

## 2. Summary of Research Results

### 2.1 Spring Cereals – Variety Evaluation:

#### *Specialty Wheat:*

- Twenty four varieties of different types of wheat (hard red, durum and hard white) and triticale from the east and west of Canada were compared.
- *T-200 triticale* (6,939 kg/ha), *Bumper triticale* (5,577 kg/ha) and *Stettler-hard red spring wheat* (5,531 kg/ha) surpassed *Sable* (5,048 kg/ha) in grain yield. *Bumper* had the highest straw (10,760 kg/ha) and *T-200* the highest biomass yield (16,647 kg/ha).
- Grain yields (~4,400 kg/ha) from the two hard white wheat varieties (*Snowstar* and *Snowbird*) were equal, but lower than top yielding hard red wheat varieties.
- Grain protein content in *Glencross* (20.4 %), *Carberry* (20.3 %) and *Enterprise* (20.1 %) was higher than that in other varieties; 18.6 % in *Stettler* and 18.1 % in *Sable*.

#### *Organic wheat (with alfalfa/grasses green manuring):*

- Grain yields were in the order of *Sable* (4,154 kg/ha) > *Superb* (3,262 kg/ha) > *Red Fife* (2,032 kg/ha) > *Kamut* (1,646 kg/ha).
- Straw (8,611 kg/ha) and biomass (12,765 kg/ha) yields were highest with *Sable*.
- Seed treatment with mycorrhizal fungi didn't improve the grain yield.
- Grain protein content was highest in *Kamut* (20 %) followed by *Superb* (19.8 %), *Sable* (18.5 %), and *Red Fife* (17.1 %).

#### *Older Wheats:*

- It was a single replication demonstration that compared older wheat varieties (*AC Mimi*, *Pembino*, *Garnet*, *Saunders*, *Thatcher*, *Marquis*, *AC Michael* and *Kamut*) with *Sable*.
- Grain yields in older varieties, except *Thatcher* and *AC Michael*, were lower than 4,000 kg/ha. Grain yield from *Sable* was ~5,300 kg/ha.
- Grain protein content in *Pembino*, *Thatcher* and *Kamut* (18 % or more) was higher than that in *Sable* (15.9 %). *Thatcher* could be a good choice for local food production/and processing.

#### *Durum wheat:*

- Ontario's *Hallmark* (5,121 kg grains/ha), out yielded all western durum varieties (4,350-4,800 kg grains/ha) this year! Straw and biomass yields were also highest with *Hallmark*.
- Grain protein content (16.4 %) was highest in *Enterprise*!

#### *Wheat Performance:*

- In grain yield, *HY 162-HRF* (5,449 kg/ha), *Batiscan* (5,417 kg/ha) and *AW 625* (5,412 kg/ha), were the three top yielding varieties amongst the 27 wheat entries. Grain yield from *Sable* was only 4,826 kg/ha. It appears that *Sable* didn't like the heat and drought towards maturity!
- Amongst registered varieties, *AW 625* (though not significantly better than *Batiscan*) had a top rank in straw (7,338 kg/ha) and biomass (12,750 kg/ha) production.

#### *Barley Performance:*

- Twenty four barley varieties/lines were evaluated.
- *Cyane* (5,443 kg/ha), *Amberly* (5,128 kg/ha), and *Encore* (5,097 kg/ha) produced the highest grain yields. In the last couple of years too, *Encore* was one of the three top yielding varieties. *Oceanik* was left behind in grain yield (4,322 kg/ha) not only this year, but last year too. It seems that *Encore* is better suited to fluctuating weather conditions than *Oceanik*!
- *Encore* recorded the highest straw (6,853 kg/ha) and biomass yields (11,950 kg/ha).
- *Farmers may wish to add Encore to their barley portfolio during 2012 season!*

*Specialty barley/other barley varieties:*

- In the grain yield, *HB 122*, a new hulless barley, out yielded *Millhouse*, earlier hulless barley, by ~1,000 kg/ha. The yield differences were however due to relatively poor plant stand in *Millhouse* (probably the seed was old and had lost its viability!).
- *Quest (M122)*, a new 6 row barley variety from the University of Minnesota, USA, produced 400 kg/ha higher grain yield than *CDC Coalition*.
- *Millhouse* produced the highest straw yield (5,304 kg/ha) and *Quest* the highest biomass yield (8,275 kg/ha).
- *Millhouse* had the highest grain protein content (15.1 %; 3-4 % point > other varieties).
- Grain yield (~4,500-4,600 kg/ha in all) from new barley varieties (*CF 00712*, *Raquel* and *Sedna*) was no better than *Cyane*; *Raquel* had the highest grain protein content (11.4 %).

*Barley – silage and grain:*

- Eleven high yielding food, feed and malting varieties from the east and the west of Canada were compared.
- *CDC Coalition* (5,942 kg/ha) and *Bentley* (5,901 kg/ha), both 2 row barley, surpassed 6 row barley varieties in grain yield; highest with *Cyane* (5,587 kg/ha). *Grain yield from Conlon, 2 row barley cultivated by some area growers, was relatively poor (4,780 kg/ha).*
- Grain protein was higher in *Major* (15.6 %) and *Chigwell* (14.9 %) than other varieties.
- Silage yields from *CDC Coalition* (5,617 kg/ha) and *Bentley* (5,772 kg/ha) or even *Conlon* (5,696) were statistically at par with that from *Cyane* (5,829 kg/ha), which had higher relative feed value than the aforesaid 2 row varieties. *However, over the years, CDC Coalition has proved to be a good dual purpose (silage and grain) variety!*
- Total biomass yield (10,948 kg/ha) was highest with *Bentley*.

