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Winter Pea Evaluations in Eastern North Dakota*

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Field pea or dry pea (*Pisum sativum* L., Fabaceae) is a legume native to Southwest Asia and was one of the first crops cultivated by man. World production of field pea is 5,389 × 10^6 ha with the most important producing countries being Canada, China, India, and the Russian Federation all representing almost 70% of the total crop area (Table 1) (FAOSTAT 2006). Field pea crop area has increased rapidly in Canada, India, and the USA from 2000 to 2004. Production in the USA increased from 74,000 ha in 2000 to 374,000 ha in 2006 (Table 2). Most of the dry pea produced in the USA is exported to Canada, Mexico, and other Latin-American countries (NASS 2006).

North Dakota has the largest production region in the USA with 66% of the total hectarage, followed by Montana, Washington, Idaho, and Oregon. Field pea production in North Dakota increased from 25,000 ha in 2000 to 247,000 ha in 2006 (Table 2). State seed yields averaged 2128 kg ha^{-1} in 2006 at a price of $94.7/tonne (t) (NASS 2006). Field pea has quickly become an attractive alternative crop in the region because of good crop performance, edible and feed markets, and reduction in nitrogen inputs in subsequent crops.

Current field pea production in North Dakota is associated with green and yellow spring types. Green and yellow peas are used for human consumption in soups, canning, and as an ingredient in processed food. Lower

Table 1. Important countries in world field pea production based on planted hectares between 2000 and 2004 (FAOSTAT 2006; NAAS 2006).

	Production area (ha × 10^3)				
Country	2000	2001	2002	2003	2004
Canada	1220	1285	1050	1271	1346
China	840	942	950	900	878
India	580	530	570	580	748
Russian Fed.	536	648	758	718	723
France	429	417	337	366	356
Australia	397	337	380	354	330
Ukraine	285	299	324	337	258
Ethiopia	159	216	204	204	228
USA	74	78	113	132	204
Others	560	534	472	423	318
Total world	5080	5286	5158	5285	5389

Table 2. Important states in field pea production in the USA based on planted hectares between 2000 and 2006 (NAAS 2006).

	Production area (ha × 10^3)						
Country	2000	2001	2002	2003	2004	2005	2006
North Dakota	25	35	63	65	125	218	247
Montana	10	11	13	13	28	55	85
Washington	26	25	31	34	36	32	27
Idaho	10	10	17	22	23	19	12
Oregon	2	2	2	3	3	2	3
Others	1	0	0	0	0	1	0
Total	74	83	126	137	215	327	374

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quality seed not suitable for human consumption is used to feed livestock. Some small-seeded and mottled cultivars are used only for animal feed. The seed has a high amino acid content including lysine and tryptophan, two essential amino acids deficient in cereals (Oelke et al. 1991).

Pea is a cool-season crop that grows well with temperatures between 12 and 18°C. Temperatures within this range would commonly occur in May and June over much of North Dakota, however, July and August temperatures typically are several degrees warmer. There are two main plant types of field peas, the normal type which has a prostrate growth habit with long vines of 0.9 to 1.8 m and normal leaves with three leaflets and a terminal tendril. The semi-leafless (afila) plant type has an erect growth habit with shorter vines and no leaflets, only tendrils (Krall et al. 2006). The semi-leafless types are preferred among producers due to a greater harvest ease compared to the normal leaf types that are prone to lodging.

All field pea planted in North Dakota are spring cultivars (McKay et al. 2003). Production of winter annual pea could offer potential advantages compared to spring sown pea that include greater yield, earlier markets, improved on-farm workload distribution, expanded production region within the state, and improved crop quality and value. Winter-hardy field pea cultivars are grown in Washington, Idaho, and Montana (Chen et al. 2006). Winter pea performance has not been evaluated in North Dakota. The objective of this study was to determine the performance of winter pea genotypes grown in eastern North Dakota.

