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Grant Project Final Report

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Grant Project Title: Improving Production Quality of Wisconsin-Grown Onions

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Opportunities for production of onion for processing in Wisconsin
Project no. 20020
Final Report 6-22-067

This is the second year of at least a 2 year program intended to identify production capacity of WI for producing onions for processing. Several trials have been designed to address key production questions relative to processing onion production. Challenges to producing onions for processing are reaching size requirements necessary for processing, meeting ring thickness requirements, and maintaining single centerness. The overall project goal and specific objectives included:

GOAL: Develop management practices that ensure production of onion with high processing quality and demonstrate the ability of the Wisconsin vegetable industry to consistently produce onions that meet end use value of local processors.

-Identify varieties with high processing quality that are suitable for planting and production for processing in Wisconsin
-Study onion bulking patterns to identify stress factors that lead to interruptions in growth or loss of single centerness and could guide development of appropriate irrigation strategies.
-Evaluation of planting date, rate, pattern and transplants for yield and quality attributes.
-Companion cropping strategies that will protect seedling onion plants from blowing sand when grown in the Central Wisconsin Vegetable Production region.

OBJECTIVES:

1) Identify optimal management practices for production of onion with superior processing quality.
2) Quantify onion bulking rates over the growing season and measure response to different management practices and stress events.
3) Demonstrate the potential of Wisconsin vegetable growers to produce a crop that met the quality standards of onion processing plants.
4) Quantify the cost of production for processed onions and determine price and yield levels necessary to ensure profitability

Summary:

In my brief time researching this question, the biggest challenge was to form enough leaves in order to reach the diameter onion that McCain required for processing. Onion plants did not produce many if any leaves after initiation of bulbing by the beginning to middle portion of July. In addition, heat stress and insect pressure decreased onion bulbing by early to mid August limiting total potential growth. The result was that onions were done bulbing by mid to late August, but most the crop was 1/2 to 1" short of meeting average size requirements of McCain. This left 4 to 6 weeks at the end of the growing season where onions did not grow.

The bulbs of different varieties had between 8 and 11 rings depending on management practice. Onions that do meet size requirements appear to have a minimum of 12 to 14 rings. Based on my experiences, production of onions with large size required for processing is limited by the number of leaves which influenced the number of rings and the ability of individual plants to bulb. These issues are not independent of one another and delaying bulbing can also cause

issues with maturation of the crop and conditioning of the crop in the field. Fertility, irrigation, and pest management strategies will have to be adjusted to improve late season bulbing. In addition, onions will have to be grown from transplants established by April 30th to grow enough leaves and ultimately rings to reach size goals for processing.

Onion growers of Wisconsin marketed onions to McCain in 2006, but prices have discouraged growers from planting large acreages in 2007. Fresh market prices in 2006 for similar sized onions are 3 to 4 times contract price for processing onions. In addition, growing onions from transplant requires more operational costs and increases risks as off grade onions can be rejected by the processor. At the same time, sourcing of local raw produce is a top priority for Wisconsin based onion processors. Commercial trials are continuing in 2007 to evaluate alternative management strategies and locations for processing onions and for storage evaluations. Processors continue to negotiate with growers for local sourcing of onion in 2008, but challenges in expanding or relocating production, trucking, storage, and price must be overcome.

Accomplishments

Plot work in 2006 focused on monitoring leaf development and ultimately bulbing on onion. In certain trials leaf development and bulbing were closely monitored on specific plants for the entire summer. More focus was placed on time of planting of transplanted onion as well as comparisons of onion from transplant and from seed. We also finished work on density effects on onion as well as intraspecific competition (onion to onion competition) which had a dramatic affect on size. We evaluated different onion varieties with a range of maturity dates and background genetics.

Research indicated several onion varieties have better size potential in WI than others. These onions were evaluated for productivity from seed and transplant in trial 001. Vaquero, Montero, Sedona, and Gunnison were the 4 best varieties in trials last year and were the focus of other cultural management trials. In addition, sets were available for several varieties that were not previously evaluated.

Study sites were established on Paul Miller Farms near Hancock, WI and on Dean Kincaid Inc. farms near Palmyra WI. Miller site was an irrigated sand soil. Limitations in sand included lower water holding which required more frequent irrigation and soil fertility issues. However, sand soils allow for earlier planting and actually have warmer soil temperatures than heavier soils in more Southern regions in April and cooler soils in July and August. Warm soils promoted earlier growth if irrigation and fertility needs were be met. Kincaid site was irrigated muck soils. Muck soils have been the primary onion production region in WI. We also supplied transplants and sets to the drip demonstration near Delavan.

Paul Miller is an irrigated vegetable grower in Central, WI, who is highly interested in promoting processing vegetable production. Paul Miller has developed carrot management production systems for sand soils. This has included optimization of cover cropping, fertility, irrigation, pest, and crop management strategies that have allowed for successful carrot production for carrot. The trial site on Millers had several challenges including weeds which were managed by hand pulling. Unfortunately, we had severe thrip pressure at Millers which limited the productivity of the onion.

Gary, J.D., John, and Cory Kincaid have a long history of producing onions in Southern, WI. They currently produce close to 30 A of onion targeted to the colossal size market which has comparable size requirements for onion for processing. Kincaids also managed a site near Delavan, WI.

