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Irrigated Corn Response to Reduced Well Capacity

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ABSTRACT

Many of the irrigation systems today in the Central Great Plains no longer have the capacity to apply peak irrigation needs during the summer and must rely on soil water reserves to buffer the crop from water stress. The objective of this study was to determine grain and biomass yield response of corn hybrids to different irrigation capacities. Field studies were conducted at the KSU-NWREC near Colby, KS and KSU-SWREC near Garden City, KS from 2014 to 2017 and at KSU-SWREC near Tribune, KS from 2015 to 2017. The studies were a factorial design of irrigation capacities (ranging from 0.08 to 0.25 inch/day [2 to 6 mm/day]) and corn hybrids (drought tolerant and conventional). Average grain yields increased 7 to 15% when increasing irrigation capacity from about 0.08 to 0.25 inch/day (2 to 6 mm/day). Yield increases were due to an increase in the number of kernels/ear, greater seed mass or both components. Grain yields were not increased by use of a drought tolerant hybrid. At one site, increasing seeding rate from 24,000 to 40,000 kernels/acre (59,000 to 99,000 kernels/ha) increased grain yields an average of 14% with some increase observed at all irrigation capacities.

KEYWORDS: Grower/Farmer, Sprinkler, Deficit irrigation,

INTRODUCTION

Irrigated crop production is a mainstay of agriculture in western Kansas. However, with declining water levels in the Ogallala aquifer, optimal utilization of limited irrigation water is required. The most common crop grown under irrigation in western Kansas is corn. Almost all of the groundwater pumped from the High Plains (Ogallala) Aquifer is used for irrigation. Irrigators are faced with the problem of declining well capacities due to water withdrawals from the Ogallala aquifer for irrigation exceeding mean annual recharge. In addition to limited well capacities, public policy may also impose limits on total amounts of water that can be pumped. For example the 20% reduction in pumped water that is being implemented as part of a Local Enhanced Management Area (LEMA) policy in parts of Groundwater Management District (GMD) 4 and several Water Conservation Areas (WCAs) that have been implemented in GMD 1 and GMD 3. One of the major challenges facing irrigated corn producers in Kansas is how to maintain or increase yields under declining well capacities or limited water supplies.

The major corn seed companies have extensive hybrid development work underway in the western Corn Belt to develop hybrids that are drought tolerant. The overall goal is to develop hybrids that will not incur a yield reduction under ideal conditions, yet stabilize yield under water-stressed conditions. A major secondary trait associated with drought tolerance in corn is the shortening of the anthesis to silk interval (ASI) which has a strong influence on biomass partitioning (Bolaños and Edmeades, 1996). The flowering period of corn often coincides with the period of greatest irrigation demand and consequently

a limited irrigation capacity during this critical stage can markedly affect the ASI, biomass partitioning, and grain yield.

Although corn yields have increased greatly during the last 30 years, much of the increase can be attributed to achieving greater final kernel set at higher plant densities (i.e., greater number of kernels/unit area). However, Lobel et al. (2014) suggested that greater plant densities result in greater sensitivity to drought.

Most of the irrigation systems today in the Central Great Plains no longer have the capacity to apply peak irrigation needs during the summer and must rely on soil water reserves to buffer the crop from water stress. Therefore, this study was conducted to evaluate whether management factors such as hybrid selection and seeding rate can be used to increase productivity when well capacity is limited and insufficient to fully meet crop requirements.

MATERIALS AND METHODS

Field studies were conducted at three sites in Kansas. All sites evaluated multiple irrigation capacities and corn hybrids but some treatments differed among sites. At the NWREC near Colby and SWREC near Garden City, whole-plot treatments were sprinkler irrigation capacities of 1 inch every 4, 6, 8, 10, or 12 d (0.25, 0.17, 0.13, 0.10, and 0.08 inch/day [6, 4, 3, 2.5, and 2 mm/day], respectively) in randomized complete block designs. Garden City also had a dryland treatment. Two DeKalb corn hybrids DKC 62-27 DGVT2PRO (DroughtGard) and DKC 62-98 VT2PRO planted at 32,000 seeds/acre (79,000 seeds/ha) were superimposed as split plot treatments. At the SWREC site near Tribune, the whole plot treatments were sprinkler irrigation capacities of 1.5 inch (38 mm) every 1, 2, or 3 weeks (approximates about 1 inch [25 mm] every 4, 8, or 12 days) in a randomized complete block design. Subplots were three corn hybrids (the two Dekalb hybrids along with Pioneer P1151AMX [AquaMax]) at three seeding rates (24,000, 32,000, and 40,000 seeds/acre [59,000, 79,000, and 99,000 seeds/ha]).