*Oats Performance:*

- Twenty one varieties/biotypes of oats were compared with each other.
- Amongst known varieties, highest grain yields were obtained with *Vitality* (6,000 kg/ha), *RC Amaze* (5,931 kg/ha) and *Prescott* (5,863 kg/ha).
- Highest biomass yield was obtained with *Cantal* (12,629 kg/ha) followed closely by *Navaro-hulless* (12,333 kg/ha) and *Synextra* (12,332 kg/ha).
- *Synextra* (6,749 kg/ha) and *AC Gwen-hulless* (6,502 kg/ha) topped in straw yield.

*Western Oat varieties:*

- Grain yields from *Summit* (6,577 kg/ha), *AC Rigodon* (6,287 kg/ha) and *Oscar* (6,074 kg/ha) were statistically similar.
- *AC Jordan* (7,149 kg/ha) and *Dieter* (7,020 kg/ha) produced higher straw yields than other varieties (5,332-6,257 kg/ha); Biomass yield was highest with *AC Jordan* (12,911 kg/ha) followed closely by *Summit* (12,756 kg/ha) and *Dieter* (12,701 kg/ha).
- Grain protein content was higher in two hulless oat varieties (*Navaro-18.6 %* and *Gehl-17.8 %*) as compared to the other varieties (12.4-14.3 %).

## **2.2 Spring Cereals – Other Experiments:**

*Tillage in barley (after Oat-Barley-Soybean-Barley-Soybean-Barley-Soybean):*

- Disking twice in spring without any fall tillage/and cultivation in spring gave as much barley grain yield (3,642 kg/ha) as the conventional tillage (fall plowing, spring disking and cultivation before seeding; 3,668 kg/ha), but saved time (40 %) and fuel (60 %). Grain yield with chisel plowing in the fall followed by disking and cultivation in the spring was equally good (3,600 kg grains/ha).
- Grain yields (~3,400 kg/ha) with other alternate tillage systems, such as single or double disking in fall and cultivation in spring, equaled yields from conventional tillage systems.

*Optimizing population for spring barley + winter wheat seeded together in spring:*

- Highest forage dry matter yield (~6,900 kg/ha) was obtained by seeding winter wheat (*CDC Falcon*) at 85 % of the recommended seed rate with spring barley (*CDC Coalition*) at 75 % of the recommended seed rate. Protein content from this crop combination was 0.5 % point better and NDFd was as good as that from barley alone, which yielded ~500

kg/ha less than the two crops grown together. *Winter wheat after barley harvest could serve as a good cover crop and could be left for fall grazing/or for forage/grain production in the next spring.*

*Fertilizers requirements of spring barley + winter wheat seeded together in spring:*

- Fertilizer (N, P and K) requirements of spring barley + winter wheat, for forage production, were no different than fertilizer requirements of spring barley grown alone!
- Increasing NPK rates by 25-50 % of normal/recommended NPK rates increased the forage protein content by 0.7-1 % point. NDFd yield was highest (2,000 kg/ha) at 1.5 times of the recommended NPK rates.

*Response of barley + pea intercropping to N:*

- There was some, though not significant, response to application of N @ 40 kg/ha when barley was grown alone (472 kg/ha) or when barley and peas were grown in the same row (272 kg/ha). Likewise for straw and biomass yields.
- Peas didn't respond to application of N @ 20 or 40 kg/ha.
- Grain yields from the two crops grown alone were 3,643 kg barley/ha at 40 kg N/ha and 3,200 kg peas/ha without any N application. *Thus growing peas could be economically more rewarding than barley!*
- Barley + peas grown in alternate/or the same row @ 20 kg N/ha produced similar combined grain yield (3,420/3,460 kg/ha). *Growing barley and pea together could save on N fertilizers and that too with a better (feed) quality grain production.*

*Nitrogen requirements of spring wheat as affected by previous crops in the rotation:*

- Pre seeding (spring wheat) nitrate N was in the order of alfalfa (25 ppm) ≥ soybean (24 ppm) > silage corn (22 ppm) > wheat (20 ppm) > barley (16 ppm).
- Spring wheat (*Sable*) didn't exhibit any significant response to application of N when grown after alfalfa/or silage corn. It appeared to need 40 kg N/ha when grown after soybean/or barley and 80 kg N/ha when grown after wheat.
- Grain yields after different crops, in the rotation, were not affected significantly (hot and dry weather at maturity?), though appeared to be higher after alfalfa, soybean and silage corn (~3,600 kg/ha) than after wheat (3,300 kg/ha)/or barley (3,440 kg/ha). Grain protein content was highest (19.4 %) after soybean and lowest after barley (17.5 %)
- Straw (5,400 kg/ha) and biomass yields (9,000 kg/ha) were highest when wheat was grown after silage corn.