Trial results from 2006 are attached and will be mailed in hard copy form. Trials specifics were:

Onion variety performance from seed and transplant

Trial ID: Miller Farms
Location: Hancock, WI

Study #	Planting Date		Harvest Date
001	4/24/06		9/26/06
002	4/24/06		9/26/06
003	4/24/06		9/26/06
005	4/20/06	Planting Date 1	9/26/06
	4/26/06	Planting Date 2	9/26/06
	5/2/06	Planting Date 3	9/26/06
	5/8/06	Planting Date 4	9/26/06
	5/15/06	Planting Date 5	9/26/06
	5/22/06	Planting Date 6	9/26/06

Misc. management

NOTE: All transplants treated with Regent (off label use)

5/8/06 Goal 2XL @ 1 pt/A in 40 gal/A
All transplants 001: transplants
004: entire study
005: entire study

6/1/06 Goal 2XL @ 1 pt/A in 40 gal/A
All seeded plots: 001, 002, 003

6/16/06 Fertilize w/NH4NO3 @ 59 lb/A (20 lb N/A)
All plots

7/10/06 Fusilade DX @ 12 fl oz/A in 20 gal/A
All plots

7/31/06 Fusilade DX @ 12 fl oz/A in 20 gal/A
All plots

9/26/06 Harvest

Trial ID: Kincaid Farms
Location: Palmyra, WI

Study #	Planting Date		Harvest Date
001	4/27/06		9/5/06
002	4/27/06	Planted by Seminis	9/5/06
003	4/27/06		9/5/06
005	4/21/06	Planting Date 1	9/5/06
	4/27/06	Planting Date 2	9/5/06
	5/3/06	Planting Date 3	9/5/06
	5/10/06	Planting Date 4	9/5/06
	5/18/06	Planting Date 5	9/5/06
	5/24/06	Planting Date 6	9/5/06

NOTE: All transplants treated with Regent (off label)

Study Synopsis:

001 and 003 were variety trials to compare onion performance from seed, sets, and transplants. Trials were conducted at two sites (Hancock and Palmyra). Results for yield and quality factors are compiled in table form on the following pages.

005 was a trial to compare onion tansplants across six planting dates. Trials were conducted at two sites (Hancock and Palmyra). Results for yield and quality factors are compiled in table form on the following pages.

002 was a trial comparing various planting population densities within single and paired rows. Trials were conducted at two sites (Hancock and Palmyra). Results for three yield components: Yield (Cwt / Acre), Average Bulb Diameter (in.), and Average Bulb Weight (oz.) are displayed in chart form on the following pages.

Study: 001 2006 Onion variety performance from seed and transplant. Palmyra, WI. A.J. Bussan, M.E. Copas, and M.J. Drilias.

Variety	Type	Yield (Cwt/A)	Bulbs / A	Storage % Loss	Bulb Weight (oz)	Bulb Diameter (in)	< 3 in. (%)	3-3.5 in. (%)	3.5-4 in. (%)	> 4 in. (%)	Single Centered (%)	Intermediate (%)	Physical Damage (%)	Rings / Bulb
Condor	Transplant	330.0	47432	4.8	11.18	3.43	9	34	52	4	20	67	13	5.47
	Seed	261.5	60984	9.5	6.22	2.79	47	45	8	0	47	47	7	5.80
Gunnison	Transplant	321.6	49368	3.4	10.27	3.38	8	50	32	9	27	33	40	5.27
	Seed	358.6	82280	10.1	6.47	2.82	69	31	0	0	87	13	0	6.47
Legend	Transplant	318.6	53240	3.0	9.17	3.21	18	42	37	3	40	47	13	5.20
	Seed	312.9	67760	7.3	7.27	2.90	48	49	3	0	87	7	7	5.47
Montero	Transplant	309.4	56144	6.1	8.38	3.15	19	38	44	0	0	100	0	8.20
	Seed	262.1	63888	9.2	6.23	2.86	51	41	7	0	80	13	7	7.00
Sedona	Transplant	414.7	55176	7.4	11.20	3.45	6	36	50	8	73	13	13	7.47
	Seed	368.9	76472	3.5	7.60	2.97	42	45	13	0	67	27	7	6.33
SR7004ON	Transplant	329.9	58080	6.7	8.51	3.14	19	57	25	0	100	0	0	8.53
	Seed	148.5	55176	13.9	3.96	2.33	94	6	0	0	100	0	0	6.80
SR7008ON	Transplant	387.5	60016	4.3	9.81	3.37	13	33	54	0	100	0	0	9.00
	Seed	255.7	77440	8.1	4.90	2.54	85	15	0	0	100	0	0	7.73
Vaquero	Transplant	258.4	53240	7.3	7.19	2.95	29	57	14	0	100	0	0	7.93
	Seed	174.2	52272	4.2	5.22	2.69	78	19	3	0	100	0	0	8.00
XP0077151813	Transplant	336.8	48400	8.8	10.14	3.40	4	51	42	2	87	13	0	8.27
	Seed	271.6	60984	11.6	6.32	2.83	61	39	0	0	100	0	0	6.93
XP07715819	Transplant	279.8	45496	5.2	8.40	3.31	18	34	43	5	80	13	7	7.73
	Seed	257.7	62920	4.8	6.26	2.82	66	34	0	0	93	7	0	7.60
Talon	**Sets**	287.1	49368	1.8	9.03	3.24	5	73	20	2	27	27	47	4.33
	Seed	301.3	69696	8.0	6.42	2.85	67	33	0	0	73	27	0	6.20
Manes	**Sets**	283.3	48400	8.3	8.59	3.19	17	47	36	0	7	40	53	3.00
LSD (p=0.10)		NS	6128	2.8	1.31	0.32	37.56	NS	7.75	2.11	NS	7.77	7.77	NS

Study: 001 2006 Onion variety performance from seed and transplant. Hancock, WI. A.J. Bussan, M.E. Copas, and M.J. Drilias.

