TAURUS

OSTARA
CrystalGreen®

NEW
CANOLA RESEARCH

Taurus Ag and New Era Ag Research proves Crystal Green® improves phosphate uptake for higher yields.

NEW ERA AG
TECHNOLOGIES

CANOLA TRIAL PROTOCOL

OBJECTIVE: To evaluate the yield effect of CRYSTAL GREEN in 3 ratios with mono-ammonium phosphate and to determine the weight of product and available phosphorus remaining after harvest.

VARIETY: L140P

SEEDING DATE: MAY 22

SEEDING DEPTH: 0.75 IN

SEEDING RATE: 5LBS/ACRE

SOIL P*: 7-10 PPM

PLOT SIZE: 8X32

ROW SPACING: 10IN

 # OF ROWS: 8

 # OF REPS: 4

SOIL P1*: 9-18 PPM

SOIL MOISTURE, TEMP: DRY & WARM

IN-SEASON RAINFALL: 170MM

HARVEST DATE: SEPT 28

TIMING: PRIOR TO HERBICIDE

SOIL pH*: 8-8.2 **SPRING SOIL TEST 2018*

TRT#	TREATMENT	RATE
1	GROWER STANDARD MAP	19.3-58-5-8 ACTUAL
2	PHYSICAL BLEND 25% CRYSTAL GREEN 75% MAP	19.3-58-5-8 ACTUAL
3	15:85 AGGREGATED PRILL	19.3-58-5-8 ACTUAL
4	25:75 AGGREGATED PRILL	19.3-58-5-8 ACTUAL

FERTILITY - FERTILIZED BASED ON SOIL TEST FOR 60BU YIELD • SIDE BAND BLEND: 19.3-58-5-8 ACTUAL • BROADCAST ON ALL TREATMENTS 125-0-35-25 (ACTUAL) • ALL TREATMENTS RECEIVED THE SAME LEVEL (LBS/AC) OF ACTUAL P BASED ON PRODUCT ANALYSIS.

RATINGS

1: STAND COUNT - 2 X HOOP COUNTS = PLANTS PER 0.25M^2

2: EARLY SEASON VIGOR, 1-9 SCALE

3: YIELD MEASUREMENTS (WEIGHING, CLEANING, MOISTURE TESTING)

4 SOIL COLLECTION AND ANALYSIS (2 TREATMENTS X 4 REPS) EXCAVATE 2 1FT ROW SECTIONS FROM TREATMENT 2 AND TREATMENT 4 IN ALL REPS TO THE DEPTH OF THE FERTILIZER BAND; SOIL SAMPLE 0-6' IN ROW, 10 COMPOSITE WELLS PER PLOT.

RESEARCH FINDINGS

77% of CRYSTAL GREEN was used by the plant.

	A	B	C	D	E	F	G
	EST. AMT APPLIED / FT ROW (G)	VISUALLY IDENTIFIED CG/AP (G)	UNIDENTIFIABLE SAMPLES WITH A +'V REACTION WITH CITRIC ACID (G)	VISUALLY SEPARATED PARTICLES ID'D AS "OTHER SOIL PARTICLES" (G)	"OTHER SOIL PARTICLES" WITH +'V REACTION WITH CITRIC ACID (G)	TOTAL CG/AP RECOVERED (G)	% OF PRODUCT RECOVERED
TREATMENT	CALCULATED	MEASURED	MEASURED	MEASURED	CALCULATED	VISUALLY ID'D + UNIDENTIFIABLE	TOTAL RECOVERED/EST. AMT APPLIEDX100%
2- CRYSTAL GREEN *PLOT 103*	0.52	0.21		1.13	0.92	0.21	20.2%
2- CRYSTAL GREEN *PLOT 203*	0.52	0.25		0.66	0.31	0.25	24.0%
2- CRYSTAL GREEN *PLOT 304*	0.52	0.27		1.26	0.58	0.27	26.0%
4- 25:75 AGGREGATED PRILL *PLOT 104*	1.313	0.12	0.40	0.57	0.19	0.52	19.8%
4- 25:75 AGGREGATED PRILL *PLOT 201*	1.313	0.17	0.60	0.42	0.12	0.77	29.3%
4- 25:75 AGGREGATED PRILL *PLOT 302*	1.313	0.13	0.43	0.49	0.11	0.56	21.3%
4- 25:75 AGGREGATED PRILL *PLOT 401*	1.313	0.06	0.16	0.4	0.18	0.22	8.4%