*Comparative performance of urea and polymer coated urea (ESN) @ 40, 80 and 120 kg N/ha in spring wheat; urea broadcast at seeding and ESN drilled with the seed:*

- Application of N either as urea or ESN significantly increased the grain, straw and biomass yields as compared to the check (No N).
- Grain, straw and biomass yields and total N removal were similar with the two fertilizers. However, ESN resulted in 1.1 % point higher grain protein content as compared to urea.
- There was no significant difference between the rates of N application (40-120 kg/ha), especially between 80 and 120 kg N/ha in grain or straw yield; though the total biomass yield (~10,800 kg/ha) was highest with 80 kg N/ha.
- Each incremental rate of N application, from 0 to 120 kg/ha, improved the grain protein content from 14.8 % to 17.8 %.
- Post harvest residual nitrate, ammoniacal and total mineral N (0-90 cm) was higher with urea than with ESN. In fact ESN was no better than the check (No N) in this respect. Nitrate N in 60-90 cm soil with urea was 4 times more than that with ESN. *This only proves that ESN is environmentally safe!*

*Effect of nitrogen, fungicides and growth regulators on wheat:*

- Application of N @ 90-150 kg/ha didn't increase the grain, straw and biomass yields as compared to the check (No N).
- Fungicides or growth regulators (*Cycocel and Ethrel*) had no significant effect on grain, straw or biomass yields, though *Stratego + Proline* seemed to out yield other fungicide treatments.

*Effect of nitrogen, fungicides and growth regulators on barley:*

- Application of N @ 70 kg/ha improved the grain, straw and biomass yields. However, increasing N application rates above 70 kg N/ha, to 100/or 130 kg/ha, didn't increase the grain, straw and biomass yields further.
- Fungicides (*Stratego* + *Prosaro* and *Headline*)/or growth inhibitors (*Cycocel* and *Ethrel*) didn't significantly increase barley grain, straw or biomass yields.

*Effect of nitrogen, fungicides and growth regulators on oats:*

- Application of N @ 50 kg/ha significantly improved the grain, straw and biomass yields as compared to no N application. However, increasing rates of N from 50 to 80/or 110 kg N/ha didn't bring any additional yield advantage.
- Fungicides (*Headline*/or *Headline* + *Stratego*)/and growth regulators (*Cycocel* and *Ethrel*) sprays didn't help in increasing grain yields.

### **2.3 Winter Cereals Dates of Seeding, Forage and Grain, and Survival Management:**

*Winter Barley Seeding Dates:*

- Winter barley seeded on August 15, without cutting of tops for forage in fall, produced the highest grain (5,162 kg/ha), straw (3,230 kg/ha) and biomass (8,393 kg/ha) yields.
- However, effect of harvesting of tops for forage before snow fall couldn't be assessed properly, because the crop was trimmed by deer in the fall 2010.

*Winter Rye, Triticale, Wheat and Barley forage and grain production:*

- *CDC Falcon* (winter wheat) seeded on September 5 produced the highest forage dry matter (12,208 kg/ha) and grain yields (6,071 kg/ha); forage yields (10,100-10,400 kg/ha) from winter rye and triticale seeded on August 25 and *CDC Buteo* (winter wheat) seeded on September 5 were the second best. Forage yield from spring barley (*Cyane*) was 6,600 kg/ha. *Winter cereals could therefore be a better alternative to spring barley for forage production.*
- Grain yields (4,200-4,900 kg/ha) of winter triticale and rye didn't appear to be affected by seeding dates (August 25-September 25), equaled that with spring barley (~4,500 kg/ha), but were lower than that from *CDC Falcon* (winter wheat).
- Grain protein content at the same seeding date (September 5) was in the order of winter triticale (18 %) > rye (16 %) > wheat (15 %). Grain N removal was however highest in *CDC Falcon* (146 kg/ha).
- Triticale (*Luoma*) seeded on September 5 produced the highest straw (9,750 kg/ha) and biomass yields (14,100 kg/ha).
- Forage from winter barley had the maximum protein content (15 %), and varied from 5.3-10.2 % in winter rye (*Common # 1*) and 6.3-12.2 in winter triticale (*Luoma*). Forage protein content in winter wheat (*CDC Buteo*) was 7.8 % and that in spring barley (*Cyane*) was 11.8 %. *Overall, feed quality from winter barley appeared to be the best!*

### **2.4 Winter Wheat varieties:**

*Ontario Winter Wheat Varieties:*

- None of the Ontario winter wheat varieties (*Princeton*, *Stanford*, *Keldin* and *AC Morley*) gave as much grain yield as the western *CDC Falcon* (~5,800 kg/ha; 11.9 % protein).
- Only *AC Morley* equaled *CDC Falcon* in straw yield and *Stanford* in grain protein content. Total biomass yield (~14,600 kg/ha) was highest in *CDC Falcon*.

*Manitoba Winter Wheat Varieties:*

- Thirteen winter wheat varieties/biotypes were evaluated.
- DH00W31\*34 produced the highest grain (6,441 kg/ha; 13.9 % protein), straw (8,578 kg/ha) and biomass (15,019 kg/ha) yields.
- *Flourish* (4,935 kg/ha) that was promoted by seed dealers as a high yielding variety, didn't exceed *CDC Falcon* in grain yield (5,150 kg/ha). Grain yields (~5,500-5,800 kg/ha), but not the protein content, in *Peregrine*, *Broadview* and *Sunrise* were  $\geq$  to that from *CDC Falcon*.

## 2.5 Winter Wheat Nutrient Management:

*Effect of seeding dates, S and Mn on winter wheat (CDC Buteo):*

- Maximum grain (4,715 kg/ha) and biomass (11,983 kg/ha) yields were obtained with seeding on September 15, whereas straw yield (7,629 kg/ha) was highest with seeding on August 25. Though the two seeding dates didn't differ in grain protein content (~12.5 %).
- Application of S @ 24 kg/ha, as ammonium sulphate, increased grain, straw and biomass yields by over 600 kg/ha, 1000 kg/ha and 1,600 kg/ha, respectively, but not the grain protein content. Favourable effect of S was however missing in the seeding on August 25.
- Mn spray @ 2 kg/ha didn't prove to be beneficial.