Variety	Type	Yield (Cwt/A)	Bulbs / A	Storage % Loss	Bulb Weight (oz)	Bulb Diameter (in)	< 3 in. (%)	3-3.5 in. (%)	3.5-4 in. (%)	> 4 in. (%)	Single Centered (%)	Intermediate (%)	Physical Damage (%)	Rings / Bulb
Condor	Transplant	148.2	27878	8.0	7.69	2.94	38	55	7	0	67	27	7	5.47
	Seed	135.4	79279	7.5	2.74	2.05	100	0	0	0	87	7	7	5.13
Gunnison	Transplant	183.2	38333	3.4	7.30	2.93	63	34	3	0	87	7	7	6.00
	Seed	115.6	70567	6.8	2.99	2.06	100	0	0	0	93	7	0	6.07
Legend	Transplant	336.8	48787	5.4	10.50	3.30	8	48	41	2	27	47	27	5.40
	Seed	153.5	61855	4.8	4.13	2.38	91	9	0	0	80	13	7	4.93
Montero	Transplant	106.7	21780	12.2	6.84	2.86	43	53	4	0	93	7	0	6.60
	Seed	165.0	88862	5.5	2.97	2.12	100	0	0	0	100	0	0	6.27
Sedona	Transplant	142.7	24394	14.8	8.09	2.97	39	50	11	0	62	23	15	6.03
	Seed	193.3	91476	4.4	3.56	2.22	100	0	0	0	80	20	0	5.80
SR7004ON	Transplant	217.4	39204	8.7	8.71	3.15	12	84	4	0	100	0	0	6.50
	Seed	150.6	85378	7.4	2.81	2.08	100	0	0	0	100	0	0	5.80
SR7008ON	Transplant	179.1	43560	14.2	5.97	2.72	60	36	4	0	93	7	0	7.33
	Seed	162.1	80150	8.4	3.34	2.22	96	4	0	0	93	7	0	6.67
Vaquero	Transplant	213.9	36590	6.8	8.70	3.18	17	59	24	0	93	7	0	7.73
	Seed	84.4	48352	9.2	3.12	2.22	100	0	0	0	90	10	0	5.90
XP0077151813	Transplant	259.1	45302	6.1	8.69	3.14	19	76	6	0	93	7	0	7.00
	Seed	93.9	73181	11.3	1.60	1.62	100	0	0	0	100	0	0	6.40
XP07715819	Transplant	254.7	36590	8.1	10.34	3.33	10	42	47	0	70	20	10	6.90
	Seed	115.8	61855	8.1	3.53	2.21	100	0	0	0	100	0	0	6.60
Talon	**Sets**	128.2	35284	6.0	5.18	2.54	80	20	0	0	90	10	0	5.70
	Seed	145.2	94090	3.4	2.34	1.91	100	0	0	0	100	0	0	6.40
Manes	**Sets**	77.8	20909	5.6	5.60	2.60	79	21	0	0	80	20	0	5.00
LSD (p=0.10)		33.57	10605	NS	0.76	0.13	12.64	8	6	NS	11	NS	2	0.20

Study: 003 2006 Onion variety performance from seed and sets. Palmyra, WI. A.J. Bussan, M.E. Copas, and M.J. Drilias.

Variety	Yield (Cwt/A)	Bulbs / A	Storage % Loss	Bulb Weight (oz)	Bulb Diameter (in)	< 3 in. (%)	3-3.5 in. (%)	> 3.5 in. (%)	Single Centered (%)	Intermediate (%)	Physical Damage (%)	Rings / Bulb
Safrane	213.6	57112	9.9	5.30	2.69	71	29	0	53	40	7	5.00
Calibra	242.8	77440	6.8	4.75	2.52	85	15	0	60	33	7	4.73
Sherman	262.4	62920	7.9	6.27	2.92	51	49	0	13	67	20	4.00
Tahoe	227.2	59048	7.3	5.85	2.75	76	24	0	40	47	13	5.07
Redwing	160.4	56144	2.4	4.35	2.57	90	10	0	73	20	7	4.80
Red Bull	218.6	64856	11.7	4.93	2.58	86	14	0	40	53	7	4.33
15843	212.6	61952	6.2	5.23	2.67	72	24	3	100	0	0	7.60
16035	200.1	51304	5.9	6.04	2.83	63	37	0	80	20	0	6.87
Ranchero	206.5	70664	7.6	4.29	2.52	90	11	0	100	0	0	7.07
Granero	207.1	68728	8.4	4.51	2.55	89	11	0	93	7	0	7.40
7200	195.8	60016	7.5	4.99	2.66	80	20	0	93	7	0	7.13
6011	119.1	44528	13.4	3.81	2.29	90	10	0	100	0	0	7.27
5003	1.3	2904	0.0	0.71	1.07	100	0	0	100	0	0	1.00
5026	31.5	8712	7.0	5.41	2.70	100	0	0	47	29	11	5.67
2030	112.5	41624	8.0	3.91	2.45	100	0	0	93	7	0	6.67
2003	19.6	6776	17.2	4.70	2.49	100	0	0	89	11	0	6.22
5012	44.0	9680	39.8	4.18	2.43	87	13	0	72	28	0	6.14
5014	63.8	18392	7.1	5.80	2.74	86	14	0	81	11	8	7.24
Onions from Sets												
Forum	261.0	45496	8.3	8.41	3.30	16	34	50	13	53	33	3.40
Troy (small)	202.2	55176	6.0	5.72	2.84	44	40	16	33	33	33	3.67
Troy (large)	170.3	52272	5.5	5.07	2.74	57	29	14	47	47	7	4.07
Talon (small)	322.2	54208	5.6	9.27	3.33	8	59	33	13	27	60	4.00
Braunschwieger	151.4	53240	12.1	3.99	2.51	94	6	0	53	33	13	4.27
LSD (p=0.10)	58.85	14745	9.55	1.21	0.26	21.66	21.68	10.24	30.56	23.69	19.79	1.62

Study: 003 2006 Onion variety performance from seed and sets. Hancock, WI. A.J. Bussan, M.E. Copas, and M.J. Drilias.

