

INVESTIGATING PRACTICAL SOLUTIONS TO IMPROVE SOIL TEMPERATURE, WATER HOLDING CAPACITY AND DRAINAGE CAPACITY IN FINER TEXTURED SOILS

Seeding rate lb ac-1													
1	Deep rooted cover crop species	2	3	4	5	6	7	8	9	10	11	12	13
Fallow	Daikon radish	1.6	3.2	4.8	1.6	3.2	4.8	1.6	3.2	4.8	1.6	3.2	4.8
	Forage radish	1.6	3.2	4.8	1.6	3.2	4.8	1.6	3.2	4.8	1.6	3.2	4.8
	Forage turnip	1.6	3.2	4.8	1.6	3.2	4.8	1.6	3.2	4.8	1.6	3.2	4.8
	Oat												
	Japanese millet	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4
	Sweet clover	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
	Chicory	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	Field pea	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	Sunflower	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
	Spring triticale	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	Red proso millet												
	Berseem clover	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4
	Brown midrib corn	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
	Annual ryegrass	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	Hairy vetch	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4

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Saturated Hydraulic Conductivity

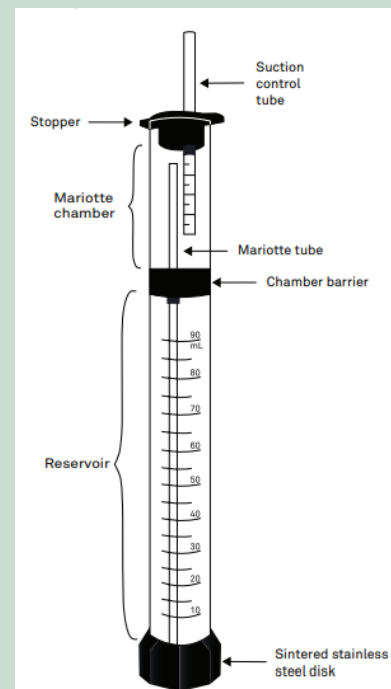
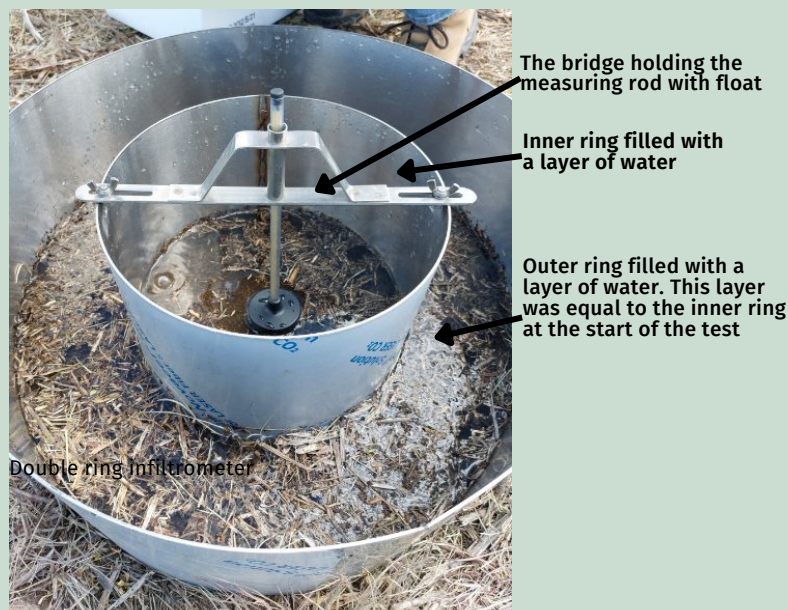
Hydraulic conductivity refers to the rate at which water moves through soil and can be an important indicator of soil structure. Compaction and soil type are both factors that can impact hydraulic conductivity.

Saturated hydraulic conductivity was measured with a large set of rings that are hammered into the ground and filled with a layer of water, a double ring infiltrometer. Rates for this method are measured in height over time. Data is recorded from the start when the water is added until the rate becomes consistent, the number at this plateau gives the infiltration rate of a saturated soil.