*Split application of N (CDC Falcon):*

- All N fertilizer treatments (@ 120 kg N/ha) significantly improved grain yield and grain protein content as compared to the check (No N).
- Highest grain yield (6,211 kg/ha) was recorded with 10.25 kg N/ha applied as ammonium sulphate (AS) in the fall and 109.75 kg N/ha applied as urea in spring (sulphur advantage!). This was followed closely (~5,820 kg grains/ha) by application of urea @ 120 kg/ha; 10 or 30 kg N/ha applied in the fall and the rest in the spring.
- Straw (8,947 kg/ha) and biomass (15,159 kg/ha) yields were also highest with the application of AS (10.25 kg N/ha) in the fall and urea (109.75 kg N/ha) in spring.
- Grain yield (~5,500 kg/ha) from ESN @ 30 kg N/ha in the fall and urea @ 90 kg N/ha in spring was statistically at par with treatments listed in the previous bullet point.
- Grain protein content was 1.8-2.7 % point higher with N than without it. Application of ESN @ 30 kg N/ha and urea @ 90 kg N/ha in spring or urea @ 10 kg N/ha in fall and @ 110 kg N/ha in spring resulted in the highest grain protein content (15.8 %).
- Total post harvest mineral N in soil (0-90 cm) was highest (14-15 ppm) when all N as urea was applied in fall or when > 90 % of N was applied as urea in spring.

*Blends of N fertilizers (CDC Falcon):*

- Almost all N fertilizers (@ 120 N kg/ha) or their blends in different proportions significantly increased grain yield as compared to the check (No N).
- Highest grain (5,600 kg/ha), straw (9,395 kg/ha) and biomass (14,955 kg/ha) yields were obtained with urea @ 90 N kg/ha + ammonium sulphate @ 30 kg N/ha. The yield advantage here obviously comes from sulphur.
- Application of urea @ 90 N kg/ha + ESN @ 30 kg N/ha or urea @ 60 N kg/ha + ESN @ 30 kg N/ha + ammonium sulphate @ 30 kg N/ha equaled in grain yield (~5,100 kg/ha).
- Grain protein content (only 11.1 % without N) was highest with urea @ 120 kg N/ha (14.4 %)/or with urea @ 30 N kg/ha + ESN @ 90 kg N/ha (14.2 %).
- Post harvest soil analysis revealed that total mineral N in 60-90 cm soil with ESN @ 120 kg N/ha was only as much as in check; without N (5 ppm). This shows that there is no risk of leaching of N from ESN to deeper soil layers.

## 2.6 Spring Pulses – Variety Evaluation:

- Chickpeas grain yield: Corinne (Desi; 3,277 kg/ha with highest protein content of 20.1 %) and Frontier (Kabuli; 3,070 kg/ha) out yielded Vanguard (Desi) and Luna (Kabuli).
- Lentils: Rosetown produced the highest grain yield (3,721 kg/ha; 27 % protein content).
- Peas grain yield: CDC Patrick (5,156 kg/ha), Sorrento (5,025 kg/ha) and CDC Golden (4,956 kg/ha) were the top yielding varieties. Grain protein content (28.4 %) was the highest in CDC Tucker, which had a low grain yield (3,330 kg/ha).
- Edible beans: Grain yield ranged from 2,361 kg/ha in Winmore to 3,327 kg/ha in Earlired (23.5 % protein). Protein content was highest (25.6 %) in Pintoba (2,814 kg/ha).

*Pulses could be an integral part of the cropping systems in northwestern Ontario!!*

## 2.7 Winter Pulses (peas and lentils):

- Survival in winter peas varied from 30 % to 61 %; mean 41 %. Lack of pre/or post emergence herbicides at/after seeding resulted in tough weed competition and that could be the reason for low winter survival (and consequently for low grain yield) as well.

- In the variety evaluation trial, *PS03100848* produced the highest grain yield (3,256 kg/ha; ~1000 kg/ha higher than the standard varieties, *Specter* and *Windham*).
- In the experiment on seeding dates, grain yields from *Specter* (that could compete with weeds relatively better) and *Windham* seeded on August 25 were 3,576 kg/ha and 2,611 kg/ha, respectively.
- Survival in *winter lentils* was too low (0-9 %) to harvest and thresh the scant plants!

## 2.8 Soybean:

### Varieties:

- Soybean grain yields were too low (1,227-1,640 kg/ha; trial mean 1,410 kg/ha) to make any meaningful comparisons.

### Maximizing economic yield in soybean:

- Most economic treatment appeared to be recommended rates of P and K and seed treatment with *Vitaflow 280*. The treatment increased grain yield by ~550 kg/ha as compared to the check (recommended P and K only).

## 2.9 Oilseeds (Canola/Flax):

### Seed placement of P and sulphur (S) forms and rates in spring canola:

- Canola seed yield (3,212 kg/ha) obtained with seed placement of 20 kg P<sub>2</sub>O<sub>5</sub> + 9 kg S/ha from mono ammonium phosphate (MAP) and ammonium sulphate was as good as that from 40 kg P<sub>2</sub>O<sub>5</sub> from MAP/or coated MAP + 9 kg S/ha (3,229/3,313) from ammonium sulphate. *Coated MAP had no yield advantage over conventional MAP*.
- Rapid release sulphur or sulphur from Microessentials S15 was no better than sulphur from ammonium sulphate.
- Increasing the rate of S application from 9 to 18 kg S/ha didn't add to the seed yield.