Variety	Yield (Cwt/A)	Bulbs / A	Storage % Loss	Bulb Weight (oz)	Bulb Diameter (in)	< 3 in. (%)	> 3 in. (%)	Single Centered (%)	Intermediate (%)	Physical Damage (%)	Rings / Bulb
Safrane	85.8	113256	6.0	1.24	1.53	100	0	93	7	0	4.93
Calibra	77.6	109771	9.0	1.19	1.47	100	0	100	0	0	4.47
Sherman	65.8	91476	10.7	1.12	1.44	100	0	100	0	0	4.67
Tahoe	57.2	60113	8.0	1.40	1.64	100	0	100	0	0	5.60
Redwing	131.0	134165	7.6	1.70	1.73	100	0	100	0	0	5.87
Red Bull	106.9	133294	9.7	1.19	1.51	100	0	100	0	0	5.33
15843	150.1	140263	11.3	1.87	1.76	100	0	93	7	0	5.60
16035	86.0	86249	9.2	1.72	1.75	100	0	100	0	0	5.70
Ranchero	102.2	124582	11.7	1.27	1.51	100	0	100	0	0	5.13
Granero	98.4	107158	10.4	1.49	1.58	100	0	100	0	0	5.70
7200	56.8	108464	11.6	0.86	1.32	100	0	100	0	0	5.20
6011	73.8	112385	10.2	1.20	1.47	100	0	100	0	0	6.07
5003	22.4	24394	12.3	1.39	1.57	100	0	100	0	0	5.33
5026	77.4	106286	7.5	1.11	1.44	100	0	93	7	0	5.33
2030	54.9	84506	8.4	1.10	1.48	100	0	100	0	0	5.87
2003	30.3	43124	10.0	1.03	1.40	100	0	100	0	0	5.70
5012	43.8	40946	10.5	1.58	1.54	100	0	93	7	0	5.40
5014	68.0	71438	7.8	1.82	1.67	100	0	100	0	0	5.80
Onions from Sets											
Forum	87.3	35719	11.4	3.50	2.35	89	11	93	7	0	5.13
Troy (small)	60.8	38333	10.6	2.36	2.07	96	4	100	0	0	5.13
Troy (large)	54.9	38333	9.0	2.16	1.95	100	0	93	7	0	4.93
Talon (small)	78.1	47916	5.6	2.56	2.00	100	0	93	7	0	5.67
Braunschweiger	25.9	27007	27.7	1.12	1.64	100	0	100	0	0	4.27
LSD (p=0.10)	45.73	62308	3.7	0.74	0.32	NS	NS	NS	NS	NS	0.86

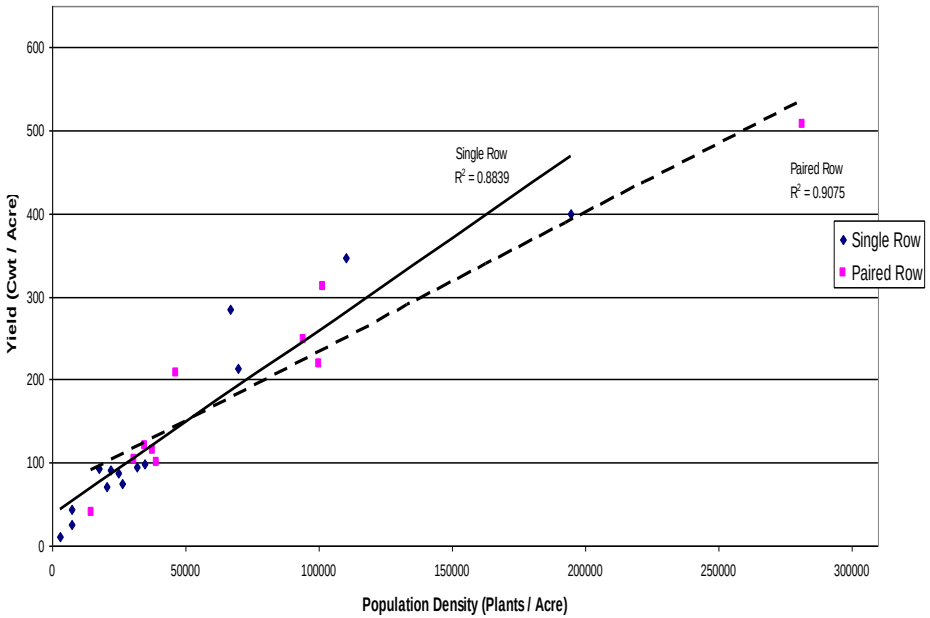
Study: 005 2006 Onion transplant performance based on planting date. Palmyra, WI. A.J. Bussan, M.E. Copas, and M.J. Drilias.

