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No-till Popcorn Performs as well as Conventionally Grown Popcorn

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Abstract. **A two-year study of popcorn cultivars grown by no-tillage (NT) and conventional tillage (CT) systems indicated that popcorn can be produced successfully by NT. Plant populations, plant heights, ear lengths, and ear weights were generally greater for NT than for CT. Popping expansion of NT corn, except for 'Snow Puff', a white kernel cultivar, was equal to that of CT. The use of either NH_4NO_3 or $Ca(NO_3)_2$ at 56 kg N/ha in 1981 and 84 kg N/ha from NH_4NO_3 in 1982 produced the highest yields. Increasing N to 140 kg/ha decreased yields of 'Snow Puff' in CT. The N levels had no effect on popping quality.**

Field corn (8) and sweet corn (6) have performed well by no-tillage (NT) culture, but no studies have been published on the production of popcorn by this system of tillage. Eldredge and Thomas (3) stated that soil and fertilizer requirements of popcorn were similar to those of field corn and that they could find no effect of either factor on kernel popping. Because popping expansion is the most important quality factor for popcorn (3, 5), large kernels (5) with low stress cracking (9) and a moisture content of 13-14% (3) were preferred for their high expansion volume. The objectives of this study were to evaluate the performance of popcorn cultivars by tillage systems and to determine if the tillage system and nitrogen levels affected popping quality.

The tillage experiments were conducted over a 2-year period. In 1981, the cultivar 'Iopop-12' was used in NT at 0, 56, and 112 kg N/ha from NH_4NO_3 and $Ca(NO_3)_2$. The control plot, conventional tillage (CT), was fertilized with NH_4NO_3 at 56 kg N/ha. One-half of the N was applied prior to planting, and the other one-half of N was sidedressed on 22 July. The experimental design was a randomized block with three replications. In 1982, 3 cultivars, 'Iopop-12', 'Purdue-410', and 'Snow Puff', were grown in both tillage systems in a split-split-plot design with N rates of 28, 84, and 140 kg N/ha from NH_4NO_3 in 3 replications. The 28 kg N rate was applied prior to planting to all plots, and the additional N was sidedresed on 23 June. Plot size for each N rate was 2.7×10.1 m for each cultivar. Seeds were sown with a NT seeder at a row spacing of 0.92 m, with three rows per plot. Data were recorded on the middle row.

For NT plots, a cover crop of winter wheat was killed with glyphosate at the rate of 1.7 kg/ha about one week before planting on 13 June 1981 and 7 June 1982. The CT plots which did not contain a cover crop, were plowed about 2 weeks before planting dates previously stated. The soil pH averaged 6.1 in 1981 and 6.3 in 1982; its P and K levels were about 170 and 450 kg/ha, respectively. The soil was a Maury silt loam. A combination of cyanazine and alachlor was applied at rates of 2.2 and 3.3 kg/ha, respectively, immediately after planting.

Kernels were shelled from the mid-portion of the matured ears then dried in environmentally controlled temperature (18°C) and relative humidity (67%) chambers until they reached a stable moisture content (13-14%) for popping evaluation.

Total weight of ears was greater for NT than for CT plants in both years (Table 1). Most of this weight increase was attributed to more ears and/or larger ears by NT plants than by CT plants. Yields in 1982 were lowest for 'Snow Puff' and 'Purdue-410' plants. Ears of 'Snow Puff' were shorter than those of 'Iopop-12' and 'Purdue-410', and they weighed less then those of 'Iopop-12'. The low yield for 'Purdue-410' was attributed mostly to fewer and lighter weight ears than those of 'Iopop-12'.

The greater plant population, plant height, ear length, and ear weight for NT plants (Table 1) was attributed to better soil moisture in NT than in CT soils. Although no data were recorded on soil moisture conditions in these studies, others (2, 4) have reported that NT soils contain more moisture than CT soils. In 1981, rainfall for the month of June was 4 cm below average, with only 1.2 cm after sowing. In 1982, rainfall for June and July was 3.4 cm below average.

