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# YIELD AND FRUIT-SIZE DISTRIBUTION OF 17 PUMPKIN (*CUCURBITA PEPO*) CULTIVARS GROWN IN NORTHERN UTAH

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## ABSTRACT

Jack-O-Lantern type pumpkins are a locally grown commercial crop in northern Utah. We organized a 2 year trial of 15 hybrid cultivars and 2 open-pollinated cultivars and gauged yield, color, stem strength, height, and width of marketable fruit. Plants were arranged into a randomized complete block design (n=3). We initially grew 15 hybrid cultivars ('Camaro', 'Challenger', 'Charisma', 'Corvette', 'Cougar', 'Gladiator', 'Magic Lantern', 'Magic Wand', 'Magician', 'Mustang', 'New Moon', 'Orange Rave', 'Racer', 'Sorcerer' and 'Summit') and two open-pollinated cultivars (Connecticut Field and Howden). After year 1 harvest all had acceptable color and stem strength except New Moon (50% of stems broke). 'Camaro', 'Challenger', Connecticut Field, 'Corvette', 'Cougar', Howden, 'Magic Lantern', 'Magician' and 'Mustang' all yielded greater than 23 tons per acre (TPA) with 'Challenger' producing 32.4 TPA. Additionally, 75% of 'Magic Lantern' fruit weighed between 15-25 pounds and measured between 10-15 inches high and wide, a size required by many grocery chains. Seventy-six percent of 'Challenger' fruit weighed above 25 pounds. 'Howden' produced a variety of fruit sizes on the same plant and is potentially useful for roadside-stand style businesses. In year 2, we planted all cultivars that yielded 23 TPA or greater in year 1, except 'Connecticut Field' and 'New Moon', for further evaluation. Due to unforeseen circumstances plants received approximately 50% of the water they received in year 1. Most varieties yielded 30%-50% of year 1. Exceptions to this included 'Camaro' and 'Mustang' which produced 20.4 and 18.6 TPA respectively.

## INTRODUCTION

Jack-o-lantern type pumpkins are a popular crop with commercial growers in Northern Utah. In meeting and working with local fresh market growers they independently said they consider a yield of 20 tons per acre profitable. (Harward, Jake; Jensen, Ron; Rowley, Tod; 2014 personal communication). However, yield is not the only useful criteria for selecting pumpkin cultivars suitable for a growers' business model. For example, those marketing directly using roadside stands or agro-tourism require a wide variety of sizes, depending on the age of the individual choosing the pumpkin (Harward, Jake; Jensen, Ron; Rowley, Tod; 2014 personal communication). Conversely, growers who market to wholesale distributors and large grocery chains are usually required to provide pumpkins to be of consistent size and weight as per specifications from the buyer.

For example most box stores and grocers require that carving-type pumpkins meet certain specifications such as each bin must contain 40-45 marketable fruits according to their specifications. Fruit should be between 15 and 25 pounds, 11-15 inches high and wide, mostly orange, free of major defects, and have intact stems. Minor deviations are usually acceptable (Harward, Jake 2014 personal communication). Growers selling directly to the public often market smaller and larger carving-type pumpkins than what large grocers require (Harward, Jake 2014 personal communication). In conversation with local growers, some expressed concern that fruit size/weight distribution and stem strength were often not stated in cultivar descriptions (Harward, Jake; Jensen, Ron; Rowley, Tod; 2014 personal communication).

Earlier pumpkin cultivar studies typically give yield per plant, overall yield, and numbers of fruit produced (Reiners & Riggs, 1999; Kelley *et al.*, 2007). Fruit size and weight distribution are rarely given. One exception to this includes Cushman *et al.* (2004), which gave fruit weight distribution (but not size distribution), and only included two cultivars. We wanted a more comprehensive evaluation of pumpkin fruit size and weight distribution in order to better assist local growers, so we undertook a two year field trial of 17 pumpkin cultivars.

### Materials and Methods

Hollar Seeds (Rocky Ford, CO) and Lockhart Seeds (Coachella, CA) provided seed of 15 cultivars they felt would be useful for local growers: 'Camaro', 'Challenger', 'Charisma', 'Corvette', 'Cougar', 'Gladiator', 'Magic Lantern', 'Magic Wand', 'Magician', 'Mustang', 'New Moon', 'Orange Rave', 'Racer', 'Sorcerer' and 'Summit' (Table 1). We also purchased seed for 'Howden' and 'Connecticut Field', two locally popular open-pollinated cultivars, from Mountain Valley Seed (Salt Lake City, UT). Table 1 contains cultivar descriptions provided by the seed suppliers.

A local producer (Jensen Family Farm, North Logan, UT) agreed to grow the plants according to their practices for both years of the study. This allowed us to gather data that growers may find more acceptable because research was performed in a real-world situation.