Variety	Planting Week	Yield (Cwt/A)	Bulbs / A	Storage % Loss	Bulb Weight (oz)	Bulb Diameter (in)	< 3 in. (%)	3-3.5 in. (%)	3.5-4 in. (%)	4-4.5 in. (%)	> 4.5 in. (%)	Single Centered (%)	Intermediate (%)	Physical Damage (%)	Rings / Bulb
Montero	1	262.0	27657	9.1	13.69	3.72	3	12	41	44	0	60	33	7	7.13
	2	245.0	29040	8.3	12.71	3.70	1	22	52	21	4	73	27	0	7.27
	3	227.0	30423	11.6	11.06	3.53	5	30	57	8	0	73	20	7	7.33
	4	185.1	29731	10.1	8.78	3.33	11	34	55	0	0	67	20	13	6.27
	5	164.3	29731	8.0	8.11	3.19	16	54	30	0	0	93	7	0	7.67
	6	83.0	29731	8.1	4.28	2.53	94	6	0	0	0	93	7	0	6.93
Gunnison	1	255.3	29731	3.7	13.22	3.67	1	16	77	6	0	33	33	33	5.07
	2	240.8	31114	3.1	11.99	3.62	0	30	62	8	0	33	40	27	5.27
	3	203.7	30423	4.4	10.03	3.33	5	63	32	0	0	53	13	33	5.53
	4	177.2	30423	3.6	9.01	3.23	12	70	17	0	0	40	33	27	5.47
	5	169.1	31114	5.3	8.39	3.14	8	84	8	0	0	53	33	13	5.93
	6	76.6	30423	4.9	3.84	2.38	100	0	0	0	0	73	13	13	5.40
Vaquero	1	282.2	29731	6.2	14.24	3.81	0	9	58	31	3	87	7	7	7.67
	2	200.5	29731	6.4	10.05	3.36	5	40	55	0	0	87	13	0	7.67
	3	195.7	29731	5.5	10.13	3.30	15	48	37	0	0	100	0	0	8.47
	4	128.6	31114	8.1	6.15	2.81	60	36	4	0	0	87	13	0	7.13
	5	133.1	31806	7.5	6.10	2.84	57	43	0	0	0	87	13	0	7.13
	6	51.2	29731	9.7	2.51	2.03	100	0	0	0	0	100	0	0	6.80
Sedona	1	292.6	27657	5.1	15.97	3.93	0	2	51	45	2	73	13	13	7.33
	2	268.3	29040	5.0	13.96	3.80	2	26	56	11	4	67	20	13	7.40
	3	238.4	30423	7.7	11.72	3.54	3	32	61	4	0	53	33	13	7.00
	4	203.8	31806	4.9	9.70	3.32	6	67	27	0	0	60	20	20	6.60
	5	166.9	31806	5.3	7.97	3.10	22	69	10	0	0	67	27	7	6.80
	6	95.8	31114	7.4	4.64	2.58	97	3	0	0	0	73	20	7	5.53
LSD (p=0.10)		25.33	1202.6	NS	1.17	0.15	11.63	9.13	11.58	9.64	NS	NS	NS	NS	1.81

Study: 005 2006 Onion transplant performance based on planting date. Hancock, WI. A.J. Bussan, M.E. Copas, and M.J. Drilias.

Variety	Planting Week	Yield (Cwt/A)	Bulbs / A	Storage % Loss	Bulb Weight (oz)	Bulb Diameter (in)	< 3 in. (%)	3-3.5 in. (%)	> 3.5 in. (%)	Single Centered (%)	Intermediate (%)	Physical Damage (%)	Rings / Bulb
Montero	1	229.1	47294	11.7	2.95	7.04	30	62	8	100	0	0	7.07
	2	123.9	31114	17.4	2.49	4.94	96	4	0	92	8	0	5.60
	3	183.0	44805	8.2	2.88	6.34	55	45	0	100	0	0	6.47
	4	156.5	49783	9.0	2.53	4.64	96	4	0	100	0	0	7.00
	5	103.9	44805	12.8	2.27	3.36	100	0	0	100	0	0	6.87
	6	117.2	42315	8.3	2.43	4.16	87	13	0	87	13	0	6.20
Gunnison	1	174.5	47294	4.6	2.69	5.88	85	15	0	87	13	0	6.67
	2	172.3	49783	5.0	2.64	5.28	100	0	0	100	0	0	6.80
	3	155.0	46049	4.0	2.59	5.19	100	0	0	93	7	0	6.47
	4	122.5	54761	4.7	2.26	3.38	100	0	0	100	0	0	6.60
	5	84.4	44805	5.3	2.10	2.81	100	0	0	100	0	0	6.50
	6	90.1	44805	7.4	2.13	3.04	100	0	0	93	7	0	6.33
Vaquero	1	192.9	36093	9.8	3.04	7.56	43	47	9	100	0	0	6.27
	2	256.0	51027	9.0	2.95	7.62	45	55	0	100	0	0	6.27
	3	204.1	43560	8.8	2.93	6.87	50	50	0	100	0	0	6.80
	4	116.9	52272	8.5	2.22	3.28	100	0	0	100	0	0	6.60
	5	131.2	53517	8.2	2.32	3.60	100	0	0	100	0	0	7.20
	6	136.0	52272	12.0	2.32	3.77	94	6	0	100	0	0	6.40
Sedona	1	250.2	49783	8.3	2.86	7.50	27	70	3	87	0	7	6.00
	2	228.7	42315	7.1	3.04	8.14	28	67	5	60	33	7	6.00
	3	181.0	39826	4.4	2.90	6.97	63	32	5	73	27	0	6.13
	4	177.3	54761	6.2	3.12	4.87	97	3	0	80	20	0	5.87
	5	178.3	57250	6.2	2.45	4.68	92	8	0	73	27	0	5.87
	6	174.5	53517	6.6	2.48	4.88	100	0	0	80	13	7	6.00
LSD (p=0.10)		43.4	NS	NS	0.72	0.23	8.56	6.7	3.1	NS	NS	NS	NS

2006 Onion from transplants (Var: Montero) bulb density effect on yield. Palmyra, WI. A.J. Bussan, M.E. Copas, and M.J. Drilias.



