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CAN AN INTERCROP OF FORAGE SOYBEANS AND FLOURY SILAGE CORN PRODUCE A HIGHER VALUE FORAGE CROP THAN A MONOCULTURE OF EACH CROP?

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Can an intercrop of forage soybeans and floury silage corn produce a higher value forage crop than a monoculture of each crop?

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Figure 1. Corn monocrop (L) vs corn soy intercrop (R) in Redvers on July 10.

Introduction

The purpose of this demonstration is to evaluate the potential or problems with intercropping corn and soybeans for forage. It also serves to evaluate the potential of a monoculture of a new type of corn for forage and the potential of soybean monocrops for forage.

A new type of glyphosate-tolerant floury forage corn 932S was obtained from Northstar Genetics for this demonstration. It is a 2300-2400 heat unit type suitable for silage with especially digestible starch and fiber. A glyphosate-tolerant soybean NSC Winkler RR2X was chosen in consultation with Northstar because it is relatively later maturing (2500 heat unit) and has a tall plant structure with little branching. A monoculture of soybean was evaluated for forage production and this was compared with corn monocrops and corn intercrops with soybean. There was two different nitrogen rates for the corn monocrops and corn intercrops. The treatments are summarized in Table 1.

Materials and Methods

Intercrop corn density was targeted at 4.6 plants/m2 (18,700 plants per acre) and monocrop corn density was targeted at 6.9 plants/m2 (28000 plants per acre). Soybean density was targeted at 52 plants/m2 (210,000 plants per acre) for the monocrop and 34 plants/m2 (140,000 plants/m2) for the intercrop. Urea nitrogen rates were 1x (142 kg/ha applied) and 0.5x (65 kg/ha) and an addition 11 kg/ha of N was applied as phosphate fertilizer. The urea was a 50:50 mixture of regular urea and polymer coated urea to reduce risk of seedling toxicity under dry spring conditions. Corn was cultivar 932S, which is a 2300-2400 heat unit corn.

The trial was seeded using the Seedmaster drill with the corn and soybeans being placed at the same depth (2 cm) in mixed rows. Fertilizer was side-banded at 3.5 cm. It was seeded into flax stubble on 25 cm row spacing with plots measuring 10 ft by 20 ft. There were four replicates arranged in a randomized complete block design. The trial was seeded on May 26 into relatively dry soil but there was no problem with germination. Glyphosate was applied on May 29 as a burn-off and applied again on June 22 (0.67L/ac 540 concentration). Plant counts were done in late June.

There was negligible weed pressure in any plots because the glyphosate application was very effective and it was very dry. Weed counts were not performed. There was an early frost on September 8 that killed most of the corn and soybeans. While there was some drought stress through July and August, the plants did not wilt.

Plant heights were measured when the biomass was collected on September 11, 2020. Four total meter rows were collected (two from the front and two from the back) from each plot. Those samples were combined for weighing with a hanging scale in the field. The soybeans were removed from the intercrop samples and the corn weight was recorded. Samples were recombined for subsampling for quality. Corn and soybeans were mulched with an electric wood chipper and frozen for submission to Central Testing for forage analysis. Total forage yield is reported on a dry matter basis. Individual fresh biomass weights of corn and soybean are reported to determine the influence on the balance of the crops in mixes but we can't determine dry matter yield of components in intercrop mixes. Soybeans were close to physiological maturity when they were harvested. Corn was at milk stage when it froze on September 8.

TREATMENT	CORN SEED	SOYBEAN SEED	P APPLIED	N APPLIED	SOIL AVAILABLE	TOTAL AVAILABLE N
#	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
1	12	59	56	76	45	121
2	12	59	56	153	45	198
3	19	0.0	56	76	45	121
4	19	0.0	56	153	45	198
5	0.0	89	56	12	45	57

Results

The total dry matter biomass in MT/ha produced as of September 11, 2020 showed a significant reduction in the intercrops compared with the monocrops. The dry biomass was lowest for the monocrop soy treatment. The dry matter content of the soybeans was higher than the corn at the time of harvest while the other treatments had similar dry matter content.

Table 2. Dry matter biomass yield for five treatments of corn and soybean in Redvers in 2020.

Treatment		**Dry matter**		**Total dry matter**	
#		%		MT/ha	
1	Intercrop 0.5x	37.4	B	10.4	B
2	Intercrop 1x	36.9	Bc	10.3	B
3	Mono Corn 0.5x	36.6	Bc	16.2	A
4	Mono Corn 1x	34.5	C	16.4	A
5	Mono Soy	53.5	A	3.9	C
P-value		<0.01		<0.01	
LSD		2.6		1.7	

Table 3. Corn plant density, height, fresh biomass in Redvers in 2020.

Trt #		Plant density Pl/m2		Height Cm		Fresh biomass MT/ha	
1	Intercrop 0.5x	9.1	c	162	C	27.7	B
2	Intercrop 1x	10.6	Bc	191	B	27.9	B
3	Mono corn 0.5x	14.8	A	209	Ab	44.3	A
4	Mono corn 1x	13	Ab	210	A	47.4	A
5	Mono soy	X		X		X	
P-value		0.03		<0.01		<0.01	
Lsd		3.6		19		3.6	
0.5x Fertility Trts		11.9		185		36.0	
1x Fertility Trts		11.8		200		37.6	
P-value		0.91		0.06		0.19	
Lsd		Ns		Ns		Ns	
Monocrop Trts		13.9	A	210	A	45.8	A
Intercrop Trts		9.8	B	176	B	27.8	B
P-value		<0.01		<0.01		<0.01	
LSD		2.6		16		2.6	

Corn seeding rates were lower in the intercrop treatments than in the monocrop treatments and resultant plant densities reflect this difference (Table 3). Corn densities were higher than expected, which may reflect a calibration issue. The corn crop height was lower in the intercrops than in the monocrops. The effect of nitrogen rate was more variable but corn tended to be taller with fertilizer added. Intercrop treatments had a statistically significant 60% reduction in corn biomass. Fertilizer rate didn't affect corn biomass significantly.