Corn was planted in late April to early May under lateral move sprinkler systems at all locations. Irrigations were scheduled as needed according to weather-based water budgets, but limited to the irrigation capacity treatments as indicated in the specific site procedures. Soil water was measured in the complete root zone (0 to 240 cm) periodically throughout the season to help quantify periods of water stress and to determine crop water use. Weather data was measured using automated weather stations that exist on all sites. Corn grain yield was determined by harvesting a representative sample after physiological maturity. Determinations were made of all corn yield components; (grain yield, plant density, ears/plant, kernels/ear, and kernel mass) as well as the important intermediate yield component, kernels/area. Total dry aboveground biomass was also determined through destructive sampling of 5 adjacent plants and drying the samples and weighing the resultant sample.

Crop water use was calculated by summing soil water depletion (soil water at planting less soil water at harvest) plus in-season irrigation and precipitation. In-season irrigations and precipitation amounts at each site-year are shown in Table 1. Crop water productivity (CWP) was calculated by dividing grain yield (lb a^{-1} [kg ha^{-1}]) by crop water use (in [mm]).

RESULTS AND DISCUSSION

Growing conditions were generally favorable during the years of this study. At Colby, growing season precipitation (May through August) was above normal 3 years of the 4 years (Table 1). At Garden City,

growing season precipitation was above normal in 3 of the 4 years and, at Tribune, precipitation was above normal every year. However, at Tribune in 2017, hail damage caused some reduction in grain yield.

Colby

Averaged across 4 years, grain yields were increased about 7% (16 bu/a [1,004 kg/ha]) by increasing irrigation capacity from 1 inch (25 mm) every 12 days to 1 inch (25 millimeter) every 4 days (Table 2). This was due mainly to an increase in number of kernels/ear. Biomass was also increased by increasing irrigation capacity. Crop water productivity decreased with increased irrigation capacity. There was little difference (5 bu/a [315 kg/ha] or less) in grain yield between the conventional and drought tolerant hybrids at any irrigation level with an average of 3 bu/a (188 kg/ha) greater yield with the drought tolerant hybrid. The drought tolerant hybrid had greater number of kernels/ear but less seed mass. Biomass production was least with the lowest irrigation capacity with little difference between hybrids.

Garden City

Irrigation at the lowest capacity (1 inch [25 mm] every 12 days) increased yields 66% (79 bu/a [4,955 kg/ha]) compared to non-irrigated (Table 3). This was due to increased seed mass and greater number of kernels/ear. Increasing capacity to 1 inch (25 mm) every 4 days increased yields and additional 15% (30 bu/a [1,882 kg/ha]) due primarily to greater seed mass. Biomass was about 6500 lb/a (407,680 kg/ha) greater with the lowest irrigation capacity compared to dryland and increased an additional 3000 lb/a (188,160 kg/ha) with the highest irrigation capacity. Crop water productivity was greater for all irrigation capacities than for dryland. However, CWP was similar for all levels of irrigation capacity. Hybrid selection had little effect on grain yield when averaged across all irrigation capacities (including dryland) with 4 bu/a (251 kg/ha) less yield with the drought tolerant

Tribune

Increasing irrigation capacity from 0.08 inch/day (2 mm/day) to 0.25 inch/day (6 mm/day) increased average corn grain yields by 11% due primarily to greater kernel mass and a tendency towards greater number of kernels/ear as there were no differences in plant or ear population (Table 2). Increasing seeding rate from 24,000 to 40,000 seeds/acre (59,000 to 99,000 seeds/ha) increased average yields by about 14%. The increase in seeding rate and corresponding increase in ear population more than made up for the decreases in kernel mass and kernels/ear. The total number of kernels/ft^2 (kernels/m^2) was increased with increased seeding rate. The drought tolerant hybrid did not produce greater yield than the conventional hybrid. The conventional hybrid had greater plant and ear populations, and kernel mass than the drought tolerant hybrids but fewer number of kernels/ear. Total biomass production was also greater for the conventional hybrid. Increasing seeding rate and irrigation capacity also increased biomass production. Crop water productivity was increased by increased seeding rate but decreased by increased irrigation capacity. Crop water productivity was greater with the conventional hybrid than the drought tolerant hybrids.