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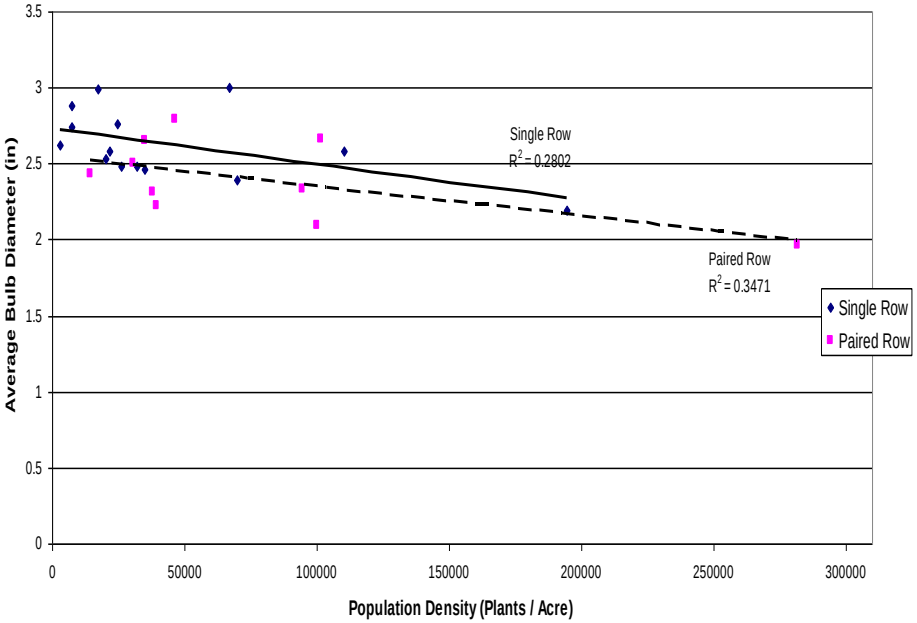
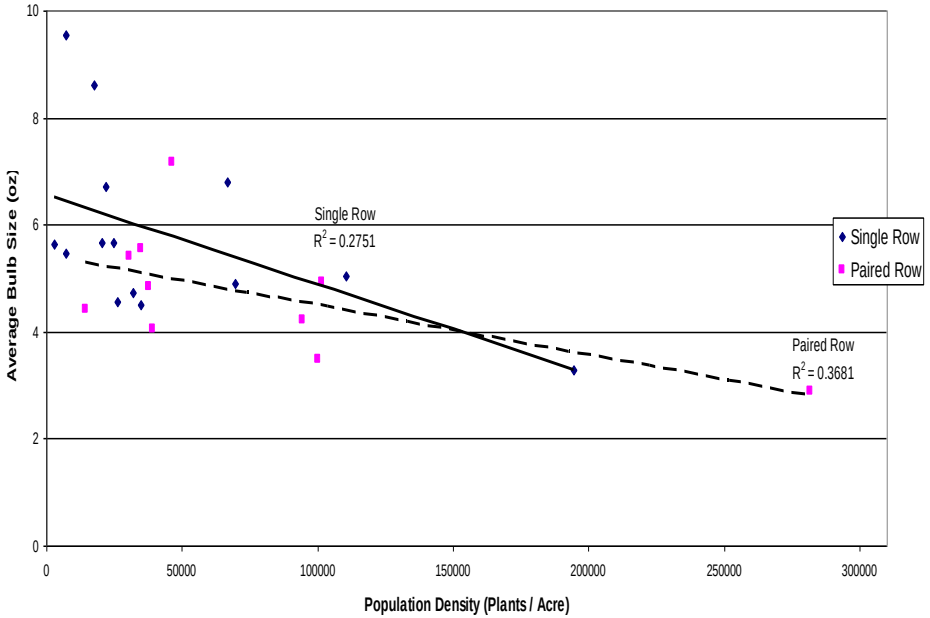


2006 Onion from transplants (Var: Vaquero) bulb density effect on average bulb weight. Palmyra, WI. A.J. Bussan, M.E. Copas, and M.J. Drilias.



Study # 002: Population density effects in paired versus single rows.
2006 Palmyra, WI.
Variety: Montero

