Effect of seed-placed ammonium sulfate and monoammonium phosphate on germination and emergence of canola

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INTRODUCTION

In western Canada there are approximately 4.5 million hectares of agricultural land under *Brassica* oilseed crop production (Malhi, S.S., 2007). Canola-quality *B. juncea* and oilseed *Camelina sativa* are being developed as alternative oilseed crops that are better adapted to areas with periods of hot, dry conditions in western Canada. Tolerance of *Brassica* crops to seed-row application of nutrients is low when compared to many other crops (Qian and Schoenau, 2010), and emergence differences have been observed between open-pollinated and hybrid cultivars (Brandt et al., 2007). Differences have also been noted in the tolerance and responsiveness of yellow- and black-seeded canola cultivars to seed-placed P (Grant, 2008). Excess application of fertilizer in the seed-row can lead to seedling damage; through direct ammonia toxicity or osmotic (salt) effects (O'Donovan et al., 2008) depending on the fertilizer source and type. Ammonium sulfate has a high salt index and can produce significant amounts of free ammonia, leading to the possibility of both osmotic damage and direct ammonia toxicity at high application rates (Follett et al., 1981).

OBJECTIVES

The objectives of this research are to: (1) determine the effects of seed-placed ammonium sulfate (AS) and monoammonium phosphate (MAP) fertilizer applied at different rates on seedling emergence under controlled-environmental conditions; and (2) determine if *Brassica* oilseed crops/cultivars differ in their response to seed placed S and P fertilizer.

MATERIALS AND METHODS

The *Brassica* species/cultivars selected for this study are listed in Table 1. Tray experiments were conducted using a phosphorus-deficient Brown Chernozemic loam textured soil from southwestern Saskatchewan. The soil was collected in the fall of 2010 from a field that has been in continuous alfalfa for ten years (pH 7.7, OM 3%). Six treatments consisting of an unfertilized control and five rates of seed-placed S (10, 20, 30, 40 and 50 kg SO_4 ha^{-1} applied as ammonium sulfate (AS 21-0-0-24) were applied in combination with three rates of seed-placed P_20_5 (0, 15 and 30 kg P_2O_5 ha^{-1}.

B. species/cultivars were designated as main plots, S rates as subplots and P rates as sub-subplots within the trays and were arranged in a randomized complete block design with four replications.

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 were created in the trays using a seeding tool. The trays were kept under 24 h of lighting per day. The trays were seeded on a seed number per unit area that equates to a seeding rate of approximately 10 kg ha^{-1} using a seeding tool creating a seed bed utilization of approximately 15 %. Sixteen seeds were seeded in each row at a uniform depth of 1.25cm.

The fertilizer was passed through a 2mm sieve to provide uniform granule size and spread uniformly down the seed-row with the seed. During germination, trays were kept under constant light and regularly watered to maintain soil moisture at 80% to 100% water holding capacity. Emergence counts were taken every two to three days after seeding until 14 days after seeding (DAS), when plant counts were constant and no new emergence was observed. Plants were harvested 14 DAS. Plant samples were washed in deionized water after cutting and oven-dried at 45°C for 3 d to a constant weight (data not shown).

RESULTS AND CONCLUSIONS

Generally, there was no significant difference in percent emergence up to 20-30 kg S^{-1} when ammonium sulfate was applied alone (Table 3). *Camelina sativa* appeared more sensitive to AS placed in the seed-row than the *Brassica* crops. At rates of 30 kg S ha^{-1} and above, percent emergence dropped below 80% for some *Brassica* cultivars (Table 3, Figure 1). Addition of 15 to 30 kg 30 P_2O_5 along with the S application caused some decreases in the percent emergence, but decreases were typically small with the *B. napus* cultivars. The *B. rapa, B. juncea* cv. Dahinda, and *Camelina* appeared more sensitive to the addition of the P along with S. The *B. juncea* cv. Dahinda, was less tolerant to fertilizer in the seed-row than Xceed 8571, another *B. juncea* canola. The seed sample from which the Dahinda was taken was two years old, which may have affected seed vigour and reduced germination. The cultivar 45H26 RR was the most tolerant of cultivars tested while the most sensitive to seed-row placed S and S+P were *B. rapa, B. juncea* cv. Dahinda, and *Camelina sativa.*

STATISICAL ANALYSIS

Main and interaction effects of *Brassica* cultivars and AS, alone and, in combination with MAP were determined from analysis of variance (ANOVA) using the GLM procedure in SAS (SAS Institute, 2008). Least significant difference (LSD0.05) was used to determine significant differences between treatment means.