CONCLUSIONS

Increasing irrigation capacity from about 0.08 to 0.25 inch/day (2 to 6 mm/day) increased average grain yields at all sites with the magnitude of the increase ranging from 7 to 15%. The yield increase was due to an increase in the number of kernels/ear and/or greater seed mass. Grain yields were generally similar for the conventional and drought tolerant hybrids. At the site with a population variable, increasing seeding rate from 24,000 to 40,000 kernels/acre (59,000 to 99,000 kernels/ha) increased grain yields an average of 14% with some increase observed at all irrigation capacities. Crop water

productivity decreased with increased irrigation capacity at two sites and was similar for all irrigation capacities at the other site.

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Table 1. Growing season precipitation (May to August) and in-season irrigation amounts at Colby, Garden City, and Tribune from 2014 to 2017.

Year	Colby	Garden City	Tribune
Precipitation		inches (mm)	
2014	13.28 (337)	16.93 (430)	--
2015	15.94 (405	16.37 (416	13.78 (350)
2016	7.61 (193)	12.35 (314)	14.19 (360)
2017	16.05 (408)	7.20 (183)	15.63 (397)
Normal	12.25 (311)	11.41 (290)	10.50 (267)
Irrigation			
2014	7.5 – 13.4 (191-340)	5.0 – 12.0 (127-305)	--
2015	6.7 – 15.4 (170-391)	4.0 – 8.0 (102-203)	6.1 – 15.3 (155-389)
2016	7.7 – 14.4 (196-366)	3.0 – 9.0 (76-229)	6.2 – 12.1(157-307)
2017	7.7 – 14.4 (196-366)	5.0 – 12.0 (127-305)	6.0 – 14.1 (152-358)

Table 2. Average crop parameters as affected by irrigation capacity and corn hybrids, Colby, KS, 2014 - 2017.

Irrigation	Hybrid	Yield	CWP[†]	Plant Pop.	Ear Pop.	1000 seed	Kernels		Biomass
1" per		bu/a (kg/ha)	lb/ac-in (kg/ha-mm)	10^3/acre (10^3/ha)		oz (g)	no/ear	no/foot^2 (no/m^2)	lb/a (kg/ha)
4 days	DKC 62-98	248 (15555)	472 (8.44)	33.5 (82.7)	33.6 (83.0)	12.51 (355)	537	414 (4455)	21737 (24345)
	DKC 62-27 DG	251 (15743)	479 (8.56)	33.1 (81.8)	33.2 (82.0)	10.96 (311)	623	475 (5111)	23311 (26108)
6 days	DKC 62-98	245 (15366)	502 (8.97)	33.2 (82.0)	33.2 (82.0)	12.51 (355)	535	408 (4390)	22748 (25478)
	DKC 62-27 DG	248 (15555)	507 (9.06)	33.3 (82.3)	32.7 (80.8)	10.83 (308)	643	482 (5186)	22671 (25392)
8 days	DKC 62-98	242 (15178)	519 (9.28)	33.5 (82.7)	33.3 (82.3)	12.51 (355)	528	403 (4336)	22071 (24720)
	DKC 62-27 DG	243 (15241)	519 (9.28)	33.4 (82.5)	33.1 (81.8)	11.01 (313)	603	459 (4939)	22642 (25359)
10 days	DKC 62-98	243 (15241)	568 (10.15)	33.4 (82.5)	33.2 (82.0)	12.48 (354)	535	408 (4390)	22028 (24671)
	DKC 62-27 DG	245 (15366)	546 (9.76)	33.1 (81.8)	33.0 (81.5)	10.79 (306)	631	478 (5143)	22070 (24718)
12 days	DKC 62-98	232 (14551)	521 (9.31)	33.4 (82.5)	33.4 (82.5)	12.56 (357)	504	386 (4153)	20513 (22975)
	DKC 62-27 DG	237 (14865)	537 (9.60)	33.1 (81.8)	33.0 (81.5)	10.73 (305)	604	458 (4928)	21779 (24392)
MEANS									
4 days		250 (15680)	475 (8.49)	33.3 (82.3)	33.4 (82.5)	11.74 (333)	580	445 (4788)	22529 (25232)
6 days		246 (15429)	504 (9.01)	33.3 (82.3)	32.9 (81.3)	11.67 (331)	589	446 (4799)	22709 (25434)
8 days		242 (15178)	519 (9.28)	33.4 (82.5)	33.2 (82.0)	11.76 (334)	565	431 (4638)	22357 (25040)
10 days		244 (15304)	557 (9.96)	33.3 (82.3)	33.1 (81.8)	11.64 (331)	583	443 (4767)	22050 (24696)
12 days		234 (14676)	529 (9.46)	33.3 (82.3)	33.2 (82.0)	11.65 (331)	554	422 (4541)	21149 (23687)
	DKC 62-98	242 (15178)	516 (9.22)	33.4 (82.5)	33.3 (82.3)	12.52 (356)	528	404 (4347)	21821 (24440)
	DKC 62-27 DG	245 (15366)	517 (9.24)	33.2 (82.0)	33.0 (81.5)	10.87 (309)	621	470 (5057)	22494 (25193)
2014		238 (14927)	499 (8.92)	32.9 (81.3)	33.0 (81.5)	11.81 (335)	551	418 (4498)	22155 (24814)
2015		249 (15617)	473 (8.45)	32.9 (81.3)	32.9 (81.3)	11.21 (318)	616	465 (5003)	22061 (24708)
2016		238 (14927)	585 (10.46)	32.9 (81.3)	32.5 (80.3)	11.33 (322)	601	448 (4820)	21516 (24098)
2017		249 (15617)	511 (9.13)	34.4 (85.0)	34.3 (84.7)	12.41 (352)	529	416 (4476)	- - -