TABLE 4

TAURUS

RESEARCH REPORT

MATERIALS AND METHOD

Fertilizer blends were created to normalize NPKS across treatments so all treatments received the same actual nutrient levels regardless of source. Individual fertilizer blends were weighed by hand on a calibrated scale and mixed in a tumbler. Plots were seeded by treatment according to the randomized complete block design. At plot 402 the GPS sensor malfunctioned and the seed applicator wheel did not apply the correct seeding rate.
This plot has been removed from all analysis but was left in the field to fill in and can be seen in the aerial photos.

Conditions were dry at seeding but early spring rains on May 24th hastened germination and emergence of the seedlings. Early season weed pressure was greater than ideal due to a poor pre-burn down pass. Several clethodim applications were made along with a Liberty application.

Plant stand counts were done using a 0.25m^2 hoop in the early season. A vigor rating was done prior to flowering. Combining was completed on September 28th with a Hege 140 plot combine. Grain moisture average 11% at harvest. Samples were stored in a cool dry environment until weighing and moisture testing could be carried out. A post harvest soil test was conducted by plot. The samples were taken within the stubble row in an effort to detect residual P levels which were all applied in a sideband blend. The phosphorus was measured by the weak Bray method, the Mehlich test and the sodium bicarbonate test.

Soil samples from two locations in plots 103, 104, 201, 203, 302, 304 and 401 were excavated as outlined in Figure 4 (Soil Sampling). These samples were dried until processing. To clean the samples and retrieve the product, soil was crumbled by hand then soaked in water 1 L at a time to create a slurry. This was washed through a 1mm sieve. Large particles and plant material were removed by hand and the remaining potential granules of the approximate size of the Crystal Green (CG) and Aggregated Prill (AP) products and smaller were set aside in petri dishes using tweezers (Figure 5). Each samples of granules was visually separated with the naked eye then further separated with a microscope and diagnostic test with citric acid (Figure 6). Factors considered during identification to distinguish from natural soil particles included: color, luster, cleavage and effervescence.

The samples that were culled from the whole sample were kept separate but also treated with citric acid to determine their composition. Each plot contained three samples which included; 1 - the most likely CG/AP products as identified under the microscope 2- granules that could not be identified with certainty as CG/AP but dissolved in citric acid and 3-granules that were visually unlike CG/AP. Each of these were placed in a solution of citric acid and water for 2 hours then dried and any remaining samples were weighed (Table 4).

RESEARCH REPORT

RESULTS AND DISCUSSION

Treatment 2 contained the physical blend of MAP and Crystal Green (CG) and showed a significantly higher plant stand than either the check or treatment 3. The Yates method was used to calculate the missing data for plot 402 so the average is based on 3 plot measurements and an estimation. Plant stand numbers show that Crystal Green and the aggregated prill product are of equal seed safety or better than compared to the grower standard MAP when placed in a side band.

Vigor ratings were not significantly different among treatments during the early season. Vigor was based on plant size, canopy cover, leaf color and plant stage.

The average yield for the trial was 67.52 bu/ac . All treatments containing Crystal Green yielded higher than the grower standard fertilizer blend. Treatments 3 and 4 that contained the aggregated prills were significantly higher yielding than the grower standard ($p<0.05$) by 4.3 and 4.7bu/ac respectively. The variability in the trial was low (CV 3.14) indicating the yield data is reliable.

Three methods of measuring soil P were conducted. Of these three tests the sodium bicarbonate test is the most suitable for the soil pH of the samples. Treatments containing CG/AP had higher post harvest soil P levels (BiCarb method) compared to the grower standard treatments. This increase ranged from 0.5ppm (1lb/ac) to 3ppm (6 lbs/ac). There was a high level of variability in these results (CV 19.75) therefore the differences were not significant at a 95% confidence level.