Unsaturated Hydraulic Conductivity

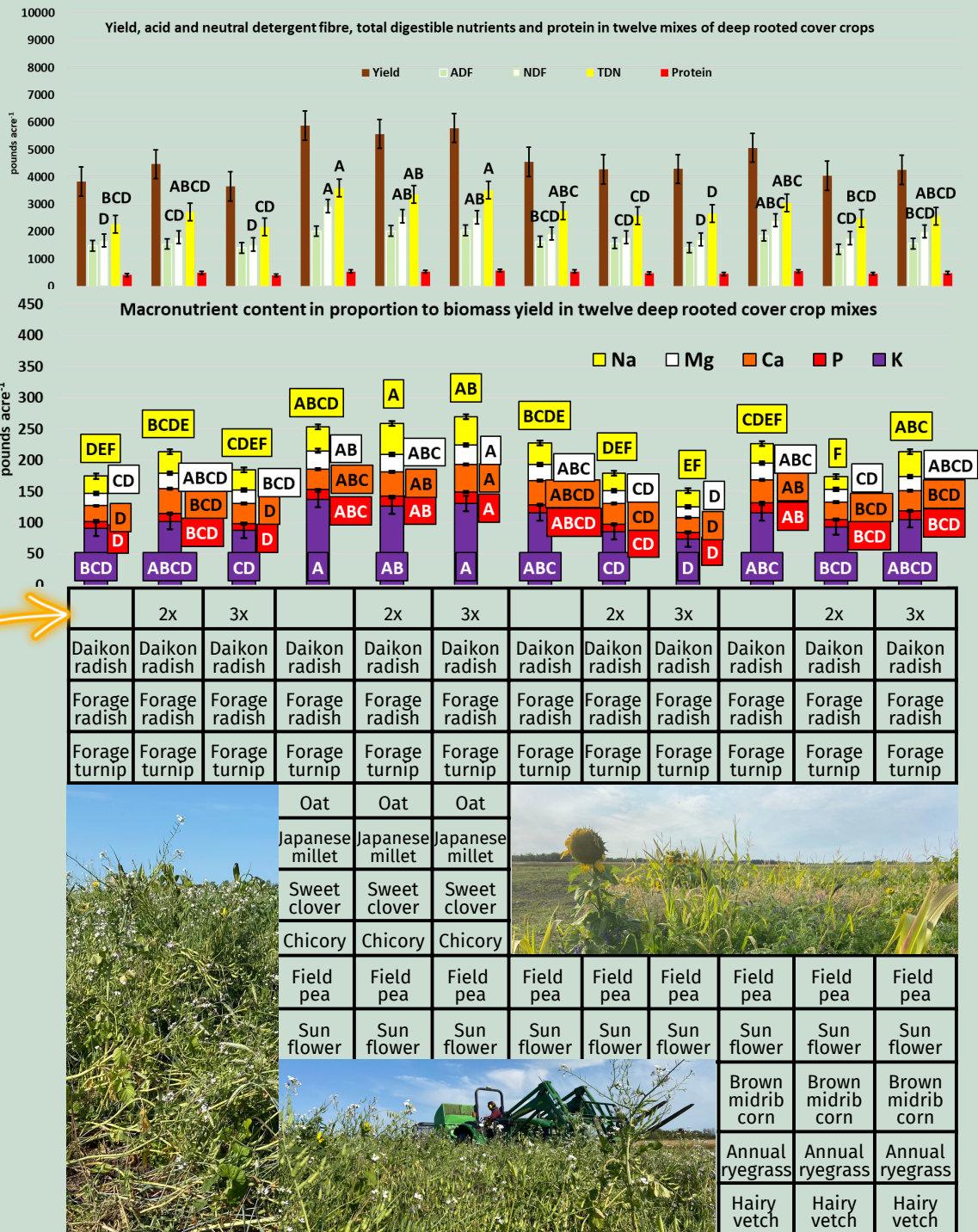
Unsaturated hydraulic conductivity measurements were taken using a mini disk infiltrometer. The mini disk infiltrometer is a glass cylinder with a special permeable base. When set on soil and adjusted properly volume can be read from markings on the cylinder and with a time measurement this gives a rate of volume over time. The goal with this style of measurement is to measure the time it takes for a specific volume of water to infiltrate unsaturated soil.

Soil infiltration measurements are preliminary and do not provide any effect made by the treatments themselves. It is expected that in following seasons, soil analysis and infiltration conducted can be used to compute and further analyze differences among treatments.



Mini disk infiltrometer diagram from the manual

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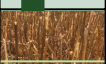
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Biomass yield and feed analysis

Cover crop mixes were crafted to observe how different cover crop roots affect infiltration and fertility across the soil column. Consider treatments as four sets of three treatments. The first set consists of a brassica group (daikon radish, forage radish and forage turnip) which is sown at 1X, 2X and 3X of the recommended seeding rate. With the exception of the fallow treatment, all other sets have a brassica group at either of these seeding rates and field pea and sunflower. Thus, The second set was sown with oat, Japanese millet, sweet clover, chicory, in addition with the brassica group and afore mentioned crops. Third set had a brassica group with only field pea and sunflower and the last set of three was seeded with a brassica group, brown midrib corn, annual ryegrass and hairy vetch. Treatments were harvested for biomass yield and sent for feed analysis. Due to funding constraints, biomass was not collected for fallow plots and no subsequent feed analysis in the plots of this treatment were made. Biomass yield was statistically the same across all treatments ($P=0.0582$). Likewise, protein ($P=0.4873$) and acid detergent fibre ($P=0.0982$) were the same among treatments. Neutral detergent fibre ($P=0.0029$) on the other hand, was greater in mixes containing oat, Japanese millet, sweet clover, chicory, field pea and sunflower, despite brassica seeding rates. Moreover, mixes with only brown midrib corn, annual ryegrass, hairy vetch and single rates of the brassica group showed NDF as great as those found in previous mentioned mixes. Values of NDF were low in mixes where only the brassica group was present or when it was accompanied with field pea and sunflower. In fact, NDF in treatment sets with sown with brassica group, field pea and sunflower plus oat, Japanese millet, sweet clover and chicory was 113% more than that found in sets sown with only the brassica group. This same set were Japanese millet, oat, chicory and sweet clover were sown and had 97% more NDF than sets where a brassica group plus field pea and sunflower were seeded and 69% more NDF than mixes including brown midrib corn, annual ryegrass and hairy vetch.