### Preceding crops (canola, flax and wheat) yields (first year; direct effect):

- Grain/or seed yields were in the order of *wheat* (3,581 kg/ha) > *canola* (2,885 kg/ha) > *flax* (2,513 kg/ha).
- *Canola* produced the highest straw (7,200 kg/ha) and biomass (10,100 kg/ha) yields.

### Effect of preceding crops (canola, flax and wheat) on N and S response to canola (2<sup>nd</sup> year):

- Canola seed yields after canola were the lowest (~2,400 kg/ha); ~3,000 kg/ha after flax and 2,850 kg/ha after spring wheat.
- Application of N without S didn't increase canola seed yield; it had a rather depressing effect on the seed yield at rates higher than 50 kg N/ha (without S).
- Application of S @ 15 or 30 kg/ha improved canola response to N, which appeared to decline above 100 kg N/ha. N @ 100 kg/ha + 15 kg S/ha almost doubled the canola seed yield (3,543 kg/ha) as compared to 100 kg N/ha without S (1,800 kg/ha).
- Increasing rate of S application from 15 to 30 kg/ha increased the canola seed yield significantly only when canola was grown after canola!

### Winter canola:

- Seed yield from *Kronos* was ~1,800 kg/ha and that from *California* ~800 kg/ha.

### Camelina Varieties:

- Three high yielding varieties were *Calena*, *Blaine Creek* and *10CS00046* (seed yield in *Calena* was ~1,040 kg/ha). The crop was over mature at harvesting (seed shedding?).

## 2.9 Forages:

### 2.9.1 Grasses Varieties:

#### OFCC 2010 (Late Timothy; one cut only):

- Highest dry matter yield (2,770 kg/ha) was recorded with *BOR 88060* followed by *Mariposa* (2,293 kg/ha). The yield in other 7 varieties ranged from 1,244-1,929 kg/ha.

### 2.9.2 Grasses Nutrition:

*Urea and ammonium sulphate blends in timothy (only one cut could be taken):*

- Application of 105 kg N/ha, as urea or ammonium sulphate or as blends of the two fertilizers significantly improved dry matter yield of timothy and its protein content. The best treatment considering the yield (4,657 kg/ha), protein content (11.2) and cost of N was application of 21 kg N/ha from ammonium sulphate and 84 kg N/ha from urea.
- Ammonium sulphate (4,570 kg/ha) and urea (4,457 kg/ha), when used alone, @ 105 kg N/ha, produced similar yields to the best blend of the two fertilizers, though protein content was higher with ammonium sulphate (13.5 %) than that with urea (9.7 %).
- N removal by timothy was highest with ammonium sulphate (99 kg/ha); 30 kg/ha higher than urea alone and 15 kg/ha higher than the best blend of the two fertilizers.
- *N use efficiency from urea was only ~66 % as compared to 94 % from ammonium sulphate and 80 % from the best blend of the two fertilizers.*

*Fall vs. spring application of N to grasses (timothy and bromegrass):*

- Application of N significantly increased dry matter yield of bromegrass and timothy, which equaled in dry matter yield (~5,300 kg/ha) from the two cuts. However, first cut yield was higher in timothy and the second cut yield was higher in bromegrass.
- Protein content was higher in timothy than in bromegrass, especially in the second cut.
- Single application of ESN @ 105 kg N/ha on September 25 gave as much dry matter yield as two applications of urea @ 70 kg N/ha on September 25/or in early spring and 35 kg N/ha after the first cut! *Protein content with fall applied ESN was 2 % point higher than that with spring/and summer applied urea in both the grasses!*
- Soil mineral N content in early spring was higher in timothy plots than in bromegrass plots and also higher with urea than with ESN (relatively colder spring in 2011!).

*Application of entire N to perennial forage grasses from ESN in the fall could therefore save one operation and widen the window of N application with extra protein content as a bonus!*

### 2.9.3 Silage Corn – ESN, Urea and their Blends (all @ 150 kg N/ha):

- Dry matter yield of corn for silage was lower with ESN/or its blends with urea than with urea alone (too cold spring to release enough N from ESN?).
- Compared to the entire N applied as urea, application of 25 % N from ESN and 75 % N from urea improved protein content by 0.7 % point without compromising on the relative feed value.

### 2.9.4 Alfalfa and Clover Varieties:

- *In OFCC 2010 Alfalfa trial* (2 cuts), *SF 2101* (5,992 kg/ha), *Starbuck* (5,806 kg/ha) and *CLF 1001* (5,682 kg/ha) were the three top (high) yielding varieties.
- *In OFCC 2009 trial*, alfalfa dry matter yield from the two cuts was highest with *4S417* (6,266 kg/ha), *OAC Superior* (6,144 kg/ha) and *Starbuck* (6,047 kg/ha). Dry matter yield from *CW 24207/or 54Q32* was statistically at par with the aforesaid 3 varieties.
- In an experiment on *cutting management* in 32 alfalfa varieties, *134* (6,257 kg/ha), *WL319 HQ* (6,228 kg/ha) and *Magnum* (6,203 kg/ha), were the best varieties for two cuts. For three cuts, *WL319 HQ* (6,440 kg/ha) *Survivor* (6,424 kg/ha), *Forecast/OAC Superior* (6,421 kg/ha) were the best.
- *WL319 HQ* was good for both two and three cut management!