Although all P test results were correlated to one another only the BiCarb test was independent (prob r2 =0.29) of soil pH. Correlation analysis also shows that yield was significantly correlated to all Phosphorus levels at p=0.1. This indicates that higher levels of available phosphorus in the soil may have been a contributing factor to increased yields.

KEY FINDINGS

In all plots the particles identified as CG/AP dissolved completely as did the samples from treatment 4 that were unidentifiable as CG/AP (Table 4 - Research Findings, Column C). A portion of the visually distinct particles or "other soil particles" also dissolved (Table 4 - Research Findings, Column E). It is believed that this was the portion of the natural soil particles made of carbonate material such as limestone . The total CG/AP recovered accounts for an average of 23.4% of the applied Crystal Green and an average of 19.6% of the aggregated prill. **If an average of 23.4% of CG was still in the soil post-harvest, then 76.6% was dissolved into solution/made plant-available.** A negative control was overlooked in the design of this experiment. Plans are in place to excavate soil samples in the trial area early in the spring prior to plant growth. These samples will follow the same procedures as described in Figure 4 and 5. This will give a base amount of natural carbonate material in the top soil for the trial area to further support the data presented in this report.

Further work on phosphorus deficient soils where treatments are designed to build soil P levels would be valuable in assessing the long term availability of Crystal Green and the aggregated prill products in high pH soils. Further exploration of methods to accurately apply and recover fertilizer products on a larger scale with more efficiency is required.