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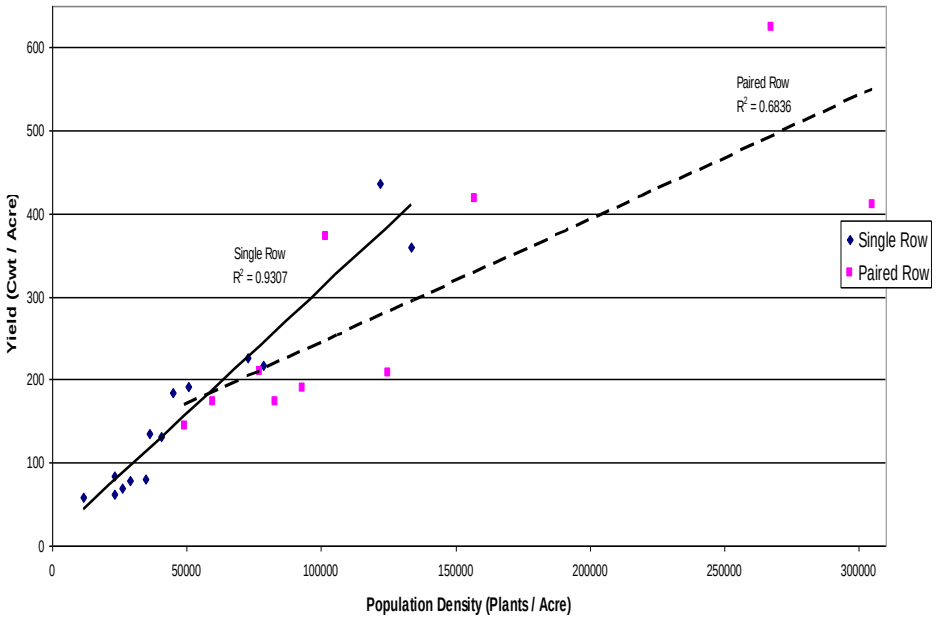

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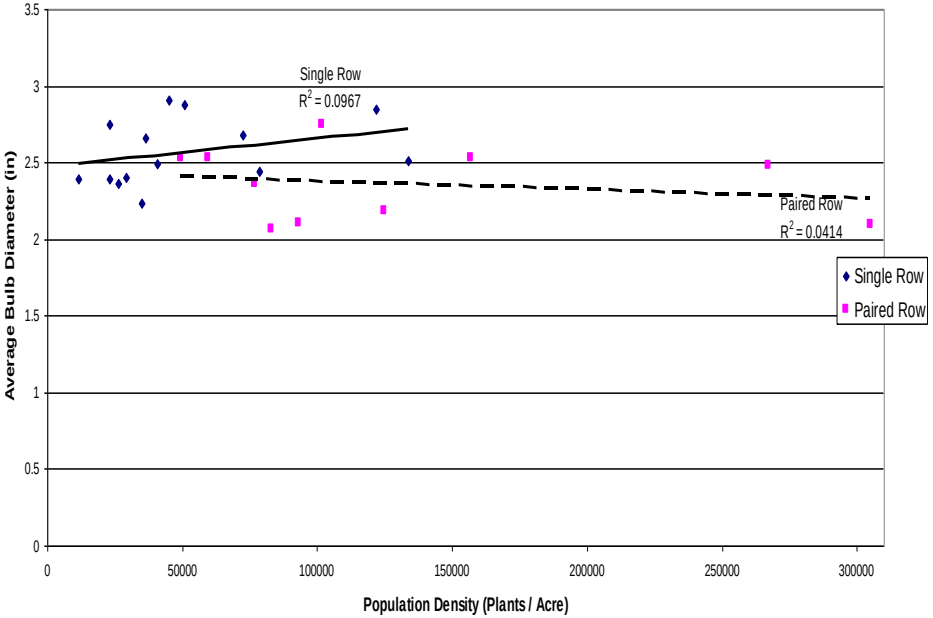

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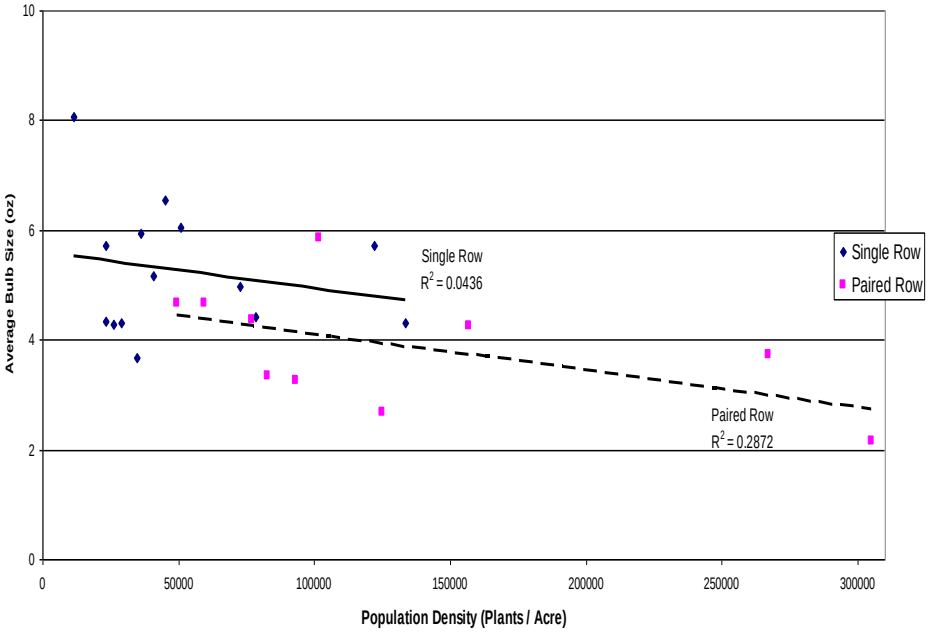