In both years, kernels from NT-grown 'Iopop-12' plants popped as well as those from CT-grown plants, but 'Snow Puff' kernels from NT did not pop as well as those from CT (Table 1). The expansion volume of 'Purdue-410' kernels by NT was slightly greater than those by CT. These values were slightly lower than the average reported for 'Iopop-12' in Indiana in 1979 (1).

In 1981, N levels and tillage affected the ear number of 'Iopop-12' plants (Table 2). Plants grown by NT at 56 kg N/ha produced

Table 1. Effect of tillage system on the performance of popcorn cultivars in 1981 and 1982.

		1981	1982		
Character	Tillage	'Iopop-12'	'Iopop-12'	'Purdue-410'	'Snow Puff'
Plant population (1000/ha)	CT	48 a[z]	48 aAB	45 aA	51 aB
	NT	63 b	53 bA	51bA	53 aA
Plant height to first ear (cm)	CT	---	97 aB	92 aB	67 aA
	NT	---	103 aB	107 bB	87 bA
Avg length of main ear (cm)	CT	17.6	15.0 aB	15.3 aB	11.5 aA
	NT	19.3 b	15.3 aB	16.3 bB	12.8 bA
Avg weight of main ear (g)	CT	110 a	80 aB	74 aAB	62 aA
	NT	127 b	94 bB	85 aA	82 bA
Total weight of ears (kg/ha)	CT	6660 a	5220 aB	3870 aAB	3140 aA
	NT	9070 b	6590 bA	5100 bA	5250 bA
Popping expansion volume (cc/g)	CT	37 a	39 aA	36 aA	38 aA
	NT	38 a	39 aA	37 bA	37 bA

[z]Mean separation by Duncan's multiple range test, 5% level (lowercase for columns, uppercase for rows).

Table 2. The effect of tillage system and fertilizers on yielding potential of single- and double-ear plants of 'Iopop-12' popcorn grown in 1981.

	Fertilizer		Plants with single ear			Plants with double ears		
						Avg wt (g/ears)		
Culture	Material	N rate (kg/ha)	%	Avg wt (g/ear)	Yield (kg/ha)	Lower	Upper	Yield (kg/ha)
NT	none	0	86 d[z]	119 b	5280 b	72 a	111 a	1360 a
	NH_4NO_3	56	80 cd	129 b	6550 c	81 ab	124 bc	2520 b
	NH_4NO_3	112	73 b	129 b	5410 b	83 b	120 b	3250 bc
	$Ca(NO_3)_2$	56	77 bc	122 b	5340 b	81 ab	132 c	2750 bc
	$Ca(NO_3)_2$	112	75 bc	128 b	5660 b	88 bc	119 ab	3030 bc
CT	NH_4NO_3	56	66 a	94 a	2990 a	96 c	126 bc	3670 c

[z]Mean separation within columns by Duncan's multiple range, 5% level.

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Table 3. Effect of tillage system and fertilizers on N, K, and Ca content of 'Iopop-12' popcorn main ear leaves on 2 sampling dates in 1981.

Culture	Fertilizer Material	N rate (kg/ha)	14 Aug. N	14 Aug. K	14 Aug. Ca	30 Sept. N	30 Sept. K	30 Sept. Ca
			% dry wt					
NT	none	0	3.18 a[z]	2.15 b	0.39 a	1.73 a	1.25 a	0.91 b
	NH_4NO_3	56	3.42 ab	2.38 c	0.71 c	1.90 b	1.44 c	0.79 ab
	NH_4NO_3	112	3.60 b	2.12 ab	0.56 b	2.10 c	1.40 bc	0.77 a
	$Ca(NO_3)_2$	56	3.62 b	2.23 b	0.57 b	1.78 a	1.45 c	0.80 a
	$Ca(NO_3)_2$	112	3.67 b	2.16 b	0.52 b	2.03 c	1.35 b	0.81 ab
CT	NH_4NO_3	56	3.67 b	2.03 a	0.41 a	2.35 d	1.36 b	0.74 a

[z]Mean separation within column by Duncan's multiple range, 5% level.

Table 4. Effect of tillage system and nitrogen rate on total ear (kg/ha) weight of cultivars grown in 1982.