SOIL SAMPLING

FIGURE 4

1) A 1 METER ROW SECTION WAS CHOSEN

2) DEBRIS WAS CLEARED FROM THE SOIL SURFACE

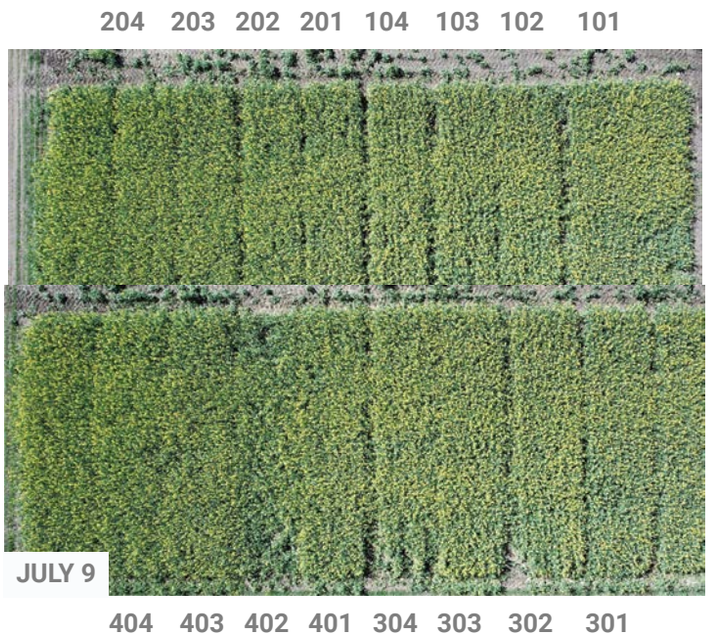
3) STUBBLE WAS REMOVED FROM THE AREA

4) SOIL WAS REMOVED 12 INCHES LONG, 6 INCHES DEEP AND 6 INCHES WIDE

5) STUBBLE WAS STORED IN A PAIL UNTIL PROCESSING

FIELD & CLEANING PHOTOS

NUMBERED PLOTS & FIGURE 5



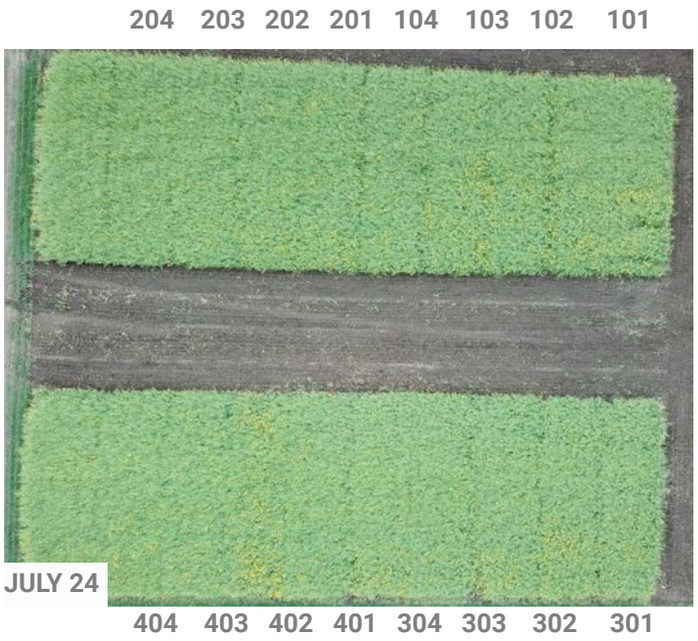
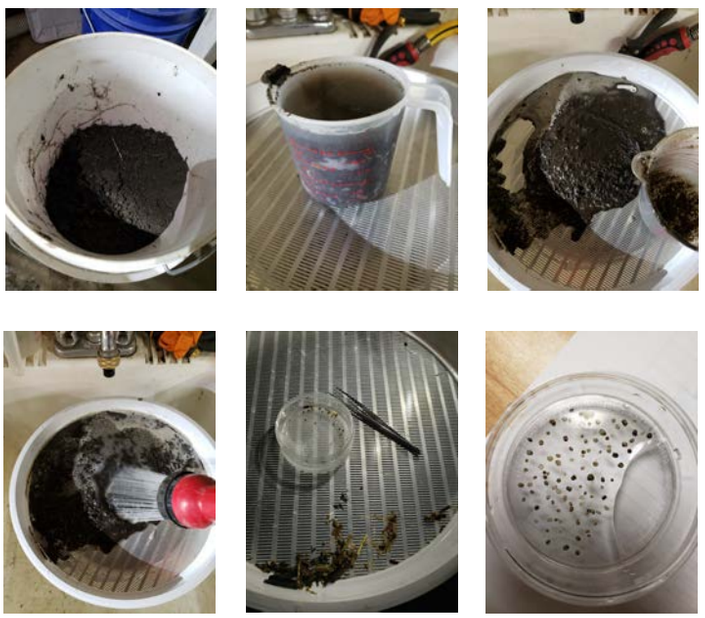