**Year 1:** Seeds were planted June 7, 2013, one inch deep, four seeds per hill, on 6-inch furrows. Hills were spaced 8 feet on centers and between rows (approximately 681 hills per acre). Ten hills of each cultivar were planted in a row and considered an experimental unit, with three replications (n=3). Hills were arranged into a randomized complete block design. Plants were thinned to one per hill three weeks after seeding.

Plants were side-dressed with 30 units of nitrogen (N) per acre at three and six weeks after germination. The field was irrigated using impact sprinklers to maintain soil moisture near field capacity from the time seeds were planted to September 10, 2013. Plants were monitored weekly for pests and diseases. No control was needed for pests or diseases.

Fruit was harvested from the middle five plants of each experimental unit on September 28, 2013. Each was weighed using A&D FG30 KBM scales purchased from San Diego Scale Company (San Diego, CA) accurate to 0.1 ounces. Marketable fruit was also rated for color quality and stem strength, using a scale of 1-5 with one being poor and five excellent. The height and width of marketable fruit was measured using Hagloth tree calipers accurate to 0.1 inches, purchased from Forestry Supply (Jackson, MS).

**Year 2:** Using data collected in year 1, we selected cultivars for further trialing that yielded 23 TPA (tons per acre) or greater (excluding 'Connecticut Field' and 'New Moon'). We planted seeds on June 4, 2014 in a different field on the same farm. Planting and culture was the same as in year 1, with the exception of irrigation. After planting, the grower replaced the overhead irrigation with drip tape due to more acres being planted. Plastic mulch is normally used with drip tape, but was not installed in our study because seeds were already planted. Local growers using drip tape with plastic mulch estimate they reduce water use in pumpkin fields by half (Harward, 2014; Jensen, 2014). Because no plastic mulch was used to reduce surface evaporation, we estimate that this resulted in plants receiving approximately half of the irrigation water they received in year one.

**Statistics:** Statistical analyses were performed using R (R Core Team, 2012), which is free software for statistical computing and graphics, and available at <http://www.r-project.org>. To perform the one-way ANOVA, normality and homogeneity of variance assumptions were checked using the Shapiro test and Bartlett test, respectively.

## RESULTS AND DISCUSSION

**Year 1** – 'Challenger' had the greatest yield at 32.4 TPA and was statistically different than all cultivars except 'Cougar', 'Magic Lantern', and 'Summit'. Nine other cultivars yielded over 23 TPA including 'Camaro', 'Connecticut Field', 'Corvette', 'Howden', 'Magic Lantern', 'Magician', 'Mustang', 'New Moon', and 'Racer' (Tables 1 and 3).

Two cultivars of potential interest to pick-your-own and agritourism businesses included 'Challenger' and 'Racer'. Seventy-six percent of 'Challenger' marketable fruit weighed in excess of 25 pounds. Conversely, nearly 60% of 'Racer' fruit were below 15 pounds and it yielded 24 TPA. 'Mustang' fruit weight was similar to 'Challenger', but yielded only 23.3 TPA (Table 2).

**Table 2. Means of yield and fruit per plant of marketable fruit grown in North Logan, Utah, in 2013 and 2014.**

Cultivar	Yield tons/acre		Average Fruit/Plant	
	2013	2014	2013	2014
Camaro	24.4 BCD <sup>2</sup>	20.4 A	2.9 BCD	2.4 A
Challenger	32.4 A	7.8 D	2.9 BCD	1.3 BC
Charisma	19.6 CD	---	3.1 BCD	---
Connecticut Field	23.8 BCD	---	3.3 BCD	---
Corvette	23.0 CD	8.6 D	3.1 BCD	1.9 ABC
Cougar	29.5 AB	14.8 BC	4.3 AB	2.1 AB
Gladiator	19.4 CD	---	3.0 BCD	---
Howden	24.7 BCD	6.3 D	3.4 BCD	1.1 C
Magic Lantern	25.7 ABC	13.5 CD	3.9 ABC	2.7 A
Magic Wand	21.5 CD	---	3.3 BCD	---
Magician	23.4 BCD	13.9 BC	3.9 ABCD	2.6 A
Mustang	23.3 BCD	18.6 A	2.3 D	1.8 ABC
New Moon	24.6 BCD	---	2.7 CD	---
Orange Rave	20.5 CD	---	3.2 BCD	---
Racer	24.0 BCD	8.6 D	5.1 A	2.2 A
Sorcerer	20.9 CD	---	3.2 BCD	---
Summit	25.9 ABC	10.0 D	3.3 BCD	2.1 ABC

<sup>1</sup> Means separation within columns by Tukey's HSD at  $P < 0.05$

<sup>2</sup> Cells with a hyphen denote a cultivar not grown in 2014.