### Red Clover Varieties:

- *Wild Cat* (2,407 kg/ha) was better than *Tempus* (1,840 kg/ha) in dry matter yield.

### White Clover Varieties (with orchardgrass):

- Five varieties tested didn't differ significantly with each other in dry matter yield. Though the three top (high) yielding varieties were *Companion* (6,580 kg/ha), *Alice* (6,416 kg/ha) and *Osceola* (6,352 kg/ha).

### 2.9.5 Alfalfa Nutrition:

**N x S:** Supplement sulphur (S) in this experiment in the urea treatments was applied as elemental S; two-third of the total S (equivalent to the amounts supplied by different rates of ammonium sulphate) in the seeding year and one-third in the first harvest year. No N or S was applied in 2011. *Results this year are the residual effect of the nutrients applied during spring 2007-'10.*

- Averaged over 20-60 kg N/ha, alfalfa dry matter yields from urea supplemented with elemental S (4,808 kg/ha) were  $\geq$  yields from ammonium sulphate (4,563 kg/ha). Similar trend was observed in the first cut protein content (~22 %).
- Urea alone (without S) had no favourable residual effect on the dry matter yield of alfalfa though it improved the first cut protein content by 1-2 % point.
- The four year (2008-'11) total yields indicated that increasing rates of N, above 20 kg N/ha, in ammonium sulphate/or urea + S treatments didn't bring any significant improvement in yield.
- Averaged over different rates of N, residual soil S after 3 harvest years was in the order of ammonium sulphate (12.7 ppm) > urea + S (11.7 ppm) > urea/or check (~10 ppm).

**P:** OMAFRA recommendation on P application to alfalfa was compared with P application at 50, 100 and 150% of P removal at 8 tonnes dry matter yield/ha and a check (No P). *This year's results are residual effects of P applied during fall 2007-2009.*

- Highest dry matter yield of alfalfa (4,975 kg/ha; 23 % protein and 155 relative feed value in the first cut) was obtained with application of P @ 50 % of P removal at 8 t/ha yield. The treatment also resulted in the highest relative feed value (160) in the second cut, but lowered the soil P test by 1 ppm.
- Applying P as per OMAFRA recommendations had no favourable residual effect on the alfalfa yield and brought down the soil P test by 5 ppm as compared to the check (no P).
- Total 4 years (2008-'11) yields were not affected by the P treatments.
- P application improved only first cut protein content by 2-4 %.
- Application of P @ 100 or 150 % of P removal at 8 t/ha yield resulted in buildup of soil P to 23 and 38 ppm (from an initial P test of 16 ppm).

**K:** OMAFRA recommendation on K application to alfalfa was compared with K application at 50, 100 and 150% of K removal at 8 tonnes dry matter yield/ha and a check (No K). *This year's results are residual effects of K applied during fall 2007-2009.*

- None of the treatments showed any significant residual effect to increase dry matter yield of alfalfa. All K, required for 3 years, applied in the first year resulted in the lowest yield. Same was true for 4 years (2008-'11) total yield though K application as per OMAFRA recommendations/or @ 50 % K removal at 8 t/ha yield seemed to improve alfalfa yields.
- None of the treatments improved first cut protein content; relative feed value was highest with K applied @ 50 % K removal (at 8 t/ha yield). This treatment registered highest 2<sup>nd</sup> cut protein content (26 %) and second best relative feed value (151).
- Surprisingly, none of the treatments, not even check (no K), depleted the soil K. Highest soil K (298 ppm), after 3 harvest years in fall 2010, was recorded with K applied @ 150 % K removal at 8 t/ha yield.
- K applied at 50 % K removal at 8 t/ha yield, left sufficient K in the soil (160 ppm); almost double than the pre-seeding soil K (81 ppm) and 72 % higher than the check. Application of K @ 50 % K removal at 8 t/ha yield may therefore be recommended.

### 2.9.6 Berseem clover, oats and teff:

- *Spring 2011 was too cold for teff to emerge and grow!*
- Averaged over berseem and oats treatments forage dry matter yields from the two seeding dates (May 10 and May 20) were almost the same (>7,000 kg/ha).
- Highest dry matter yield (~9,300 kg/ha) was obtained with mixed seeding of berseem (full seed rate) and oats (70 % of recommended seed rate). Seeding this mixture on May 10 improved the forage dry matter yield by 3,030 kg/ha as compared to oats alone and 4,311 kg/ha as compared to berseem alone.

- First cut protein content in berseem was 19 % in May 10 seeding and 25 % in May 20 seeding. Corresponding values for protein content in oats for the two seedings were 7 % and 10 %, respectively. Mixed cultivation of berseem and oats improved the protein content by 2-3 % points only in May 10 seeding.

### 2.9.7 Comparative Performance of Annual and Perennial Forage Legumes:

- Highest dry matter yield (> 5,100 kg/ha) was recorded in *berseem clover* @ 13 kg seed/ha followed by *galega* @ 35 kg seed/ha + *berseem* @ 13 kg seed/ha (> 4,600 kg/ha).
- *Alfalfa* + *berseem*, in alternate rows, both at 50 % of the recommended seed rates, didn't yield too well (3,500 kg/ha).
- Dry matter yield from *fenugreek* @ 15-45 kg seed/ha (18-21 % protein content), harvested at pod formation stage ranged from 1,520-1,770 kg/ha and from 2,730-3,500 kg/ha (12-14 % protein content) when harvested at senescence (green pod maturity).
- First cut protein content in *galega* + *berseem* (20 %) was 3-4 % point higher than that in *berseem* (17 %) and *alfalfa* + *berseem* (16 %). Second cut protein content ranged from 22 % in *galega* + *berseem* (35+6.5 kg/ha) to 25 % in *alfalfa* + *berseem* in alternate rows.