MATERIAL AND METHODS

The experiment was conducted in eastern North Dakota in the Red River Valley near Prosper (46° 58' N, 97° 4' W, elevation 220 m) during the 2004/2005 and 2005/2006 growing seasons. The previous crop was hard red spring wheat (*Triticum aestivum* L., Poaceae) each year of the study with the winter pea seeded into the standing wheat stubble that was approximately 25 cm in height. The experimental design was a randomized complete block with three replicates. Winter pea genotypes were obtained from K. McPhee, USDA-ARS, Pullman, Washington. Winter pea cultivars were sown 13 Sept. 2004 and 23 Sept. 2005. Stands were sown to establish 741,000 plants ha^{-1} in plots consisting of 6 rows spaced 30 cm apart and 7.6 m in length. Glyphosate was applied at 840 g ai ha^{-1} for preplant burn down control of volunteer wheat seedlings. The four center rows of each plot were straight harvested with a plot combine on 2 Aug. 2005 and 17 July 2006.

Characteristics evaluated were fall stand, winter survival, flowering date, plant height and lodging, seed yield, and seed weight. Fall stand was estimated by visual rating from 0 to 10 of established plant stands, where 10 is excellent and 0 is no stand. Winter survival was calculated as the percent of established plants that survived the winter and resumed growth in the spring. Flowering was determined by counting the number of days from 1 Apr. to flowering of at least 10% of plants in each plot. Plant height was measured at harvest as the extended vine length from the ground. Plant lodging was estimated by a visual rating from 0 (no lodging) to 10 (all plants lodged). Seed weight was calculated for 250 seeds and converted to weight per 1000 seeds.

RESULTS AND DISCUSSION

Winter pea fall stands were good both years ranging from 7.5 to 8.3 and 8.2 to 8.6 in 2004 and 2005, respectively (Table 3). Winter survival, however, was approximately 50% or less in spring 2005 as compared with 2006. Soil temperatures were 2.2 to 3.3°C cooler during mid December to mid February in 2005 than 2006 and may be related to winter survival (data not shown). The importance of adequate spring stands in field pea is important in yield performance since peas are limited in yield component compensation. Peel and Endres (1997) reported that minimum acceptable stands, before replanting is recommended after early season crop injury, were greater for field pea than cereals, flax (*Linum usitatissimum* L., Linaceae), soybean [*Glycine max* (L.) Merr., Fabaceae], crambe (*Crambe abyssinica* Hochst., Brassicaceae), or canola (*Brassica napus* L., Brassicaceae). Greater minimum acceptable stands for field pea indicates less yield component compensation to maintain yield for field pea compared to the other crops. Adequate spring stands for optimum crop performance will be directly related to winter survival and subsequent spring stands. Genotype, climate, and production practices will all be important in determining spring stands. During 2004/2005 and 2005/2006, winter pea survival at other North Dakota Research Extension Centers was near zero with no or very sparse stands not suitable for genotype evaluations.

Days to flowering varied among genotypes by 5 to 6 days in either year, but were fewer in 2006 due to

above-normal growing-season temperatures that hastened plant development (Table 3). Genotype plant heights were more representative in 2006 than 2005 due to higher and more uniform stands. The short genotypes exhibited shorter plant heights than the tall genotypes in 2006. Low and less uniform stands in 2005 resulted in plant height not being closely associated with vine length. All genotypes in both years whether short/tall or afila/normal showed high lodging. Genotype seed-weight differences were indicated in 2006 where spring stands averaged 89% across genotypes. Although seed weight in 2005 ranged from 126 to 148 g 1000^{-1} statistical differences were not observed due to a high variance for this character that was related to poor stands.