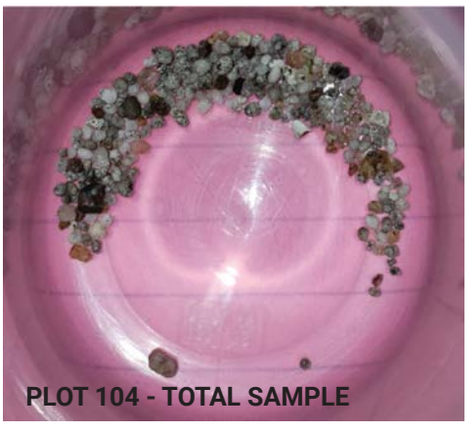
FIGURE 5 - CLEANING PROCESS

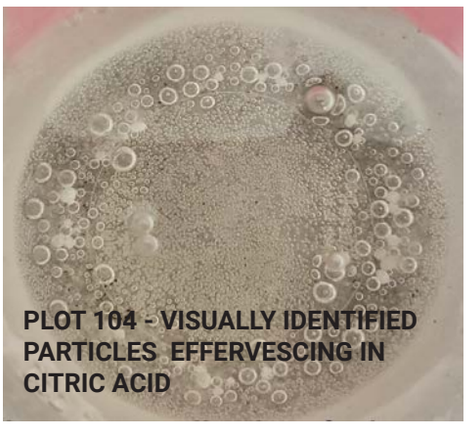


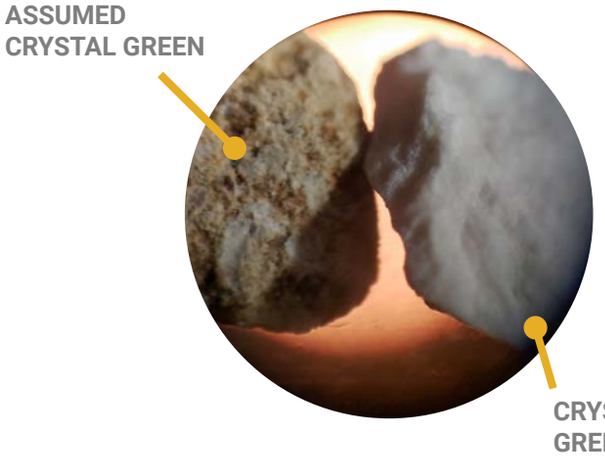
SOLUBILITY TESTING

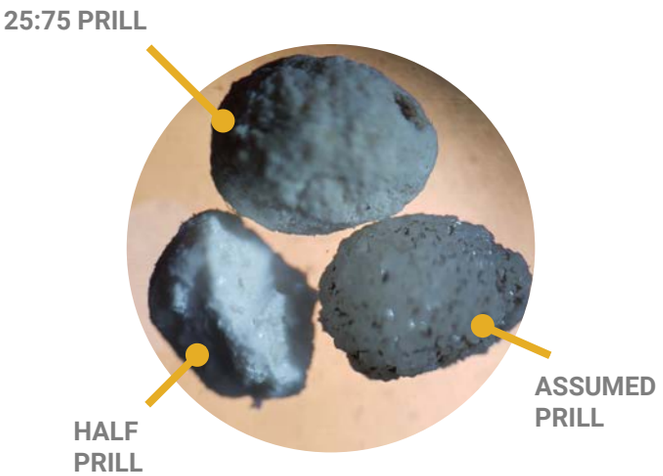
FIGURE 6

ALL FERTILIZERS IN THE BLEND WERE TESTED FOR THEIR SOLUBILITY IN WATER









THE SUCCESS BEHIND THE **SOLUBILITY**

How it Works: Season Long Plant-Availability

Phosphorus is essential to all life. It is the foundation for high quality yields, but it isn't always available in the soil when plants need it. Until now.

Crystal Green is the future of phosphorus. Crystal Green's nutrients don't tie-up in the soil, or run-off, their release is triggered by the organic acids produced by growing roots, supplying nutrients on-demand. The difference of improved efficiency is increased yields and reduced nutrient loss.