### 2.9.8 Forage Cereals:

#### *Alternate forages:*

- Spring cereals, corn, barley + peas and spring barley + winter wheat, winter wheat and winter rye (all seeded in spring) were compared for their relative forage yield.
- Dry matter yield from corn for silage (19,460 kg/ha) was more than thrice than that from the spring cereals (~6,000 kg/ha).
- Winter cereals (rye and wheat) harvested in the seeding year had low yields (~3,000 kg/ha), but high protein forage (24-25 % as compared to 14-15 % in spring cereals and 10 % in corn). Forage yields/or protein content in winter cereals harvested second time in the next year was as good as that in spring cereals.
- Forage from barley + peas had 20 % protein content (as good as normally in alfalfa) and its relative feed value was the highest (159 ≥ to corn).
- Grain yields from *Triactor*/or *AC Jordon* oats (~5,700 kg/ha) were higher than that from other cereals.

#### *Residual effect of N fertilizers applied to winter wheat (2009-'10) @ 120 kg N/ha on forage oats (no N was applied to oats):*

- Oats benefitted from the N fertilizers applied to the previous winter wheat crop as indicated by the dry matter yields. However, only a couple of treatments reached the level of significance; urea @ 30 kg N/ha + ESN @ 90 kg N/ha and urea @ 90 kg N/ha + ESN and ammonium sulphate each @ 15 kg N/ha. Dry matter yields from these treatments were 4,715 kg/ha and 4,458 kg/ha; as compared to 3,552 kg/ha in the check (No N).
- Residual effect from treatments with ammonium sulphate @ 90 kg N/ha or higher was the least, if any (too much S suppressing crop growth/yield?)

#### *Residual effect of urea, ESN and blends of the two N fertilizers applied @ 150 kg N/ha to silage corn (2010) on forage oats (N @ 0, 35, 70 & 105 kg/ha was applied to oats):*

- ESN and urea equaled in their residual effects on dry matter yield of oats (~5,350 kg/ha); the yield with the blends of the two fertilizers was no better than that from urea/or ESN.
- Application of N to oats significantly improved its dry matter yield, though there was no additional yield gain by increasing the rate of N application above 35 kg/ha. Urea, ESN or their blends applied to corn before oats didn't affect direct response of N to oats.
- Substituting 50-75 % of N from urea with ESN in corn for silage improved the protein content of the succeeding forage oats in rotation by 0.6-0.9 % points. N @ 35-105 kg N/ha increased protein contents in forage oats, as a direct effect, by 0.4-0.6 % point only.

### 2.10 Bio Energy Crops:

#### *Switchgrass vs. Other Grasses for Biomass Production:*

- Temperate forage grasses (tall fescue, orchardgrass, timothy, reed canarygrass and brome grass) were compared with switchgrass for biomass/bio energy production.

- Biomass yields on dry weight basis were higher with spring harvesting than the fall harvesting (after a killing frost). Harvesting in spring helped to increase the calorific value (heat energy) by 16 % and lower the ash content by 0.8 % point.
- Averaged over two harvest times, brome grass produced much higher biomass yield and heat energy than switchgrass. However, in the spring harvest, switchgrass almost equaled brome grass in biomass yields, heat energy and ash contents.
- The ash contents in brome grass (4 %) and switchgrass (3.7 %) were the lowest and heat energy the highest (~130 Gigajoules/ha in both) amongst the various grass species, which is a desirable trait for bio energy production.

#### *Switch Grass Varieties:*

- *Nebraska* produced the highest dry matter yield (4,581 kg/ha) and heat energy (calorific value ~80 Gigajoules/ha) amongst 5 switch grass varieties.
- Ash content was lowest in *Cave in Rock* (5.43 %) that had the highest bio energy per unit biomass (18.3 Gigajoules/t)!

#### *Miscanthus:*

- There was hardly any growth in the surviving plants from last year.

#### *Comparative heat (calorific) value and ash content in the winter and spring cereals straw, and biomass from switchgrass and forage grasses:*

- Spring triticale (*Bumper*) produced the highest heat energy (169 Gigajoules/ha) followed by winter wheat (*CDC Falcon*; 154 Gigajoules/ha) and winter triticale (*Luoma*; 150 Gigajoules/ha).
- Ash content was lower in winter cereals (5.9-6.2 %) than in spring triticale (8.7 %).
- Spring harvested switchgrass (*Sunburst*)/or brome grass (*Fleet*) had the lowest ash content (3.74/4.01 %) and next best heat energy yields (127/132 Gigajoules/ha).