'Magic Lantern' stood out for those primarily selling to grocers/box stores. It yielded 26 TPA (Table 2). Seventy-five percent of fruit was between 15 and 24 lbs. with average fruit weight of 19 pounds, and just over 50% of the fruit between 11 and 15 inches high and wide (Tables 3, 4 and 5).

**Table 3. Mean fruit weight and weight distribution of marketable fruit grown in North Logan, Utah, in 2013 and 2014.**

Cultivar	Mean Fruit Weight (lbs.)		Weight Distribution of Marketable Fruit (lbs.)							
	2013	2014	0-4		5-14		15-24		25+	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Camaro	26 BCD <sup>1</sup>	25 B	5	0	36	3	52	47	7	50
Challenger	33 A	18.5 CD	0	0	5	29	17	57	76	14
Charisma	17 GH	---	0	---	38	---	62	---	0	---
Connecticut Field	21 ECD	---	0	---	21	---	51	---	28	---
Corvette	21 EF	13.8 EF	0	0	7	57	80	43	13	0
Cougar	20 EFG	21.6 BC	5	0	20	16	48	43	27	41
Gladiator	19 FG	---	0	---	15	---	78	---	7	---
Howden	22 DEF	15.7 DEF	0	0	18	53	57	35	27	12
Magic Lantern	19 FG	15.1 DEF	1	0	12	50	75	48	12	2
Magic Wand	20 FG	---	0	---	16	---	80	---	4	---
Magician	18 FG	15.6 DEF	0	0	25	50	73	48	2	2
Mustang	29 AB	30.3 A	0	0	3	0	20	22	77	78
New Moon	28 BC	---	3	---	10	---	35	---	53	---
Orange Rave	19 FG	---	2	---	21	---	67	---	13	---
Racer	14 H	11.5 F	2	0	59	94	39	6	0	0
Sorcerer	19 FG	---	0	---	17	---	75	---	8	---
Summit	234 CDE	16.8 DE	0	8	0	30	57	58	43	8

<sup>1</sup> Means separation within columns by Tukey's HSD at  $P < 0.05$ <sup>2</sup> Cells with a hyphen denote a cultivar not grown in 2014.**Table 4. Mean fruit width and percent width distribution of marketable fruit grown in North Logan, Utah, in 2013 and 2014.**

Cultivar	Mean Fruit Width (in.)		Percent Width Distribution (in.)											
	2013	2014 <sup>3</sup>	5-6.9		7-8.9		9-10.9		11-12.9		13-14.9		15-16.9+	
	2013	2014 <sup>3</sup>	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Camaro	13 ABC <sup>1</sup>	12.9 AB	0	0	0	0	5	3	37	50	49	36	9	10
Challenger	15 A	11.3 CD	0	0	0	0	7	36	9	50	45	14	39	0
Charisma	12 BCD	---	0	---	2	---	17	---	58	---	23	---	0	---
Connecticut Field	13 ABC	---	0	---	2	---	8	---	38	---	38	---	14	---
Corvette	12 B	9.75 E	0	0	0	25	13	64	78	11	9	0	0	0
Cougar	13 ABC	11.9 BC	3	---	9	6	20	16	43	58	25	20	0	0
Gladiator	13 ABC	---	0	---	0	---	13	---	40	---	47	---	0	---
Howden	12 BCD	10.9 CD	0	0	4	13	24	54	35	28	35	1	4	1
Magic Lantern	12 BCD	11.1 CD	2	10	---	21	14	18	28	49	54	13	2	0
Magic Wand	12 BCD	---	0	---	2	---	8	---	57	---	33	---	0	---
Magician	12 BCD	11.4 C	0	0	2	10	14	21	59	59	26	10	0	0
Mustang	11 BC	13.3 A	0	0	0	0	3	7	17	30	66	63	14	4
New Moon	14 A	---	3	---	10	---	3	---	18	---	38	---	31	---
Orange Rave	12 BCD	---	0	---	---	---	28	---	55	---	17	---	0	---
Racer	11 D	10.3 DE	-	3	8	3	34	67	56	27	3	---	0	---
Sorcerer	12 BCD	---	0	---	2	---	10	---	58	---	29	---	0	---
Summit	13 ABC	11.0 CD	2	0	2	19	6	30	39	35	47	9	4	0

<sup>1</sup> Means separation within columns by Tukey's HSD at  $P < 0.05$ <sup>2</sup> Cells with a hyphen denote a cultivar not grown in 2014.<sup>3</sup> Numbers are left in tenths in this column to preserve statistical differences.