Crystal Green Remains Plant-Available vs. MAP and DAP

Crystal Green

4% Water Soluble
96% Citrate Soluble

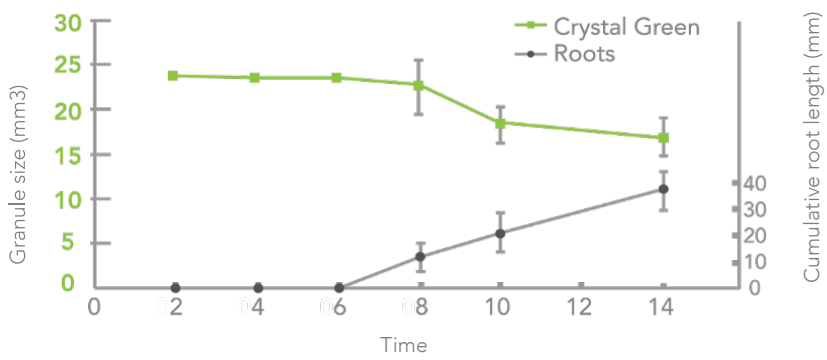
MAP

90% Water Soluble
10% Citrate Soluble

DAP

93% Water Soluble
7% Citrate Soluble

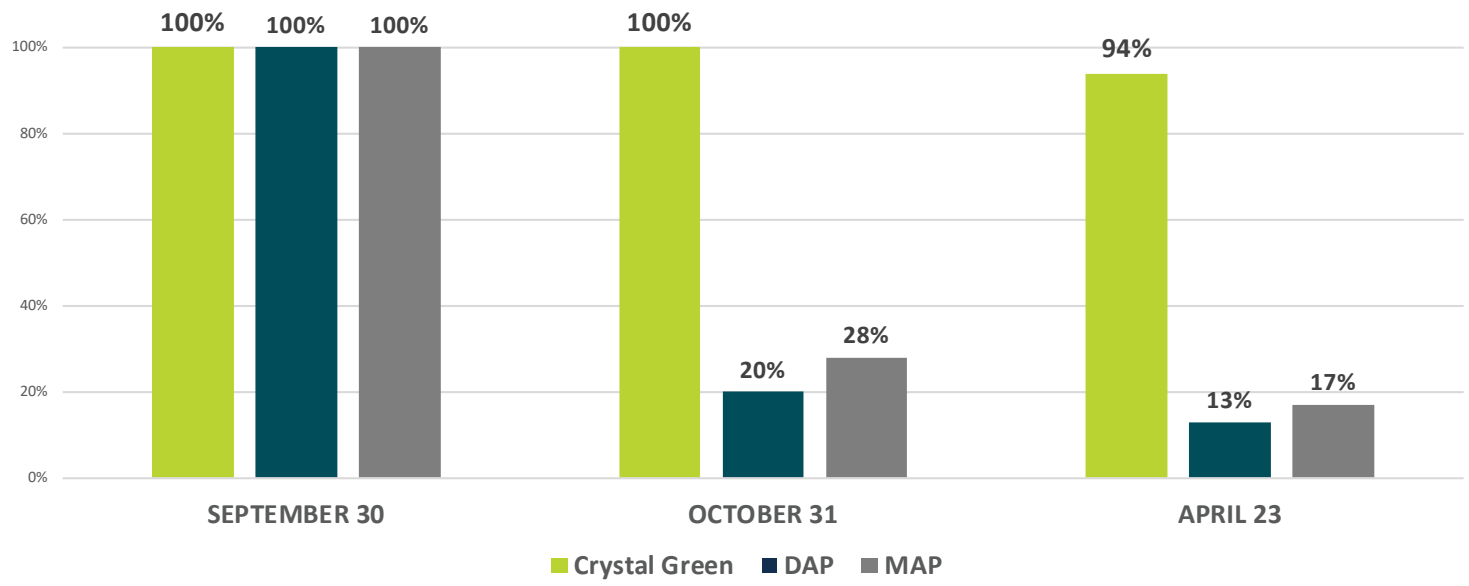
Interaction of Growing Roots and Crystal Green Release



Crystal Green Release is Key to Root Growth

Source: "Imaging the interaction of roots and phosphate fertilizer granules using 4D X-Ray tomography". Ahmed et al., Plant Soil (Springer International Publishing, Switzerland,2014) 401:125-134

94% Remains Plant-Available Even After Fall Fertilization



North Dakota State University, Dr. Joel Ransom, 2017-18

Improved Seed Safety

It's a proven fact that the salt index of traditional phosphorus sources, such as MAP and others, cause injury to crops when placed near the seed. This seedling injury reduces stand count and yield. In contrast, Crystal Green's salt index is extremely low, only one quarter of that which is found in MAP or DAP. This reduced salt index increases seed safety by reducing salt injury, resulting in an increase in stand count and ultimately, yield.

Low Salt Protects Seeds and Roots, Improving Stand Count.

Photo Credit: Mike Dolinski, Canola root feeding from a Crystal Green granule

	DAP	MAP	S15	Crystal Green®
Salt Index*	29	27	21	7.7

*Salt Index is based on the Jackson Method, current standard for North American fertilizers.

TAURUS
Advancing Every Acre™

Interested in Learning More?

Contact your Taurus rep:
crystalgreen@taurus.ag

WWW.TAURUS.AG/PRODUCT/CRYSTALGREEN

Crystal Green is sustainably produced by
Ostara Nutrient Recovery Technologies Inc.