[†] CWP = crop water productivity.

Table 3. Average crop parameters as affected by irrigation capacity and corn hybrids, Garden City, KS, 2014 - 2017.

Irrigation	Hybrid	Yield	CWP†	Plant Pop.	Ear Pop.	1000 seed	Kernels		Biomass
1" per		bu/a (kg/ha)	lb/ac-in (kg/ha-mm)	10^3/acre (10^3/ha)		oz (g)	no/ear	no/foot^2 (no/m^2)	lb/a (kg/ha)
4 days	DKC 62-98	230 (14426)	601 (10.74)	29.8 (73.6)	29.8 (73.6)	16.98 (482)	406	290 (3120)	20888 (23395)
	DKC 62-27 DG	226 (14175)	549 (9.81)	27.8 (68.7)	27.8 (68.7)	14.47 (411)	474	308 (3314)	20802 (23298)
6 days	DKC 62-98	218 (13673)	591 (10.56)	29.0 (71.6)	28.8 (71.1)	17.01 (483)	404	275 (2959)	19707 (22072)
	DKC 62-27 DG	214 (13422)	568 (10.15)	27.8 (68.7)	27.7 (68.4)	14.70 (417)	461	299 (3217)	19882 (22268)
8 days	DKC 62-98	219 (13736)	622 (11.12)	29.9 (73.9)	29.9 (73.9)	17.13 (486)	379	263 (2830)	19642 (21999)
	DKC 62-27 DG	219 (13736)	606 (10.83)	28.0 (69.2)	27.6 (68.2)	14.01 (398)	495	320 (3443)	19707 (22072)
10 days	DKC 62-98	207 (12983)	624 (11.15)	29.9 (73.9)	29.7 (73.4)	15.65 (444)	396	272 (2927)	17852 (19994)
	DKC 62-27 DG	195 (12230)	608 (10.87)	27.0 (66.7)	26.6 (65.7)	13.37 (380)	493	309 (3325)	17242 (19311)
12 days	DKC 62-98	202 (12669)	613 (10.96)	30.6 (75.6)	30.2 (74.6)	15.27 (434)	367	250 (2690)	17798 (19934)
	DKC 62-27 DG	195 (12230)	555 (9.92)	28.0 (69.2)	27.9 (68.9)	12.23 (347)	478	316 (3400)	17767 (19899)
Dryland	DKC 62-98	119 (7464)	427 (7.63)	28.8 (71.1)	27.6 (68.2)	11.26 (320)	332	192 (2066)	11452 (12826)
	DKC 62-27 DG	119 (7464)	446 (7.97)	28.0 (69.2)	27.8 (68.7)	8.99 (255)	405	258 (2776)	10987 (12305)
MEANS									
4 days		228a (14300a)	575a (10.28a)	28.8 (71.1)	28.8 (71.1)	15.72a (446a)	440a	299a (3217a)	20845a (23346a)
6 days		216ab (13548ab)	580a (10.37a)	28.4 (70.1)	28.3 (69.9)	15.86a (450a)	432a	287a (3088a)	19794a (22169a)