**Table 5. Mean fruit height and percent height distribution of marketable fruit grown in North Logan, Utah, in 2013 and 2014.**

Cultivar	Mean Fruit Height (in)		Height Distribution of Marketable Fruit (%)											
	2013	2014 <sup>3</sup>	5-6.9		7-8.9		9-10.9		11-12.9		13-14.9		15-16.9	
			20	20	20	20	20	20	20	20	20	20	20	20
			13	14	13	14	13	14	13	14	13	14	13	14
Camaro	12 AB <sup>1</sup>	11.6 B	0	0	5	3	23	28	60	44	21	17	4	8
Challenger	14 A	11.5 B	2	0	2	0	2	30	20	44	55	24	18	0
Charisma	9 C	--- <sup>2</sup>	4	---	25	---	64	---	6	---	0	---	0	---
Connecticut Field	11 B	---	1	---	6	---	42	---	26	---	18	---	6	---
Corvette	11 B	10.1 C	0	0	0	14	35	57	65	29	0	0	0	0
Cougar	11 B	11.7 B	0	0	11	6	26	13	51	68	12	13	0	0
Gladiator	11 B	---	0	---	0	---	53	---	44	---	2	---	0	---
Howden	11 B	10.3 C	0	0	14	17	31	54	25	24	22	0	6	2
Magic Lantern	11 B	10.1 C	2	10	7	17	35	35	53	40	4	0	0	0
Magic Wand	10 BC	---	2	---	12	---	71	---	14	---	0	---	0	---
Magician	11 BC	10.5 C	2	0	10	10	41	46	43	41	3	3	0	0
Mustang	14 A	14.1 A	0	0	3	0	3	0	20	15	57	56	17	34
New Moon	11 B	---	3	---	13	---	20	---	50	---	15	---	0	---
Orange Rave	11 B	---	0	---	0	---	36	---	62	---	2	---	0	---
Racer	9 C	8.3 D	4	6	44	67	48	27	4	0	0	0	0	0
Sorcerer	11 B	---	4	---	2	---	33	---	56	---	4	---	0	---
Summit	12 AB	10.3 C	0	8	2	15	18	35	57	35	20	8	2	0

<sup>1</sup> Means separation within columns by Tukey's HSD at  $P < 0.05$ <sup>2</sup> Cells with a hyphen denote a cultivar not grown in 2014.<sup>3</sup> Numbers are left in tenths in this column to preserve statistical differences.

Some open-pollinated cultivars are commonly grown and are popular because of lower-cost seed. The two we trialed, 'Howden' and 'Connecticut Field', were very similar in their performance except 'Connecticut Field' seemed to have qualitatively weaker stems and yielded nearly a ton less per acre (not statistically significant) than 'Howden'. Nearly half of both cultivars' fruit were within the size range required by the large grocers, leaving the other half of marketable fruit to be sold directly to consumers.

**Year 2** – In year 2, 'Camaro' was the only cultivar that yielded more than 20 TPA. 'Mustang' was similar at 18.6 TPA. All others were below 15 TPA, with 'Cougar' being next with 14.8 TPA. We attributed the big reduction in yield to grower irrigation practices changing at the start of year 2. Research has been done supporting the use of drip irrigation in cucurbit production. Zotarelli *et al.* (2008) conducted studies on zucchini (*Cucurbita pepo*), and reported that best yields were obtained using plastic mulch and subsurface drip. Local growers that use drip irrigation also show similar findings. The Jensen family (2014) reported after harvests were concluded that pumpkin yields on fields where plastic mulch and drip tape were both used were 25 TPA for 'Howden'. This is consistent with our 2013 findings for 'Howden' (24.7 TPA) where soil moisture was maintained near field capacity (Table 2). Water stress limits photosynthesis in cucurbits and likely led to reduced photosynthate available for fruit development in our study (Janoudi, A., *et al.* 1993). Not only were yields reduced in 2014, but number of fruit per plant was also reduced by one-third to one-half in most cultivars (Table 2).

**Both Years** – All cultivars over both years had good coloration with no significant differences (data not shown). Similarly all had good stem strength with the exception of 'New Moon' in which 48% of the stems broke during test lifts (data not shown).

## CONCLUSIONS

Fruit size and weight distribution were not consistently affected by drought stress in 2014 (Tables 3, 4, 5). However this data was important to record so that growers could get a sense of pumpkin sizes to make better decisions about growing profitably. The data revealed in 2013 'Magic Lantern' was best suited for growers marketing to grocery chains. 'Cougar', and 'Challenger' were shown to be high-yielding cultivars potentially useful for agritourism and farm-stand sales. Additionally 'Howden' should be considered because the seed is inexpensive and it yielded well with a wide variety of fruit sizes. Being an open-pollinated cultivar it is also of interest to growers who avoid using hybrid seed.

The irrigation change in 2014 showed the importance of using best irrigation practices. It also showed that 'Camaro', 'Cougar', and 'Mustang' may exhibit higher drought tolerance compared to other cultivars grown, and probably warrants further study. Evaluating vegetable cultivars for profitable yields is an area where Extension can continue to contribute to rapidly changing agricultural practices, especially for smaller growers.

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