Project Title: Spring wheat planting population study - 2018

Objective: To determine the optimal planting population and the agronomic impacts of plant population in wheat

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Summary:

Six spring wheat varieties with four planting density combinations were planted in a complete randomized block design with 3 replications. The six varieties were Egan, Expresso, Solano, Soren, Tyra, and Vida. The four target planting population were: 16, 24, 32, and 40 plants/ft^2. Each plot was sampled for tiller and plant count. Management information is available in Table 1 and agronomic performance data is shown by population density in Table 2.

Table 1. Management information.

Seeding date:	5/2/2018	Harvest date:	8/30/2018
Julian date:	122	Julian date:	242
Seeding rates:	16, 24, 32, and 40 plants/ft^2	Soil type:	Creston silt loam
Previous crop:	pea	Soil Nutrient Residual (lb/A):	123-6-82 (Fall, 2017)
Tillage:	conventional	Nutrient fertilizer applied (lb/A):	40-40-100
Insecticide:	Warrior2	Fungicide:	Headline

All graphed results are shown using actual populations. All traits were significant for varieties, but protein, thousand kernel weight, plant height, biomass at heading, and falling number were not significant between planting densities. Variety and density interaction was insignificant indicating that varieties behaved similarly under various densities.

Yields for planting densities of 24, 32, and 40 were the same as shown in Figure 1A. These three densities achieved the same number of kernels per ft^2 (Fig. 1B). Increasing planting density had more number of plants as expected, but the number of productive tillers per plant was also reduced (Fig. 1C). Thus, yields (Fig. 1A) and the resulting income did not improve (Fig. 1D).

Optimum planting density for spring wheat, based on this study with diverse varieties and tillering capacities, is **24 plants/ft^2 under well-watered condition**. The soil this experiment was planted was with subsurface recharge (abundant soil moisture). Previous year's (2017) result under rainfed and drought conditions, yields recorded were the same for 16, 24, 32, and 40 plants/ft2 seeding -- in which actual live plants were on par with the target population.

