor that influenced grain yield and other agronomic components such as oil and protein content. In particular, mono crop systems of flax and soybean appeared to yield higher than when intercropped. This makes sense considering less interspecific competition that could have arisen in intercrop situations. Lower yields in intercrops could have been due to high competition for nutrients, light and moisture. In 2019, the major factor for lower yield was as a result of low rainfall which was unevenly distributed throughout the season. Furthermore, a long dry spell in the spring meant that the crops depended much on residual moisture from snow melt, which seemed to be inadequate for early crop establishment and fertilizer dynamics. Additional site-years of research may be required in order to account for the influence of varying weather conditions, in this case, rainfall and how these impact fertilizer dynamics in the soil.

**Table 14b: Analysis of variance for soybean-flax yield, quality and land equivalence ratio in 2019**

| | Factor | | Soybean | | | | | | | Flax | | | TOTAL | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Nodules | Yield | S-LER | Height | Oil | Protein | TKWT | Yield | F-LER | Height | Yield | T-LER |
| | | | per plant | Kg ha$^{-1}$ | | Cm | % | % | g/100 seeds | Kg ha$^{-1}$ | | cm | Kg ha$^{-1}$ | |
| **Crop** | Soybean | 1 | 3.0 | 2808a | 1.06a | 63a | 21.0a | 38.1b | 19.0b | * | * | * | 2808b | 1.06 |
| | Flax | 2 | * | * | * | * | * | * | * | 1407a | 1.04a | 65 | 1407a | 1.04 |
| | Intercrop | 3 | 3.4 | 843b | 0.32b | 58b | 20.0b | 40.0a | 19.6a | 901b | 0.67b | 65 | 1744b | 0.99 |
| | **Significant?** | | **No** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **No** | **Yes** | **No** |
| **Fertility** | 0N | 1 | 4.4 | 1703 | 0.64 | 63 | 20.6 | 38.8 | 19.3 | 1215 | 0.90a | 65 | 1945 | 1.03 |
| | Agrotain | 2 | 2.8 | 1767 | 0.67 | 60 | 20.4 | 39.1 | 18.9 | 1197 | 0.89a | 65 | 1976 | 1.04 |
| | Urea | 3 | 2.6 | 2006 | 0.76 | 59 | 20.4 | 39.3 | 19.8 | 1050 | 0.78b | 65 | 2037 | 1.03 |
| | **Significant?** | | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **Yes** | **No** | **No** | **No** |
| **Interaction** | Soybean | 0N | 5.2 | 2673 | 1.00 | 64 | 21.1 | 38.2 | 18.6 | * | * | * | 2941 | 1.00 |
| | | Agrotain | 1.9 | 2808 | 1.06 | 63 | 21.0 | 38.0 | 18.6 | * | * | * | 2808 | 1.06 |
| | | Urea | 1.9 | 2941 | 1.13 | 61 | 20.9 | 38.0 | 19.7 | * | * | * | 2673 | 1.13 |
| | Flax | 0N | * | * | * | * | * | * | * | 1459 | 1.08 | 63.7 | 1459 | 1.08 |
| | | Agrotain | * | * | * | * | * | * | * | 1413 | 1.05 | 65.0 | 1413 | 1.05 |
| | | Urea | * | * | * | * | * | * | * | 1349 | 1.00 | 66.0 | 1349 | 1.00 |
| | Intercrop | 0N | 3.5 | 734 | 0.28 | 55 | 20.1 | 39.4 | 19.9 | 971 | 0.72 | 67.0 | 1704 | 1.00 |
| | | Agrotain | 3.6 | 725 | 0.28 | 62 | 19.8 | 40.2 | 19.2 | 981 | 0.73 | 64.0 | 1707 | 1.01 |
| | | Urea | 3.2 | 1070 | 0.40 | 57 | 19.9 | 40.5 | 19.9 | 750 | 0.55 | 64.3 | 1820 | 0.95 |
| | **Significant?** | | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** |
| **P values** | | Crop | 0.513 | **<0.001** | **<0.001** | **0.029** | **<0.001** | **<0.001** | **0.036** | **<0.001** | **<0.001** | 0.88 | **<0.001** | 0.641 |
| | | Fertility | 0.065 | 0.437 | 0.472 | 0.307 | 0.662 | 0.435 | 0.076 | 0.067 | **0.042** | 0.883 | 0.861 | 0.984 |
| | | C x F | 0.074 | 0.903 | 0.957 | 0.245 | 0.86 | 0.214 | 0.341 | 0.479 | 0.367 | 0.344 | 0.924 | 0.835 |
| **Coefficient of Variation %** | | | **39** | **23** | **26** | **6** | **2** | **2** | **3** | **10** | **9** | **5** | **18** | **17** |