Seed yield was approximately twice as great in 2006 than in 2005 due largely to spring stands being more than twice as great in 2006 compared to 2005 (Table 3). Mean yield of the winter genotypes was 66% of the adjacent spring sown pea variety trial (VT) mean yield in 2005. Three winter pea genotypes yielded within 540 kg ha^{-1} of the spring VT mean yield. Mean yield of the winter genotypes was 132% of the adjacent spring sown pea VT mean yield in 2006. Two of the winter pea genotypes yielded similar to the highest yielding spring pea 'CDC Mozart' (4066 kg ha^{-1}) (data not shown). Harvest was approximately 10 and 16 d earlier for the winter than spring pea in 2005 and 2006, respectively. This indicates winter pea crop development occurred earlier in the season than spring pea development and likely would have been subjected to less heat and moisture stress. Chen et al. (2006) reported average yield of winter pea lines PS9430706 and PS9530726 at 1750 kg ha^{-1} in studies

Table 3. Winter pea genotype description and mean performance results at Prosper, North Dakota, during 2004/2005 and 2005/2006.

Genotype	Vine	Leaf	Fall[z] stand	Winter[y] survival (%)	Days[x] to first flower	Plant height (cm)	Plant[w] lodging	Seed weight (g/1000)	Seed yield (kg/ha)
					2004/2005[v]				
PS9430706	Tall	Afila	8.0	45	64	132	9	126	1745
PS9530726	Short	Afila	8.3	15	64	112	9	140	1965
PS9630448	Tall	Afila	7.5	43	61	104	9	131	1965
PS9830S431	Tall	Normal	8.5	10	66	117	9	130	1090
PS9830F010	Tall	Afila	8.0	29	64	117	9	144	1405
PS9830F011	Short	Afila	8.0	28	65	150	9	125	1665
Windham	Short	Afila	7.8	15	66	150	9	148	915
Specter	Tall	Afila	8.0	40	63	114	9	142	2320
LSD (0.05)			0.4	NS	NS	NS	NS	NS	NS
Spring VT mean									2506
	2005/2006								
PS03100635	Tall	Afila	8.6	89	54	137	8	122	3540
PS03100660	Tall	Normal	8.6	83	55	117	8	116	3555
PS9830F011	Short	Afila	8.3	88	59	97	7	159	4090
Windham	Short	Afila	8.2	91	59	91	9	155	4080
Specter	Tall	Afila	8.6	92	60	127	7	134	2675
LSD (0.05)			NS	NS	3	20	1	9	845
Spring VT mean									2728

[z]Visual fall stand rating from 0 (no stand) to 10 (full stand).

[y]Visual estimate of percent of fall established plants that initiated regrowth in the spring.

[x]Days from April 1 to flowering of at least 10% of plants per plot.

[w]Visual plant lodging rating from 0 (no lodging) to 10 (all plants lodged).

[v]Spring variety trial (VT) seeding date 17 and 19 May in 2005 and 2006, respectively.

conducted in the Pacific Northwest. These lines produced a similar yield in our study in the 2005 growing season (Table 3). In 2006 winter pea seed yield was much greater in North Dakota compared with yields obtained in Washington, Idaho, and Montana (C. Chen et al., data not shown).

SUMMARY

Winter pea yield performance was influenced by winter survival, genotype, and climate. As winter survival increased greater spring stands resulted that tended to produce greater yields. This accentuates the importance of adequate spring stands since field pea does not compensate for low stands as well as many other crops. Lower yields in 2005 than 2006 are likely related to poor stands in the early year. In 2006, yield differences were more related to genotype since winter survival and subsequent spring stands were good for all genotypes. On average, winter pea yielded 132% of spring pea in 2006. This is attributed to adequate spring stands and earlier crop development that reduced heat and moisture stress of winter pea compared with spring pea in the 2006 growing season.

Our results provide the first information regarding winter pea performance in North Dakota and indicate potential for production, however, additional replication of these studies is recommended regarding genotypes, locations, and years. Also, additional plant breeding and determination of best management practices are needed before commercial winter pea production in North Dakota is attempted.

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