Tillage system	Nitrogen rate (kg/ha) 28	82	140
		'Snow Puff'	
CT	3160 ab[z]	4020 b	2250 a
NT	3800 a	5380 b	6580 b
		'Purdue-410'	
CT	3880 a	4480 a	3240 a
NT	3550 a	5820 b	5930 b
		'Iopop-12'	
CT	4750 a	5780 a	5130 a
NT	5330 a	7310 b	7150 b

[z]Mean separation within the row by Duncan's multiple range, 5% level.

the highest total yield, which was attributed mostly to a high percentage of plants with large, single ears. Plants grown by CT at the same level of N produced fewer single ears than did NT plants, and ear weight was reduced.

'Iopop-12' plants in both tillage systems, except for those grown by NT with 0 and 56 kg N/ha, had similar N concentrations in leaves by 14 Aug. (Table 3), but by 30 Sept. CT plants had more N than NT plants. This difference probably is attributed to the increased plant population in NT. NT plants fertilized with NH_4NO_3 at 56 kg N/ha also had more K and Ca on 14 Aug. This probably contributed to the higher yields by these plants than by CT plants (Table 1).

In 1982, there were significant tillage × nitrogen interactions for total ear weight of 'Snow Puff' and 'Purdue-410'. Increasing N from 28 to 84 kg increased ear weight for all cultivars in NT, but not in CT (Table 4). The additional N (140 kg/ha) had no effect on ear weight for 'Purdue-410' and 'Iopop-12', but it decreased the yield of 'Snow Puff' ears in CT. Since 'Snow Puff' is a short plant cultivar (Table 1), perhaps it has a smaller root system than plants of the other cultivars, thereby limiting nutrient absorption. Reddy et al. (7) reported that water use by corn plants is related to N levels, thus, additional levels of N with low soil moisture could adversely affect yield.

The data in these experiments indicate that popcorn cultivars can be grown by NT with the NT plants outyielding CT plants. The increase in total ear weight by NT was attributed to higher plant populations and/or heavier ears than for CT plants. Tillage systems had minimal effect on kernel expansion volume.

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In Vitro Plantlet Production from Young Capitulum Explants of *Gerbera jamesonii*

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Abstract. **Two clones of *Gerbera jamesonii* were propagated in vitro from fragments of young capitulum, 0.5 to 0.7 cm in diameter. These were cut into 20 to 25 explants and placed on several media. Media containing 0.57 μM (0.1 mg/liter) indole-3-acetic acid (IAA) and 4.4 or 8.8 μM (1 or 2 mg/liter) 6-benzylaminopurine (BA) gave best shoot production. Three mineral solutions were tested. All shoots over 0.5 cm rooted regardless of the IAA level in the medium.**

Pierik et al. (6, 7, 8) propagated *Gerbera jamesonii* using fully developed inflorescences from which disk and ligulate ray flowers had been removed and cut into 2 to 4 explants. Using the same method, Preil et al. (9) regenerated haploid plantlets with in vitro cultivated halved capitula. Our method uses young capitula and small explants.

Immature inflorescences, 0.5 to 0.7 cm in diameter, of *Gerbera jamesonii* 'Pastourelle' and 'Mardi Gras' were collected from plants cultivated at the Montreal Botanical Garden (Fig. 1). These were surface sterilized for 2 min in 70% ethanol, 90 min in 1.5% sodium hypochlorite with 0.01% Tween-20, and washed in sterilized distilled water for 45 min. After sterilization, involucral bracts were removed, and the capitula were cut into 20 to 25 explants. Each explant, containing between 25 and 40 sessile flowers, was inoculated separately on solid medium.

The basal medium (one-half MSH) contained Murashige and Skoog (MS) (3) macroelements plus Na_2EDTA + $FeSO_4 \cdot 7H_2O$ at one-half strength, Heller's (H) (1) microelements (except $FeCl_3$) plus NaFeEDTA 67 μM (25 mg/liter), 1% sucrose and 0.8% Difco Bacto agar. In addition, MS salt base at full strength and Heller's macro- and microelements (except $FeCl_3$) with NaFeEDTA 67 μM (25 mg/liter) also were tested with the same organic components. Adenine sul-

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