8 days		219ab (13736ab)	614a (10.97a)	28.9 (71.4)	28.7 (70.9)	15.57a (442a)	437a	291a (3131a)	19674a (22035a)
10 days		201b (12607b)	616a (11.01a)	28.5 (70.4)	28.2 (69.7)	14.51b (412b)	445a	290a (3120a)	17547b (19653b)
12 days		198b (12419b)	584a (10.44a)	29.3 (72.4)	29.0 (71.6)	13.75b (391b)	422a	283a (3045a)	17783b (19917b)
Dryland		119c (7464c)	437b (7.81b)	28.4 (70.1)	27.7 (68.4)	10.13c (288c)	369b	225b (2421b)	11219c (12565c)
LSD $_{0.05}$		25 (1568)	85 (1.52)	1.6 (4.0)	1.7 (4.2)	0.80 (23)	43	31 (334)	1783 (1997)
	DKC 62-98	199 (12481)	580 (10.37)	29.7a (73.4a)	29.3a (72.4a)	15.55a (442a)	381b	257b (2765b)	17890 (20037)
	DKC 62-27 DG	195 (12230)	555 (9.92)	27.8b (68.7b)	27.6b (68.2b)	12.96b (368b)	468a	302a (3250a)	17731 (19859)
	LSD $_{0.05}$	8 (502)	30 (0.54)	0.8 (2.0)	0.9 (2.2)	0.58 (16)	20	15 (161)	807 (904)
2014		175b (10976b)	635a (11.35a)	29.9a (73.9a)	29.3a (72.4a)	13.16b (374b)	392b	265b (2851b)	15711c (17596c)
2015		184b (11540b)	538b (9.62b)	27.2c (67.2c)	27.1b (66.9b)	- - -	- - -	- - -	17910b (20059b)
2016		217a (13610a)	529b (9.46b)	28.6b (70.6b)	28.2ab (69.7ab)	15.53a (441a)	456a	294a (3163a)	19809a (22186a)
2017		211a (13234a)	- - -	29.2ab (72.1ab)	29.1a (71.9a)	- - -	- - -	- - -	- - -
LSD $_{0.05}$		11 (690)	37 (0.66)	1.2 (3.0)	1.2 (3.0)	0.58 (16)	20	15 (161)	988 (1107)
ANOVA (P>F)									
Irrigation		0.001	0.004	0.803	0.528	0.001	0.016	0.001	0.001
Hybrid		0.284	0.116	0.001	0.001	0.001	0.001	0.001	0.697
Hybrid*Irrigation		0.947	0.739	0.678	0.330	0.908	0.412	0.259	0.993
Year		0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001

† CWP = crop water productivity

Table 4. Average crop parameters as affected by irrigation capacity, corn hybrids, and seeding rate, Tribune, KS, 2015 - 2017.