CONCLUSIONS

Rates of seed-row placed ammonium sulfate above 20–30 kg S ha^{-1} were associated with significant reductions in emergence of many *Brassica* species/cultivars. Addition of 15 – 30 kg P_2O_5 ha^{-1} MAP along with the AS often caused further reductions in emergence, although these were generally not large with *B*. napus cultivars. The *B*. rapa, *B*. juncea, and *Camelina sativa* were most sensitive to seed-placed AS and MAP fertilizer. Further study is required to establish whether seed grown under different growing conditions and soil type have similar responses.

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Table 1: Cultivars of *Brassica* species selected for study.

Species and Cultivar	Type	Herbicide system	Year of release	Maturity
B. napus				
5440	HYB	LL	2007	Mid-Late
5525	OP	CL	2009	Mid-Late
45H26	HYB	RR	2006	Mid
v1037*	HYB	RR	2007	Early-Mid
v1040*	HYB	RR	2010	Mid
74P00	OP	LL	2006	Early-Mid
H.E.A.R*	OP	RR		
B. juncea				
Dahinda	OP	Conv.	2004	Late
Xceed 8571	OP	CL	2008	Early
B. rapa				
ACS- C7	SYN-OP	Conv.	2001	Early
Camelina sativa				
Calena	OP	Conv.	—	Early

*-specialty oil; HYB-Hybrid; OP-open-pollinated; SYN-synthetic; Conv.-conventional
LL-Liberty Link; RR-Roundup Ready; CL-Clearfield

Table 2: Mean percentage as a percent of unfertilized control of *B*. germination with seed-row applied AS and MAP.

Cultivar	**S** **Kg S ha^{-1}**						**S+15P** **Kg S ha^{-1}**						**S+30P** **Kg S ha^{-1}**					
	0	10	20	30	40	50	0	10	20	30	40	50	0	10	20	30	40	50
Invigor 5440	100a	97a	92a	68b	57b	32c	100a	102a	82ab	76b	49c	24d	100a	100a	81a	81a	47b	32b
Victory 1037	100ab	99ab	93a	84abc	84bc	61c	100a	97a	88ab	81abc	79bc	67c	100a	89a	81a	79ab	69ab	63b
Victory 1040	100a	102a	106a	99a	65b	56b	100a	100a	93a	82a	60b	49b	100a	92a	85a	83a	58b	49b
HEAR	100a	95a	99a	95a	86a	65b	100a	98ab	100a	100a	84bc	72c	100a	90a	88a	88a	63b	61b
5525 Clearfield	100a	99a	93a	84a	84a	61b	100a	97ab	88ab	81abc	79bc	61c	100a	89ab	86abc	79abc	69bc	63c
ASC-7 *B. rapa*	100a	88ab	100a	89ab	63bc	40c	100a	65b	49bc	47bc	37c	29c	100a	61b	55b	55b	21c	27c
74P00 LL	100a	98a	94a	80a	80a	24b	100a	83a	87a	59b	41b	37b	100a	56b	54b	42b	30b	34b
45H26 RR	100a	102a	100a	100a	84b	76b	100a	97a	94a	83b	84b	78b	100a	97ab	95ab	92abc	88bc	83c
B. juncea Xceed	100ab	100ab	109a	83abc	72bc	66c	100a	80b	90ab	80ab	72bc	50c	100a	89a	81a	94a	57b	53b
B. Juncea Dahinda	100a	89ab	103a	73bc	53cd	31d	100a	93a	70b	70b	40c	7d	100a	97a	59b	47b	22c	9c
Camelina sativa	100a	91ab	71bc	63c	23d	17d	100a	103a	63b	69b	50bc	25c	100a	47b	38bc	27cd	15de	9e

