Tolerance of *Brassicae* crop species to seed-placed N, P and S specialty fertilizer

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INTRODUCTION

Sulfur is an essential nutrient needed for plant growth and development. Canola has a relatively high requirement for sulfur because of its high content of sulfur containing proteins and deficiencies can reduce crop yields and oil production. Excess application of fertilizer with the seed can negatively affect seedling germination and emergence, through ammonia toxicity or osmotic damage (O'Donovan et al., 2008) depending on the fertilizer source and type. Canola seedlings are more sensitive to seed-placed fertilizer than other crops such as wheat (Qian and Schoenau, 2010). In recent years, specialty fertilizers that blend sulfur into a mono-ammonium phosphate granule have been developed that have the potential to enhance fertilizer efficiency and nutrient uptake. However, there is little information on the relative tolerance of *Brassicae* species to seed-row placed MicroEssentials S15 (MES15).

OBJECTIVES

The objectives of this research were to determine the response of *Brassicae* species to seed-placed sulfur applied as MES15 (13-33-0-15S) under controlled environmental conditions.

MATERIALS AND METHODS

MicroEssentials S15 (MES15), a Mosaic Company product, was developed by incorporating sulfur into mono-ammonium phosphate (MAP) granules to form a fertilizer prill containing N, P and S (http:/www.mosaicco.com). The sulfur is provided in two forms; sulfate (50%) and elemental (50%). Four canola *Brassica napus* L. (cv. 5770 LL, H.E.A.R, 5525 CL, v1040 RR), one *Brassica rapa* L. (cv. ACS-C18), one canola quality *Brassica juncea* (cv. 8571), one *Brassica carinata* (070768EM), and one *Camilina sativa* (cv. Calena) cultivars were selected for this study. Tray experiments were conducted using a phosphorus-deficient Brown Chernozemic loam textured soil from southwestern Saskatchewan. This soil was selected because there was no history of herbicide application so there was no concern with herbicide residue or carryover to affect germination. The soil was collected in the spring of 2010 from the 0-6 inch depth within a field that has been in continuous alfalfa for ten years (OM 3%). Selected soil characteristics and nutrient levels are shown in Table 1. Six treatments, consisting of an unfertilized control, and five rates of seed-placed S (10, 20, 30, 40 and 50 kg S ha^{-1}) applied as MES15 (13-33-0-15S) were used with four replications of each treatment. The N and P rates were determined by the rate of S application. The amount of nitrogen applied was 0, 9, 18, 26, 35 and 44 kg N ha^{-1} at 0, 10, 20, 30, 40 and 50 kg S ha^{-1}, respectively. The amount of phosphorus applied was 0, 23, 46, 66, 89 and 112 kg P ha^{-1}, respectively.

Plants were grown in plastic trays (52cm x 26cm x 6cm) containing 5.4 kg of uniformly mixed, air-dried soil at 20 degrees C. The soil in each tray was leveled to a height of 5cm over the individual rows and packed. Six 20cm x 2.50cm x 1.25cm seed rows were created in the trays creating a seed bed utilization of approximately 15%.

The fertilizer was passed through a 2mm sieve to provide uniform granule size and spread uniformly down the seed-row with the seed. The trays were kept at 80-100% field capacity moisture content under 24 h of room lighting. Emergence counts were taken every two to three days after seeding (DAS) over a two week period, when no additional emergence was observed. Plants were harvested 14 DAS. Plant biomass samples were washed in deionized water after cutting at the soil surface and oven-dried at 45°C for 4 d to a constant weight.

Table 1: Properties of Brown Chernozem soil used in MES15 trials.

Soil	Texture	NO_3-N	SO_4-S	Extractable P	pH (1S:2W)	EC (mS/cm)
			μg/g			
Haverhill	Loam(non-saline)	7	24	10	7.5	0.57

STATISICAL ANALYSIS

Data was analyzed using analysis of variance (ANOVA) using the GLM procedure in SAS (SAS Institute, 2008). Least significant difference (LSD *p=0.05*) was used to determine significant differences between treatment means.