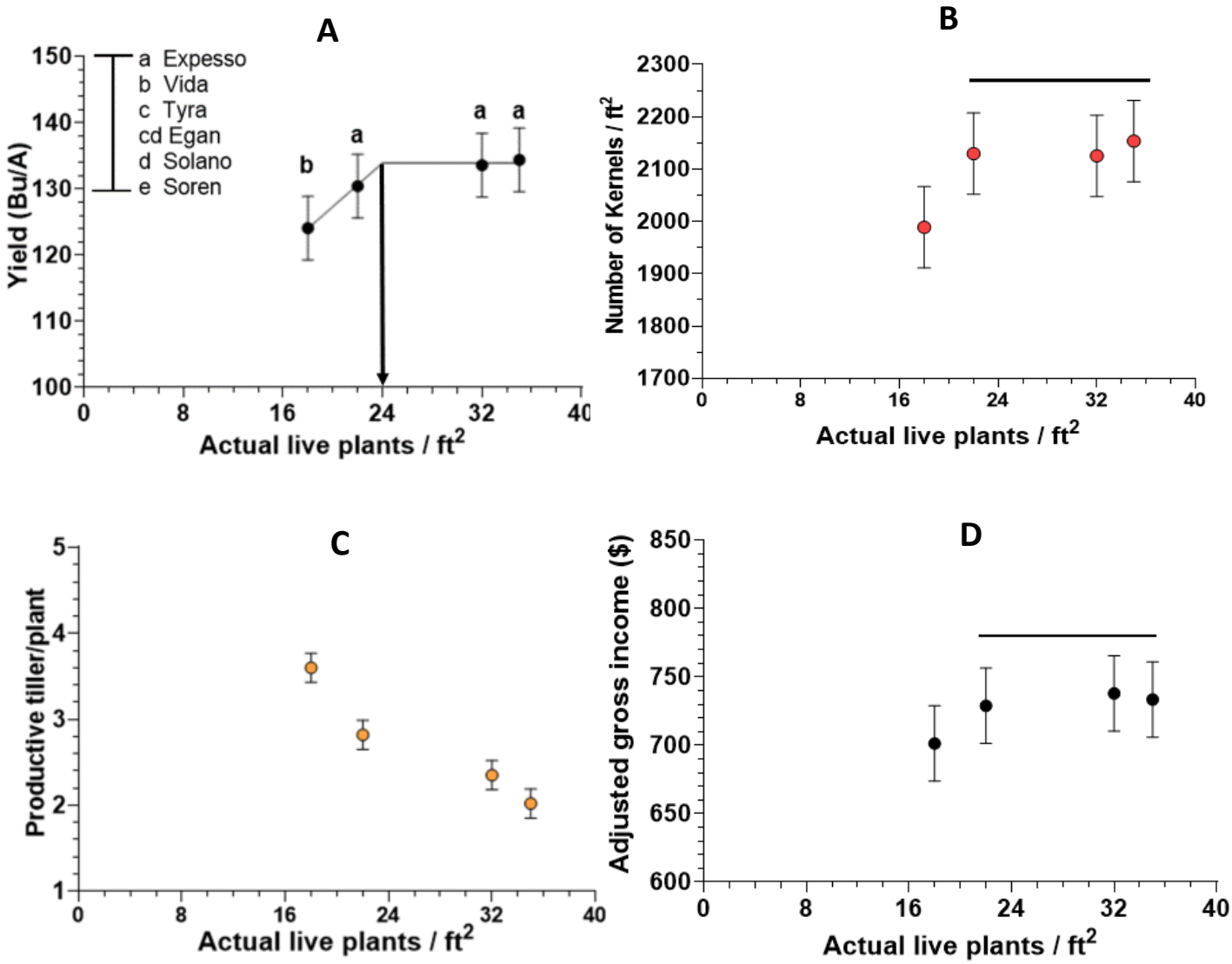

Figure 1. A) Yield, B) number of kernels per ft^2, C) productive tiller per plant, and D) adjusted gross income of actual live plants per ft^2.

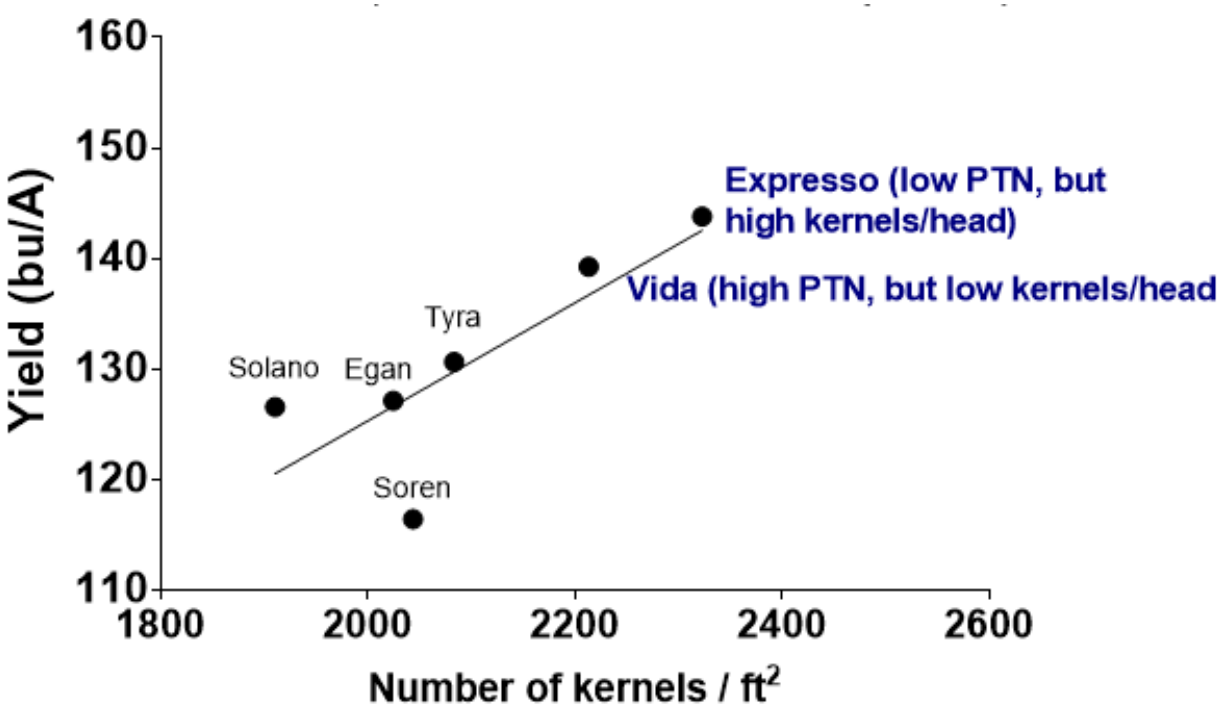

Fig. 2. Relationship between yield and number of kernels per ft^2. The relationship is linear in nature.

As shown in Figure 2, the tillering capacity of wheat is not a straightforward determinant of yield. The example is Expresso showing low productive tiller number (PTN; Table 2), but produced high yield. Vida on the other hand had high yield even with low number of kernels per head (smaller heads) but it produced high PTN.

Our results indicate that planting more seeds/ft^2 because a variety has low tillering capacity, does not guarantee increases in yield and income. The data suggest that under optimal growing condition, **24 plants/ft^2 is sufficient** (Fig 1A; Table 2).