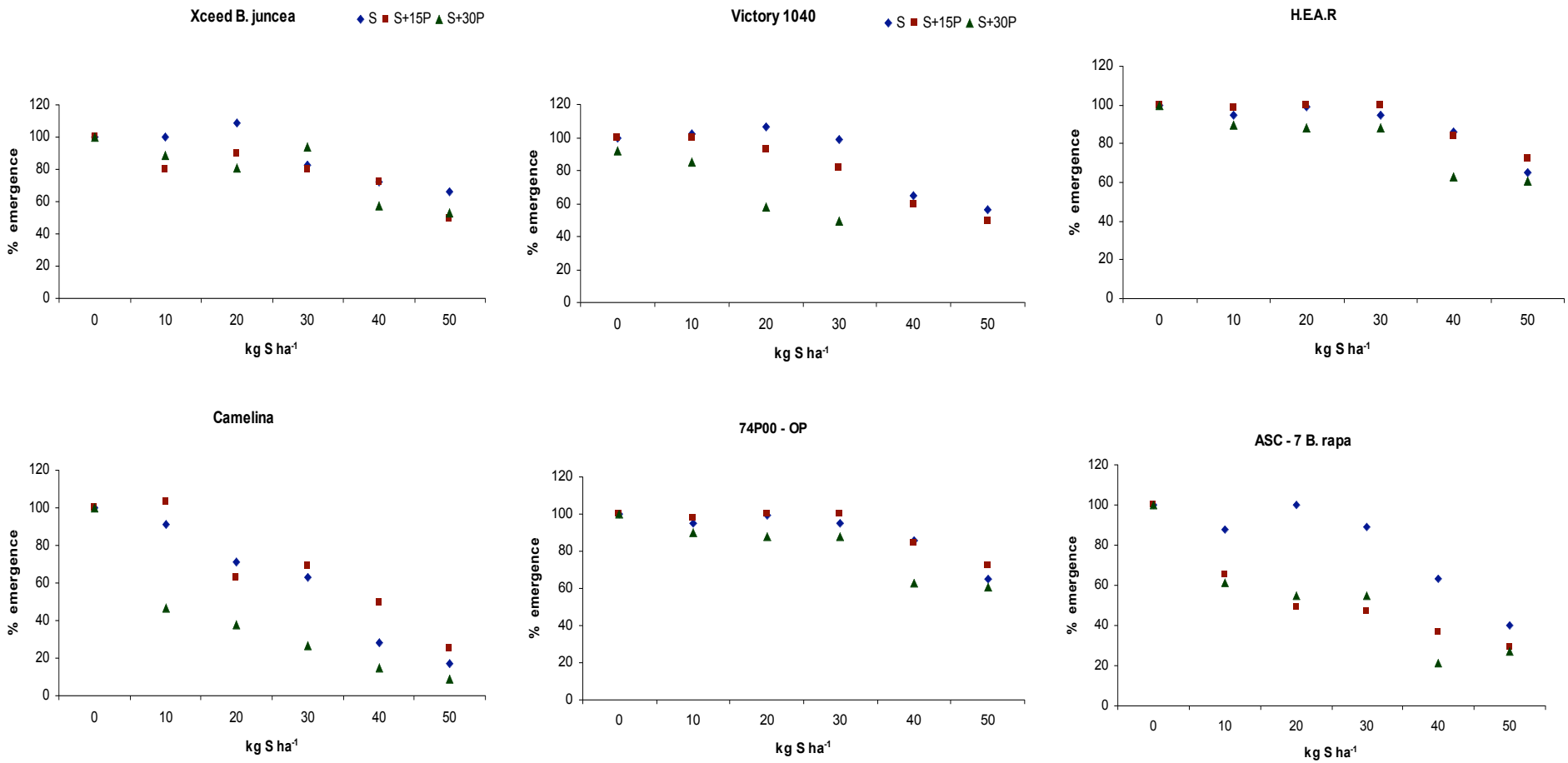

Figure 1: Effect of AS and MAP applied at 0 to 50 kg S ha^{-1} and 0 to 30 kg P on emergence of selected *B.* species / cultivars.