Total digestible nutrients were greater in mixes containing oat, Japanese millet, sweet clover, and chicory with the brassica group as well as field pea and sunflower compared to the rest of treatments. This is regardless of brassica group seeding rates. Mixes with oat, Japanese millet, sweet clover, and chicory had 95% more TDN than sets sown with only a brassica group, 71% more TDN than the brassica plus field pea and sunflower set and 67% more TDN than the cover crop mix set composed of brown midrib corn, annual ryegrass and hairy vetch with the brassica group, field pea and sunflower. This last set was had 5% more TDN than the brassica group plus field pea and sunflower set.

Macronutrient content varied across cover crop treatments. Table below describes differences in percentage of different cover crop mix sets as well as cover crop treatments individually. Percentage values determine how treatment sets or treatments on the right compare to those on the left.

		Percentage				
Comparing	To	K	P	Ca	Mg	Na
Brassica (Daikon radish + forage radish + forage turnip)	Brassica + field pea + sunflower + oat + Japanese millet + sweet clover + chicory	↓ 86	↓ 95	↓ 50	↓ 73	↓ 88
Brassica (Daikon radish + forage radish + forage turnip)	Brassica + field pea + sunflower + brown midrib corn + annual ryegrass + hairy vetch		↓ 59			
Brassica + field pea + sunflower + oat + Japanese millet + sweet clover + chicory	Brassica + field pea + sunflower	↑ 91	↑ 84	↑ 55	↑ 83	↑ 101
Brassica + field pea + sunflower + oat + Japanese millet + sweet clover + chicory	Brassica + field pea + sunflower + brown midrib corn + annual ryegrass + hairy vetch	↑ 61		↑ 54	↑ 59	↑ 94
Brassica 1X	Brassica 2X			↓ 36		
Brassica 1X + field pea + sunflower + oat + Japanese millet + sweet clover + chicory	Brassica 3X + field pea + sunflower + Oat + Japanese millet + sweet clover + chicory			↓ 26		
Brassica 1X + field pea + sunflower	Brassica 3X + field pea + sunflower				↑ 34	↑ 25
Brassica 1X + field pea + sunflower + Brown midrib corn + Annual ryegrass + hairy vetch	Brassica 3X + field pea + sunflower + Brown midrib corn + Annual ryegrass + hairy vetch			↑ 43		
Brassica 2X + field pea + sunflower + Brown midrib corn + Annual ryegrass + hairy vetch	Brassica 3X + field pea + sunflower + Brown midrib corn + Annual ryegrass + hairy vetch					↓ 47

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Macronutrient content varied across cover crop treatments. Table below describes differences in percentage of different cover crop mix sets as well as cover crop treatments individually. Percentage values determine how treatment sets or treatments on the right compare to those on the left. Table shows that brassica, field pea, sunflower sown with oat, Japanese millet, sweet clover and chicory are richer in K ($P=0.0175$), P ($P=0.0094$), Ca ($P=0.0155$), Mg ($P=0.0314$) and Na ($P=0.0004$) compared to brassica sown with field pea and sunflower. Moreover, the same mixture is richer in K, Ca, Mg and Na than mixtures of brassica plus field pea and sunflower and brown midrib corn, annual ryegrass and hairy vetch. Calcium content is lower in brassica mixes seeded at the recommended rate (1X) than those seeded twice such rate. Lower calcium content is also found in brassica mixtures sown at the recommended rate, along with field pea and sunflower, as well as oat, Japanese millet, sweet clover and chicory. Magnesium and Sodium content are greater in brassica mixtures seeded at the 1X rate with field pea and sunflower than brassica seeded at the 3X rate with the same legume and oilseed plant. However, calcium content is higher in brassica seeded at the recommended rate plus field pea and sunflower in addition to brown midrib corn, annual ryegrass and hairy vetch than in the same mixture but with brassica sown three times the recommended rate. Sodium content is lower in the afore mentioned mixture with twice the recommended brassica rate compared to the same mixture at three times the recommended brassica rate.

Overall, in terms of feed value, brassica mixes, brassica mixes with field pea and sunflower, and brassica mixes with field pea and sunflower in addition to brown midrib corn, annual ryegrass and hairy vetch are more digestible for the animals as their NDF values are lower. Moreover, mixtures containing brown midrib corn, annual ryegrass and hairy vetch have more TDN and a greater macronutrient content after mixtures consisting of oat, Japanese millet, sweet clover and chicory with brassica, field pea and sunflower. Thus brassica mixes combined with hairy vetch, brown midrib corn and annual ryegrass could be a great choice as they provide sufficient nutrients and macronutrient content without reducing digestibility.