Irrigation	Hybrid	Seed Rate	Yield	CWP[†]	Plant Pop.	Ear Pop.	1000 seed	Kernels		Biomass
1" per		10^3/acre (10^3/ha)	bu/a (kg/ha)	lb/ac-in (kg/ha-mm)	10^3/acre (10^3/ha)		oz (g)	no/ear	no/foot^2 (no/m^2)	lb/a (kg/ha)
4 days	DKC 62-98	24 (59)	211 (13234)	414 (7.40)	24.3 (60.0)	24.0 (59.3)	14.01 (398)	566	312 (3357)	17302 (19378)
		32 (79)	233 (14614)	454 (8.11)	32.5 (80.3)	32.0 (79.0)	13.68 (389)	478	351 (3777)	19096 (21388)
		40 (99)	235 (14739)	449 (8.03)	39.7 (98.1)	39.0 (96.3)	13.22 (375)	411	368 (3960)	23180 (25962)
	DKC 62-27 DG	24 (59)	199 (12481)	398 (7.11)	23.3 (57.6)	23.2 (57.3)	11.96 (340)	649	344 (3701)	16994 (19033)
		32 (79)	222 (13924)	426 (7.61)	30.8 (76.1)	30.0 (74.1)	11.42 (324)	587	402 (4326)	19272 (21585)
		40 (99)	229 (14363)	452 (8.08)	36.8 (90.9)	35.3 (87.2)	11.19 (318)	528	425 (4573)	20805 (23302)
	P1151 AMX	24 (59)	191 (11980)	375 (6.70)	21.8 (53.8)	22.7 (56.1)	13.31 (378)	572	297 (3196)	15088 (16899)
		32 (79)	201 (12607)	386 (6.90)	27.7 (68.4)	27.3 (67.4)	12.44 (353)	537	338 (3637)	16363 (18327)
		40 (99)	235 (14739)	456 (8.15)	36.4 (89.9)	35.7 (88.2)	12.12 (344)	493	404 (4347)	19351 (21673)
8 days	DKC 62-98	24 (59)	199 (12481)	460 (8.22)	23.4 (57.8)	23.2 (57.3)	13.82 (392)	560	298 (3206)	16029 (17952)
		32 (79)	220 (13798)	498 (8.90)	32.9 (81.3)	32.1 (79.3)	13.00 (369)	470	347 (3734)	19397 (21725)
		40 (99)	223 (13987)	511 (9.13)	39.3 (97.1)	38.2 (94.4)	12.90 (366)	407	356 (3831)	20203 (22627)
	DKC 62-27 DG	24 (59)	185 (11603)	410 (7.33)	23.0 (56.8)	22.5 (55.6)	11.66 (331)	634	326 (3508)	15184 (17006)
		32 (79)	205 (12858)	449 (8.03)	30.5 (75.3)	30.2 (74.6)	11.07 (314)	553	381 (4100)	16615 (18609)
		40 (99)	206 (12920)	465 (8.31)	35.8 (88.4)	35.1 (86.7)	10.77 (306)	500	397 (4272)	18419 (20629)
	P1151 AMX	24 (59)	180 (11290)	407 (7.27)	21.5 (53.1)	21.6 (53.4)	12.90 (366)	586	290 (3120)	14354 (16076)
		32 (79)	200 (12544)	464 (8.29)	28.6 (70.6)	28.0 (69.2)	12.42 (353)	522	334 (3594)	16910 (18939)
		40 (99)	203 (12732)	458 (8.19)	34.3 (84.7)	33.5 (82.7)	12.07 (343)	483	353 (3798)	17213 (19279)
12 days	DKC 62-98	24 (59)	183 (11478)	449 (8.03)	23.6 (58.3)	23.5 (58.0)	13.44 (382)	517	279 (3002)	15684 (17566)
		32 (79)	190 (11917)	460 (8.22)	31.6 (78.1)	31.5 (77.8)	12.54 (356)	426	309 (3325)	17611 (19724)
		40 (99)	214 (13422)	518 (9.26)	38.7 (95.6)	38.1 (94.1)	12.54 (356)	399	350 (3766)	19109 (21402)
	DKC 62-27 DG	24 (59)	181 (11352)	438 (7.83)	22.9 (56.6)	23.3 (57.6)	11.21 (318)	623	332 (3572)	14568 (16316)
		32 (79)	206 (12920)	481 (8.60)	30.4 (75.1)	30.3 (74.8)	10.72 (304)	567	395 (4250)	16723 (18730)
		40 (99)	195 (12230)	465 (8.31)	38.3 (94.6)	37.8 (93.4)	10.33 (293)	449	390 (4196)	18484 (20702)
	P1151 AMX	24 (59)	180 (11290)	433 (7.74)	22.2 (54.8)	23.1 (57.1)	12.67 (360)	558	293 (3153)	14965 (16761)
		32 (79)	201 (12607)	484 (8.65)	29.1 (71.9)	28.9 (71.4)	11.94 (339)	525	348 (3744)	15512 (17373)
		40 (99)	203 (12732)	477 (8.53)	35.1 (86.7)	34.7 (85.7)	11.82 (336)	452	359 (3863)	16513 (18495)

[†] CWP = crop water productivity. ** Hail event on 8/18/17 **

Table 4 (cont.). Average crop parameters as affected by irrigation capacity, corn hybrids, and seeding rate, Tribune, 2015 - 2017.