Table 1: Agronomic performance of varieties under different density treatments

Variety/line	PLNT sqft	HD Julian	HT in	No. Kernels no./ft^2	PTN no./plant	Biomass lb/ft^2	YLD[1] bu/A	PRO[2] %	TWT[1] lb/bu	TKW g	FN Seconds
16 plants/ft^2											
Expresso	19.3	181	34.6	2318.6	2.5	0.35	141.9	14.8	57.4	40.9	293.2
Vida	23.1	180	40.5	2049.0	4.0	0.35	134.8	14.0	61.8	41.2	358.1
Tyra	15.3	180	33.6	1917.3	4.8	0.28	122.9	13.3	62.5	40.3	318.2
Egan	20.4	181	39.0	1923.2	3.5	0.38	120.7	16.3	61.3	38.9	414.8
Solano	17.6	180	30.4	1791.3	2.6	0.28	114.9	14.0	61.9	40.0	339.9
Soren	13.3	179	35.2	1933.1	3.9	0.29	109.3	15.1	62.8	35.2	375.8
Mean	18.2	180	35.5	1988.8	3.6	0.3	124.1	14.6	61.3	39.4	350.0
24 plants/ft^2											
Expresso	24.8	181	36.1	2351.4	2.1	0.34	144.2	14.6	59.0	40.3	301.4
Vida	20.9	180	39.4	2371.0	3.4	0.35	136.5	13.9	62.0	36.3	345.7
Tyra	24.5	179	33.9	2059.9	3.5	0.31	131.0	13.2	62.3	39.9	296.6
Solano	19.7	180	31.5	1864.3	2.4	0.31	127.7	14.2	62.1	43.0	344.0
Egan	20.4	180	39.4	2048.5	2.7	0.33	127.3	16.3	61.6	38.5	446.9
Soren	20.6	179	33.5	2059.9	2.9	0.28	115.9	14.8	63.0	34.9	392.4
Mean	21.8	180	35.6	2129.7	2.8	0.3	130.4	14.5	61.7	38.8	354.5
32 plants/ft^2											
Expresso	32.8	180	35.9	2363.1	1.9	0.31	149.0	14.3	59.1	41.4	297.2
Vida	28.8	179	38.6	2180.6	2.7	0.35	141.3	14.1	61.8	40.7	363.2
Tyra	34.0	179	33.6	2141.2	2.8	0.31	131.8	13.2	62.6	38.7	305.9
Solano	30.9	179	32.5	1959.5	1.9	0.29	129.3	14.0	62.5	41.2	354.3
Egan	37.8	180	38.8	2029.7	2.3	0.40	128.9	16.0	61.8	39.4	439.6
Soren	27.6	178	34.5	2078.6	2.5	0.31	121.3	14.9	63.3	36.2	372.9
Mean	32.0	179	35.7	2125.4	2.4	0.3	133.6	14.4	61.9	39.6	355.5

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Variety/line	PLNT sqft	HD Julian	HT in	No. Kernels no./ft^2	PTN till/plant	Biomass lb/ft^2	YLD[1] bu/A	PRO[2] %	TWT[1] lb/bu	TKW g	FN Seconds
40 plants/ft^2											
Vida	35.3	179	40.1	2251.3	2.6	0.35	144.5	14.0	62.3	40.2	347.7
Expresso	34.9	180	35.3	2257.1	1.6	0.30	140.1	14.4	59.9	40.5	305.1
Tyra	32.2	179	35.2	2190.8	2.5	0.29	136.8	13.2	62.6	39.4	319.7
Solano	35.0	180	31.5	2025.2	1.5	0.28	134.3	14.3	62.3	41.4	341.0
Egan	38.8	180	41.2	2095.4	1.9	0.33	131.6	15.9	61.8	38.8	436.4
Soren	32.3	177	34.6	2102.0	2.1	0.30	119.0	15.0	63.3	35.2	397.3
Mean	34.7	179	36.3	2153.6	2.0	0.3	134.4	14.5	62.0	39.3	357.9
Pr>F Variety	0.2221	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Pr>F Density	<.0001	<.0001	0.2867	.0001	<.0001	0.3515	<.0001	0.3930	0.0101	0.4347	0.7271
Pr>F Var X Den	0.8280	0.4417	0.2880	.3269	0.7763	0.6098	0.2025	0.5841	0.4890	0.0676	0.7649

PLNT: stand count, HD: heading date, HT: plant height, No. kernels: number of seeds, PTN: productive tiller number, YLD: yield, PRO: protein, TWT: test weight, TKW: thousand kernel weight, FN: falling numbers

[1] Adjusted to 13% moisture

[2] Adjusted to 12% moisture