## **2.11 Long Term Experiments:**

### **2.11.1 Lime and Wood ash (soybean after 3 harvest years of alfalfa-3 years barley):**

- Lime/and wood ash were applied in spring 2004 (seeding year) and in fall 2006, 2008 and 2010 in the 'after every two years' frequency of application treatments. In fall 2008, wood ash/and lime were applied in the 'after every four years' frequency of application treatments as well. Treatments with lime/and wood ash 'after every six years' received first application of the amendments in fall 2010. Soybean was the test crop in 2011.
- Effect of wood ash/and lime application after every four years appeared to be fading away. Maximum grain yields (1,754 kg/ha) were recorded in the lime/and wood ash treatments with 'after 6 years frequency' (first harvest after application of the amendments in this treatment); not significantly higher than the grain yield in check.
- Main effects of lime, wood ash/or lime + wood ash on soybean grain yield and grain protein content were not significant; as compared to the check (no lime/wood ash).
- Mid season soil analysis indicated that both lime and wood ash brought the soil pH to neutral; availability of P, K, Zn and Mn was more with wood ash than that with lime. Reverse was true for soil Ca.

### **2.11.2 Manure, wood ash and fertilizer nutrients (4 years alfalfa-3 years barley-soybean):**

- Solid dairy manure was applied in the springs of 2004 and 2007, and falls 2008 and 2010; wood ash was applied in spring 2004 and in falls of 2006, 2008 and 2010, whereas fertilizer nutrients were applied every year.
- Both manure and wood ash significantly increased soybean grain yield. However, manure resulted in the maximum increase (505 kg/ha) in grain yield as compared to the check (no manure or wood ash).
- Application of N, P, K and S didn't bring any yield improvement.
- Manure, wood ash and fertilizer nutrients didn't improve soybean grain protein content.

- Mid season soil tests (2011) revealed that the availability of P, K, S and Na was more with manure than with wood ash. The reverse was true for soil pH, organic matter (1.3 % point higher than the check!) and availability of Ca, Mn and B.
- Application of fertilizer nutrients (N, P, K and S) didn't help in building up soil fertility.

### 2.11.3 Efficient Cropping Systems:

- An experiment with 10 potential cropping systems, including forage and grain legumes, other forages and cereals, spread over 10 years, was initiated during 2004 with alfalfa as the first crop. Alfalfa crop cycle ended in 2007 and it followed different crops thereafter.
- Oats grain yields (5,233 kg/ha) after barley were higher than wheat (3,311 kg/ha) after barley; or barley (3,671 kg/ha) after Italian ryegrass.
- Straw (5,366 kg/ha) and biomass (10,599 kg/ha) yields were also highest with oats.
- Soybean grain yields (2,118) were higher after silage corn than after spring cereals (1,748-1,881 kg/ha) and lowest after Italian ryegrass (1,578 kg/ha).
- Total N removal (grain + straw) by soybean after corn and oats/or wheat after barley were similar (154-158 kg/ha). Total P removal by cereals was almost double than P removal by soybean. Total K removal by wheat was twice as much and by oats thrice as much as by soybean.
- Cereals removed much more copper, zinc, manganese and iron than did soybean; reverse was true for boron. This means soybean needed more boron than cereals.

### 2.11.4 Alfalfa Persistence/Maximum Yield (seeded in 2005):

- Application of N, P, K and S resulted in 4,330 kg dry matter yield/ha in the 6<sup>th</sup> harvest year; 1,670 kg/ha than the check (OMAFRA recommended application of P and K only). Addition of B with N, P, K and S gave an additional yield benefit of 434 kg/ha.
- Application of Zn/and Mn and solid dairy manure/or wood ash in addition to the aforesaid fertilizer nutrients didn't give any additional yield benefit (Solid dairy manure @ 50 t/ha and wood ash @ 10 t/ha were applied in the fall 2010).
- Amongst nutrients treatments, first cut protein content was the highest (23 %; 3 % points higher than the check) with NPKSB and was raised to 25 % when wood ash was also applied in addition to nutrients. S containing nutrient treatments increased the second cut protein content by 3-6 % points as compared to the check. Manure/and wood ash further improved the second cut protein content by 1-2 % points.
- *Sulphur and B application appear to be critical for longer term persistence of alfalfa!*

### 2.11.5 Forest Tree Research:

- Experiments to optimize afforestation of fast growing conifer tree species (Norway Spruce, White Spruce, Red Pine and European Larch) were initiated during spring 2005.
- Since the trees growth rate is too small, it was decided to record growth observations after every 2-3 years. No data were therefore recorded this year.

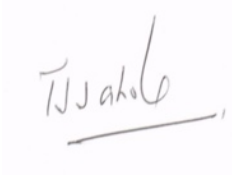
### 2.12: Medicinal Plants:

- Dry matter yield of *spearmint* was highest (4,460 kg/ha) with planting at 30 cm x 30 cm spacing; other spacings tried were 45 cm x 20 cm and 60 cm x 15 cm. Area/plant in all these spacings was the same. Spearmint was grown for a private company and it had acceptable levels of the required active constituent (data not reported for sake of confidentiality).

### 2.13: Wild Blueberries:

- Wild blueberry plants, collected from different places, were planted at TBARS in the fall 2010. Fruit maturity in the ones collected from Black Sturgeon Lake (both *V. augustifolium* and *V. myrtilloides*) was about a week late as compared to the ones from Escape Lake and Nipigon.

- Fresh fruit yield varied from 50-398 kg/ha (5-39 g/plant) with a mean value of 150 kg/ha (15 g/plant).

A handwritten signature in black ink, appearing to read 'T. Sahota', is written on a light pink rectangular background. The signature is written in a cursive style and is underlined with a single horizontal line.

**Dr. Tarlok Singh Sahota CCA**  
**Director of Research and Business**

**December 7, 2011**