Irrigation	Hybrid	Seed Rate	Yield	CWP[1]	Plant Pop.	Ear Pop.	1000 seed	Kernels		Biomass
1" per		10^3/a (10^3/ha)	bu/a (kg/ha)	lb/ac-in (kg/ha-mm)	10^3/acre (10^3/ha)		oz (g)	no/ear	no/foot^2 (no/m^2)	lb/a (kg/ha)
MEANS										
4 days			217a (13610a)	423b (7.56b)	30.4 (75.1)	29.9 (73.9)	12.59a (358a)	536	360 (3874)	18606a (20839a)
8 days			202b (12669b)	458a (8.19a)	29.9 (73.9)	29.4 (72.6)	12.29ab (349ab)	524	343 (3691)	17147b (19205b)
12 days			195b (12230b)	467a (8.35a)	30.2 (74.6)	30.1 (74.3)	11.91b (338b)	502	339 (3648)	16575b (18564b)
LSD $_{0.05}$			13 (815)	30 (0.54)	1.7 (4.2)	1.7 (4.2)	0.46 (13)	31	24 (258)	1419 (1589)
	DKC 62-98		212a (13297a)	468a (8.37a)	31.8a (78.5a)	31.3a (77.3a)	13.24a (376a)	470c	330b (3551b)	18624a (20859a)
	DKC 62-27 DG		203b (12732 b)	443b (7.92b)	30.2b (74.6b)	29.7b (73.4b)	11.15c (317c)	565a	377a (4057a)	17452b (19546b)
	P1151 AMX		199b 12481b)	438b (7.83b)	28.5c (70.4c)	28.4c (70.1c)	12.41b (352b)	525b	335b (3605b)	16252c (18202c)
	LSD $_{0.05}$		7 (439)	15 (0.27)	0.9 (2.2)	0.9 (2.2)	0.19 (5)	15	12 (129)	734 (822)
		24 (59)	190c (11917c)	420c (7.51c)	22.9c (56.6c)	23.0c (56.8c)	12.78a (363a)	585a	308c (3314c)	15574c (17443c)
		32 (79)	208b (13046b)	456b (8.15b)	30.5b (75.3b)	30.0b (74.1b)	12.14b (345b)	518b	356b (3831b)	17500b (19600b)
		40 (99)	216a (13548a)	472a (8.44a)	37.2a (91.9a)	36.4a (89.9a)	11.88c (337c)	458c	378a (4067a)	19253a (21563a)
		LSD $_{0.05}$	7 (439)	15 (0.27)	0.9 (2.2)	0.9 (2.2)	0.19 (5)	15	12 (129)	734 (822)
		2015	182c (11415c)	438b (7.83b)	27.3b (67.4b)	26.8c (66.2c)	12.66b (360b)	502c	297c (3196c)	14918c (16708c)
		2016	223a (13987a)	444b (7.94b)	31.7a (78.3a)	30.7b (75.8b)	12.97a (368a)	519b	355b (3820b)	19636a (21992a)
		2017	209b (13108b)	467a (8.35a)	31.5a (77.8a)	31.9a (78.8a)	11.17c (317c)	541a	389a (4186a)	17774b (19907b)
		LSD $_{0.05}$	7 (439)	15 (0.27)	0.9 (2.2)	0.9 (2.2)	0.19 (5)	15	12 (129)	734 (822)
ANOVA (P>F)										
Irrigation			0.015	0.028	0.826	0.573	0.030	0.089	0.152	0.031
Seed rate			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Seed rate*Irrigation			0.605	0.755	0.719	0.750	0.972	0.697	0.563	0.182
Hybrid			0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Hybrid*Irrigation			0.232	0.169	0.770	0.562	0.701	0.641	0.325	0.413
Hybrid*Seed rate			0.600	0.925	0.312	0.099	0.958	0.024	0.452	0.542
Irrigation*Seed rate*Hybrid			0.521	0.206	0.819	0.894	0.890	0.397	0.553	0.766
Year			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

[†] CWP = crop water productivity * Hail event on 8/18/17