Soybean plant density was as expected. Soybean plant height was variable and not significantly affected by treatments. Soybean biomass tended to be higher in the monocrop treatment than in the intercrop treatments.

Table 4. Soybean plant density, height and fresh biomass for soybean monocrop and intercrop treatments.

Treatment #	Name	Plant density Pl/m2		Biomass Mt/ha		Height Cm
1	Intercrop 0.5x	30.8	B	4.97	B	69.5
2	Intercrop 1x	26.8	B	4.18	Ab	72.8
5	Mono soy	46.5	A	7.39	A	64.9
P-value		0		0.097		0.2
Lsd		8.4		3.1		Ns

Soybean plant density was close to the target amount and reflects the difference in seeding rate. Soybean height of canopy was not significantly affected by intercropping or fertilization. Soybean fresh weight biomass was higher in the monocrops than in the intercrop treatments. The intercrop treatment with 0.5x rate of nitrogen applied tended to be a little higher than the higher nitrogen application treatment.

Table 5. Forage quality parameter results

	Digestibility and energy content (dry matter basis)*								Nutrient composition (dry matter basis)			
Trt	CP	ADF	TDN	MEC	NEL	DE	NEM	NEG	P	Mg	K	Ca
#	%	%	%	---------- Mcal/kg ----------								
1	8.6 bc	29.0	67.7	2.5	1.5	3.0	1.59	0.99	0.11	0.38	0.835	0.30
2	9.2 b	28.6	68.0	2.49	1.6	3.0	1.60	1.00	0.11	0.38	0.795	0.28
3	7.1 d	28.2	68.5	2.51	1.6	3.0	1.61	1.01	0.10	0.29	0.85	0.17
4	8.0 cd	28.0	68.5	2.50	1.6	3.0	1.62	1.01	0.10	0.31	0.84	0.18
5	20.8 a	34.5	61.8	2.26	1.4	2.7	1.40	0.81	0.23	0.54	1.385	0.65
P-value	0	0	0	0	0	0	0	0	0	0	0	0
Lsd	1.0	2.2	2.4	0.09	0.06	0.1	0.08	0.07	0.07	0.03	0.059	0.1493

* CP= Crude protein, ADF= Acid digestible Fiber, TDN = Total Digestible Nutrients, MEC = Metabolizable energy for cattle, NEL = Net energy for lactation, DE = Digestible energy, NEM = Net energy for maintenance, NEG = Net energy for gain.

Soybeans were less digestible than floury corn but had higher protein. Soybean monocrops differed from treatments containing corn for most quality parameters. Crude protein was a little higher in the intercrop treatments than in the corn monocrops. Mineral nutrient composition was higher in the soybean monocrops but was not substantially or significantly different in the intercrops compared with monocrop corn. The soybeans were more mature than the corn at the time of the frost on September 8.

Crop System	**Crude Protein** %		**Magnesium** %		**Calcium** %	
Mono Corn	7.51	b	0.301	b	0.174	b
Intercrop	8.93	a	0.381	a	0.289	a
p-value	<0.01		<0.01		<0.01	
LSD	0.84		0.047		0.044	

Discussion and Conclusion

The forage yield reduction as total dry matter in the intercrop was significant and substantial. When Land Equivalency Ratio (LER) is calculated from fresh biomass components, the 0.5x and 1x intercrops had LERs of 1.3 and 1.15. While this does show some positive functionality, it breaks down on the problem of using soybean as a forage. The forage yield of soybean was only 25% of the corn forage yield on a dry matter basis.

While soybean forage has high crude protein, it is less digestible than the floury corn used in this trial. The intercrop sacrificed yield with a questionable impact on quality. Adding nitrogen in this dry season with an early frost did not substantially improve overall yield, either in corn monocrops or in intercrops. Soybean growth was similar in intercrops no matter which nitrogen rate was used.

The main advantage to this intercrop combination is the availability of glyphosate herbicide to control weeds. The flip side of that is that it is relatively expensive for seed cost because of the proprietary traits. The floury corn had good quality and was highly digestible, but this demonstration did not have more traditional corn varieties for comparison.

Extension Activities

This demonstration was included in the Saskatchewan Ministry of Agriculture Crop Diagnostic School, which was virtual in 2020 as a video. We do not have access to the numbers of people who have viewed the relevant video on intercropping.

A July 10 tweet with a a photo and information about the trial had 3720 impressions and 346 total engagements. Sept 11 tweet had 1472 impressions and 139 engagements. This project will be part of a Ministry of Agriculture webinar session in March, 2021.

Abstract

A floury silage-type corn was grown as a monoculture and in an intercrop with soybean and a soybean monocrop in a replicated trial. The purpose was to evaluate the potential of both the relatively new type of corn, a late season soybean and an intercrop of the two for yield and quality. The monocrops and intercrops with corn were evaluated at two nitrogen levels (0.5x and 1x) to determine the effect of fertilization on the balance of an intercrop. Total dry matter yield was 63% in the intercrops compared with the corn monocrops. Yield was not affected by fertilizer rate. Digestibility of corn monocrops and corn soy intercrops was comparable and protein was slightly higher in the intercrop compared to the monocrop. The soybean monocrop had high protein but lower digestibility than treatments containing corn. This intercrop resulted in a reduction in yield even at a reduced nitrogen fertilizer level.

Acknowledgements

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References

www.northstargenetics.com/ca/2019/09/16/floury-leafy-silage-corn/