RESULTS AND DISCUSSION

Brassica napus was least affected by the seed-placed rates of applied S used in this study, with good tolerance up to 30-40 kg S ha^{-1} (Figure 2). Rates above 10 kg S ha^{-1} significantly reduced the emergence of *Brassica juncea* and *Camelina sativa*, while rates above 30 kg S ha^{-1} significantly reduced emergence of *Brassica rapa* and *Brassica carinata.* Responses to increased S rate varied between *Brassica* species and cultivars. *B. carinata* and *B. napus* appeared to be more tolerant to seed placed S compared to *B. rapa* and *B. juncea.* Percent emergence for most cultivars was lower when 40-50 kg S ha^{-1} (89 to 112 kg P_2O_5 ha^{-1}) was applied. It is important to note that amount of P_2O_5 P are approximately double that of S with this product, while amount of nitrogen and sulfur is the same. Small-seeded cultivars ACS-C18, Calena, and x8571 were more prone to germination damage at MES15 rates over 30 kg S ha^{-1} than the large-seeded *B. napus* cultivars and *B. carinata* 070768EM. Considerable variation occurred between cultivars in percent emergence with the application of MES15. There was an increase in time to emergence (delayed emergence) with increasing rate of S applied as MES15 (data not shown), which could affect time to maturity from date of seeding. In a similar study (Urton et al., 2011), rates of seed-placed ammonium sulfate above 20-30 kg s ha^{-1} were associated with significant reductions in emergence of most *Brassica* species/cultivars. Addition of 15 to 30 kg ha^{-1} of seed-placed P_2O_5 along with the AS further reduced emergence by about 10 to 15 %. *Brassica rapa* and *B. juncea* were generally more sensitive to injury from seed-row placed S and P than *B. napus* cultivars. Differences in sensitivity were also observed among cultivars of a species.

Table 2: Mean percent emergence of *Brassica* species expressed as percent of unfertilized control

Cultivar	**Percent emergence as % of unfertilized control**					
	Kg S ha^{-1} †					
	0N-0P-0S	9N-23P-10S	18N-46P-20S	26N-66P-30S	35N-89P-40S	44N-112P-50S
B. napus						
5770 LL	100a	94a	97a	98a	94a	95a
5525 Clearfield	100a	95a	98a	100a	95a	97a
v1040 RR	100abc	104a	93abc	102ab	86c	90bc
HEAR	100a	94ab	90ab	90ab	90ab	89b
B. rapa						
ACS-C18	100a	93ab	88b	95ab	72c	70c
B. juncea						
8571	100ab	102a	82bc	71cd	65d	55d
B. carinata						
070768EM	100ab	110a	96ab	96ab	71c	73c
Camelina sativa						
Calena	100ab	114a	74bc	71bcd	40cd	37d

LL-Liberty Link, RR- Roundup Ready

† Means followed by the same letter are not significantly different, $p<0.05$ by LSD

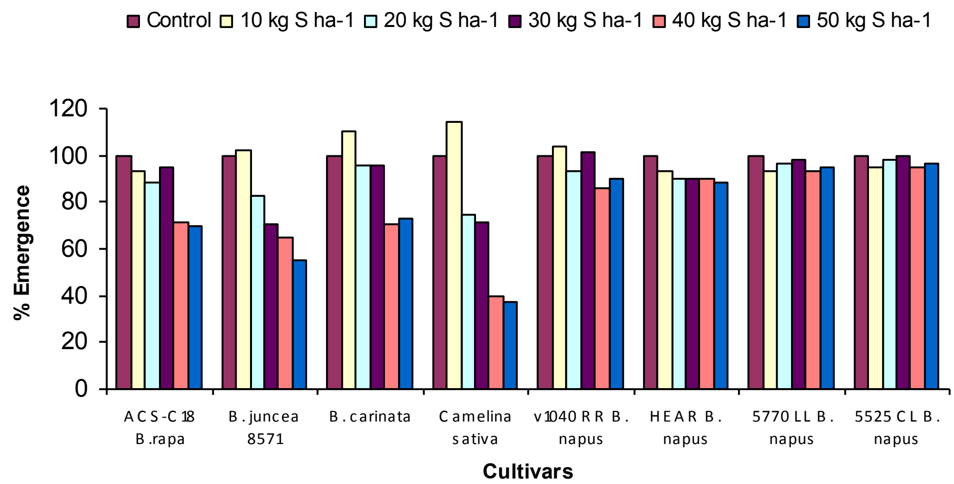

Figure 1: Effect of MES15 applied at various S rates on the emergence of *Brassica* species, expressed as % of unfertilized control (100%) under controlled environmental conditions

CONCLUSIONS

Brassica cultivars and species differed in their sensitivity and responsiveness to seed-placed MES15. *B. napus* cultivars were most tolerant to seed-placed MES15 while *B. rapa* and *Camelina sativa* were the most sensitive. In general, small seeded cultivars were more prone to germination damage than larger seeded *B. napus* and *B. carinata* cultivars. Yellow-seeded canola was slightly more prone to reduced emergence with seed-placed MES15 than the black-seeded cultivars. Further research will need to be performed in field trials under a wide range of soil and environmental conditions where yield and quality can be measured under field conditions.

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