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Inoculants and Phosphorus Fertility in the North Peace

Background: Inoculants are used to improve the absorption of nutrients or conversion of compounds to forms that can be used by plants. The best-documented benefit of arbuscular mycorrhizae (VAM) association with plant roots is the increase in phosphate absorption. Enhanced absorption of water and other nutrients including ammonium, nitrate and potassium has also been reported. Thus VAM fungi are considered as important tools to reduce fertilizer input on marginal lands. Project objectives were to evaluate the potential of inoculants to enhance plant growth and yield of wheat and canola in northern Peace region soils and do a product comparison.

Products Tested

Jump Start: A phosphate inoculant consisting of a naturally occurring soil fungus sold by Philom Bios. It comes as a powder that is mixed with water and used to treat wheat, canola, pulse and alfalfa seeds.

Mycorise® ProEndo: Pellets consisting of endomycorrhizae for seed-placement with annual field crops and many vegetables. Sold by SymbioTech Research Inc., Edmonton.

Mycorise® ProReclaim: Also a seed placed pellet, sold by SymbioTech, is a combination of endomycorrhizae and ectomycorrhizae, which is compatible with herbaceous plants.

TM-21 Terramend: A biostimulant to enhance the nutrient availability in soils by increasing the number of beneficial microorganisms. Sold by Basic Environmental Systems & Technology Inc., Sherwood Park, Alberta. This liquid can be applied using spraying equipment.

Methods and Materials

Field trials were established in 2003 using randomized block design with 3 replicates. The same rates of nitrogen (urea @ 100 lb/ac to wheat and 150 lb/ac to canola), phosphorus (4.5 lb/ac), potassium (2 lb/ac) and sulphur (3.5 lb/ac to canola) fertilizers were applied to all treatments. The test crops were seeded on May 20: canola (Dekalb 32-35) @ 7 lb/ac and wheat (AC Intrepid) @ 100 lb/ac. Emergence counts were recorded on June 10 by counting the number of plants emerged per metre of row at four random spots. Fresh and dry root weights from seedling and mature plants were obtained from 5 plants per plot. Differences between treatments were detected using orthogonal contrasts.

At Manning, the 5 treatments were Control (C), Jump Start (JS), Mycorise® ProEndo (MPE), Mycorise® ProReclaim (MPR), and TM-21 Terramend (TM-21). Crops were seeded on May 20 and harvested on Oct. 7.

At Fort Vermillion, only Jump Start (JS) and TM-21 (TM-21) were tested. The crops were seeded on May 19 and harvested in late September.

Results and Discussion

Manning: There was no difference in emergence between the control and the treated wheat plots but emergence of the Jump Start treated wheat was significantly lower (P=0.027) than ProReclaim (Table 1). Visual inspection revealed that Jump Star promoted more growth of root hair and small lateral roots than any other treatment. But, the recorded fresh weight of seedling roots did not support these visual observations (Table 1). The fresh root weight of mature plants was significantly increased by

ProEndo (P=0.095) and TM-21 (P=0.102), while Jump Start and ProReclaim also showed some improvement. The dry weight of mature plant roots showed a similar trend but the difference between Control and ProEndo only was significant (P=0.033). Heavier root biomass could be attributed to the presence of mycorhizzal hyphae in conjunction to a healthier and better developed root system.

The harvest data indicated that the inoculants had a positive impact on grain yield. Compared to Control, the yield was higher with ProEndo (26%), ProReclaim (21%), Jump Start (15%) and TM-21 (13%). But it was significantly improved by only ProEndo (P=0.013) and ProReclaim (P=0.036). There was no correlation between the root mass and yield as the highest yielding treatment, ProReclaim, did not show significant improvement in root weight over the Control. The contribution margin from wheat was increased by all inoculants, with a range of $10 with TM-21 to $29 with ProReclaim.

Table 1. Crop data at Manning.

Measurement	C	JS	MPE	MOR	TM21
Costs, $/ac	0	4.0	8.4	8.4	10.0
			Wheat		
Plants, #/m	43	40	47	48	47
Seeding roots fresh wt., g	1.9	1.7	1.5	1.9	1.8
Plant roots fresh wt., g	1.0	1.3	1.6	1.1	1.5
Plant roots dry wt., g	0.4	0.6	0.7	0.5	0.6
Yield, bu/ac	32	40	42	43	40
Margin, $/ac	27	45	56	66	37
			Canola		
Plants, #/m	28	27	30	27	27
Seeding roots fresh wt., g	1.1	0.8	1.0	0.9	0.9
Plant roots fresh wt., g	7.9	7.0	7.0	7.1	6.1
Plant roots dry wt., g	2.1	2.0	2.0	2.0	1.6
Yield, bu/ac	26	26	21	22	28
Green seed, %	4.2	3.0	8.2	3.0	4.3
Margin* $/ac	36	30	-9	4	41

* Contribution margin was the differences in revenue and production costs for each treatment.

There were no consistent effects of inoculants on emergence, root weight of seedlings or mature plants, yield, or the contribution margin of canola (Table 1). Also, unlike wheat, Jump Start did not appear to promote the growth of root hair or small lateral roots on the canola seedlings. For example, compared to the Control, the yield was higher with TM-21, equal with Jump Start, and lower with the other 2 inoculants; and the contribution margin was increased by TM-21 while reduced by the other 3 inoculants. The incidence of green seed was lowest with Jump Start and ProReclaim while it was highest with ProEndo.

Fort Vermilion: Drought conditions early in the season greatly reduced crop yields. There were no consistent differences in emergence and root growth of crops (data not shown). Crop yields were also not significantly influenced by the inoculants (Table 2). Thus the contribution margins were reduced from the use of inoculants due to their additional cost.

Table 2. Crop yield (bu/ac) at Fort Vermillion.

Crop	C	JS	TM21
Wheat	12.0	12.2	12.5
Canola	7.9	8.1	8.2

Discussion and Conclusions: The trial showed a marked benefit for the use of inoculants with wheat at the Manning site. All of the inoculants increased wheat yields. Those benefits were not duplicated with canola at Manning or with either crop at Fort Vermillion.

Since the crops at Manning were not drought stressed, the benefits associated with mycorrhizal colonization of the roots and increased water uptake were not realised. For example, with the mature plants, the water content of fresh roots ranged between 53 and 60% for wheat and ranged between 73 and 75% for canola. Very low crop yield due to drought were considered responsible for lack of inoculant effects at Fort Vermilion. Drier years, but with reasonable yield potential may be needed to enhance drought resistance and nutrient availability from the mycorrhizal association.

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