Chickpea, Field Pea and Lentil Yields when Direct-Seeded into Standing Stubble in the Semiarid Prairie of Southwestern Saskatchewan

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Introduction

- Low disturbance direct seeding into standing cereal stubble is an effective practice to reduce water stress of a growing crop in dryland agriculture.
- Standing stubble reduces evaporation of soil water making more water available to the crop.
- Standing stubble creates a more favourable microclimate for growing crops by reducing wind, solar radiation, and evaporative demand for water.

Objective

- Our objective was to determine the effects of stubble height on the growth and yield of pulse crops (desi chickpea, field pea, lentil) grown in the semiarid prairie.

Methods

- To measure the in-crop microclimate effects of stubble treatments, all treatments overwintered as tall stubble to equalize snow trapping.
- Three stubble treatments - cultivated, short (about 15 cm high), and tall (>30 cm high) - were imposed in spring.
- Pulses seeded: desi chickpea (*Cicer arietinum* L. cv. Cheston), field pea (*Pisum sativum* L. cv. Grande), and lentil *(Lens culinaris* L. cv. Laird).
- Duration of study: 1996, 1997, 1998, 2000. Location of study: Swift Current, SK, Canada.
- Plot size: 40 x 40 m. Pulses were seeded with minimal disturbance using a no-till disc drill in 1996, and with an air hoe drill in subsequent years.
- Soil water was measured just before seeding and after harvest to 1.5 m depth.
- Evapotranspiration (ET), or water use:
  ET = (soil water at seeding - soil water at harvest) + growing season precipitation.
- Water use efficiency (WUE): WUE = Grain yield / ET.

Results

Microclimate (Table 1)

- Microclimate was significantly dependent upon stubble height before flowering, with similar trends after flowering.
- Averaged across the growing season, compared to the cultivated treatment, tall stubble reduced evaporation rate by 23%, and short stubble reduced evaporation rate by 12%.
- Before flowering, compared to the cultivated treatment, tall stubble reduced wind speed by 70% and 8% at 15 and 100 cm above ground, and short stubble reduced wind speed by 25% at 15 cm above ground.
- From seeding to harvest, average daily soil temperatures at both the 5 cm and 30 cm soil depths were higher in the cultivated stubble than in the short or tall stubble.

Plant Height (Table 2)

- Crops tended to grow taller as stubble height increased and the height of the lowest pods (basal pods) tended to increase as stubble height increased. Vine length increased as stubble height increased and the pulse crop tended to stand more erect in the tall stubble.

Biomass, grain yield, evapotranspiration and water use efficiency (Table 3)

- In this semiarid climate, there were no consistent effects of stubble treatment on total ET (water use).
- Biomass production shortly before harvest was independent of stubble height, although the pulses tended to produce more biomass when grown in standing stubble compared to cultivated stubble.
- Averaged across pulses, grain yield and water use efficiency increased with stubble height. Tall and short stubble increased the overall average yield by 13% and 4% compared to cultivated stubble.
- Lentil had the greatest sensitivity to stubble management, both yield and WUE increased as stubble height increased. Chickpea and field pea yield and WUE tended to be highest when grown in tall stubble.
- Averaging across the 4 years of this study, compared with cultivated stubble, the average yield advantages for seeding into short stubble were 6%, 2%, and 5% for chickpea, field pea, and lentil, respectively, while the corresponding yield advantages for seeding into tall stubble were 11%, 7%, and 16%.

Table 1. Daily average wind speed and evaporation (averaged across 1996-98), and daily average air and soil temperature (averaged across 1996-98 and 2000) before and after flowering of pulses grown in cultivated, short and tall stubble.

Growth Period	Stubble	Wind* ($m\ s^{-1}$)		Air Temp (^{O}C)		Soil Temp (^{O}C)		Evaporation ($g\ water\ hr^{-1}$)
		15 cm height	100 cm height	15 cm height	100 cm height	5 cm depth	30 cm depth	
Before flowering	Cult.	1.7 a	3.06 a	12.4	11.9	15.2 a	13.2	3.17 a
	Short	1.3 b	3.00 a	13.8	13.3	14.6 ab	12.6	2.85 b
	Tall	0.5 c	2.82 b	14.1	13.5	14.4 b	12.6	2.34 c
After flowering	Cult.	--	1.94	17.8	17.2	19.7 a	17.7 a	1.92
	Short	--	1.88	18.8	18.5	18.8 b	16.9 b	1.65
	Tall	--	1.85	18.8	18.6	18.3 b	16.6 b	1.57

*For a given growth period and height, small letters indicate significant differences (Tukey) at P<0.10 between stubble treatments.

Table 2. Averaged across years (1996-98), vine length, plant height, and basal pod height for chickpea, field pea, and lentil grown in cultivated, short and tall stubble.

Pulse	Vine Length (cm)*			Plant Height (cm)			Basal Pod Height (cm)		
	Cult.	Short	Tall	Cult.	Short	Tall	Cult.	Short	Tall
Chickpea	31.2b	32.2b	37.4a	24.4b	26.0b	29.8a	11.2b	12.5a	13.7a
Field Pea	67.5b	73.6a	76.4a	51.4ab	50.3b	54.9a	19.9b	22.5ab	25.2a
Lentil	41.7b	42.2b	45.8a	34.5b	34.5b	37.6a	15.2b	15.9ab	17.1a
Average	46.8b	49.3ab	53.2a	36.7	37	40.8	15.4	16.9	18.7

*For a given pulse, letters indicate significant differences (Tukey) at P<0.10 among stubble treatments.

Table 3. Averaged across years (1996, 1997, 1998, 2000; except for biomass - 1996, 1998, 2000) biomass, grain yield, evapotranspiration, and water use efficiency for chickpeas, field pea and lentil grown in cultivated, short and tall stubble.

Pulse	Biomass* ($kg\ ha^{-1}$)			Grain Yield ($kg\ ha^{-1}$)			Evapotranspiration (mm)			Water Use Efficiency ($kg\ ha^{-1}\ mm^{-1}$)		
	Cult.	Short	Tall	Cult.	Short	Tall	Cult.	Short	Tall	Cult.	Short	Tall
Chickpea	3644	4070	4832	1574	1675	1751	259	257	259	6.06b	6.81	6.97
Field Pea	6590	6864	6802	2437	2494	2612	235	234	235	10.9	11.3	11.62
Lentil	4552	4731	4748	1334b	1405ab	1545a	246	234	221	5.53b	6.06b	7.13a
Average	4929	5222	5310	1782b	1858ab	2008a	246	242	240	7.49b	8.06ab	8.70a

*For a given pulse, small letters indicate significant differences (Tukey) at P<0.10 among stubble treatments.