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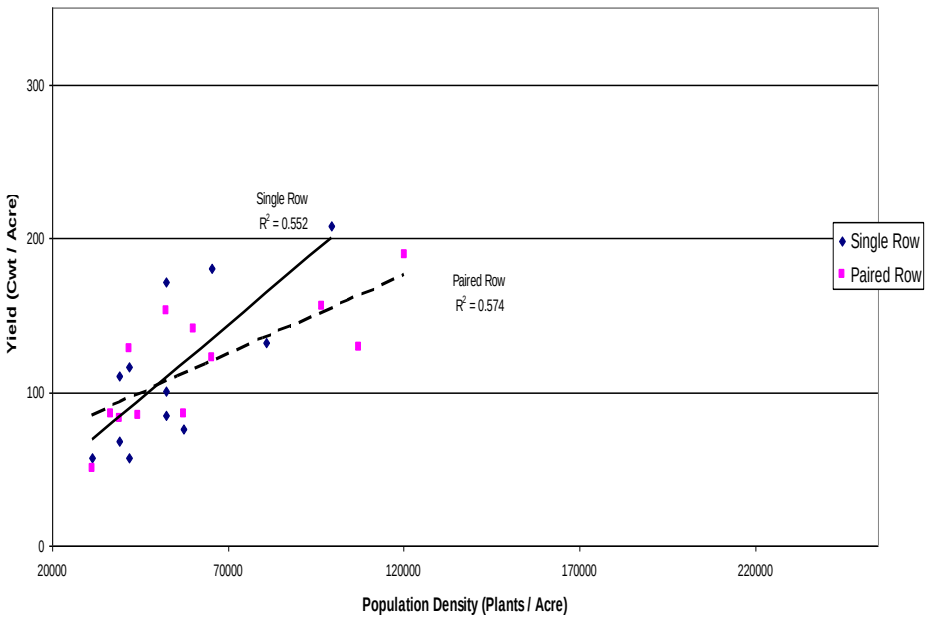

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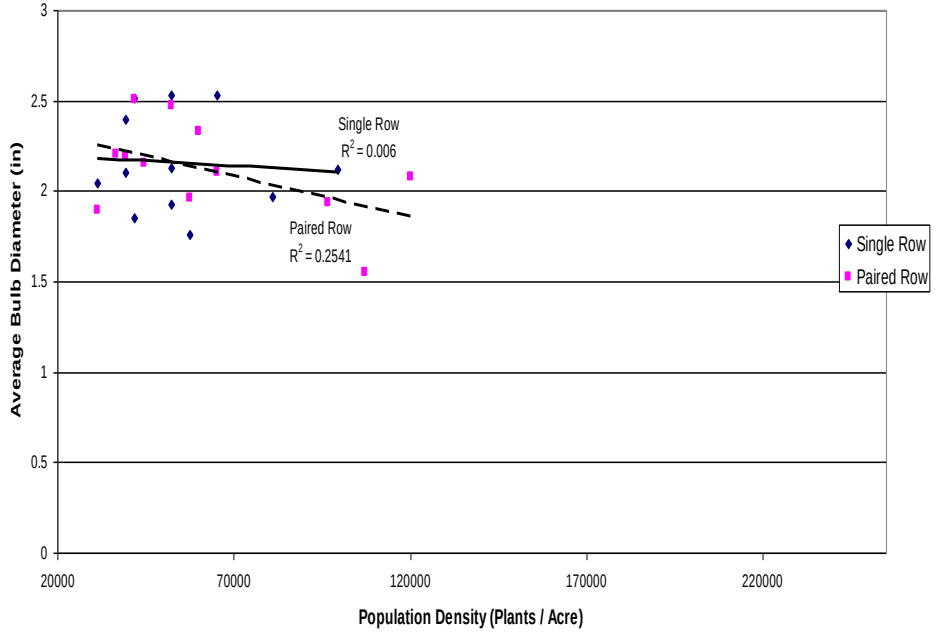

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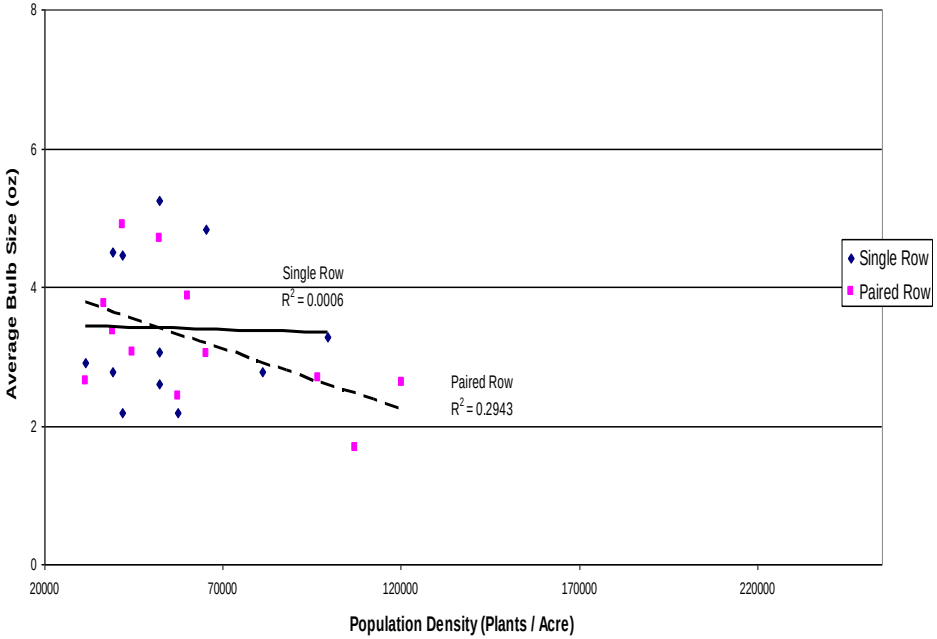

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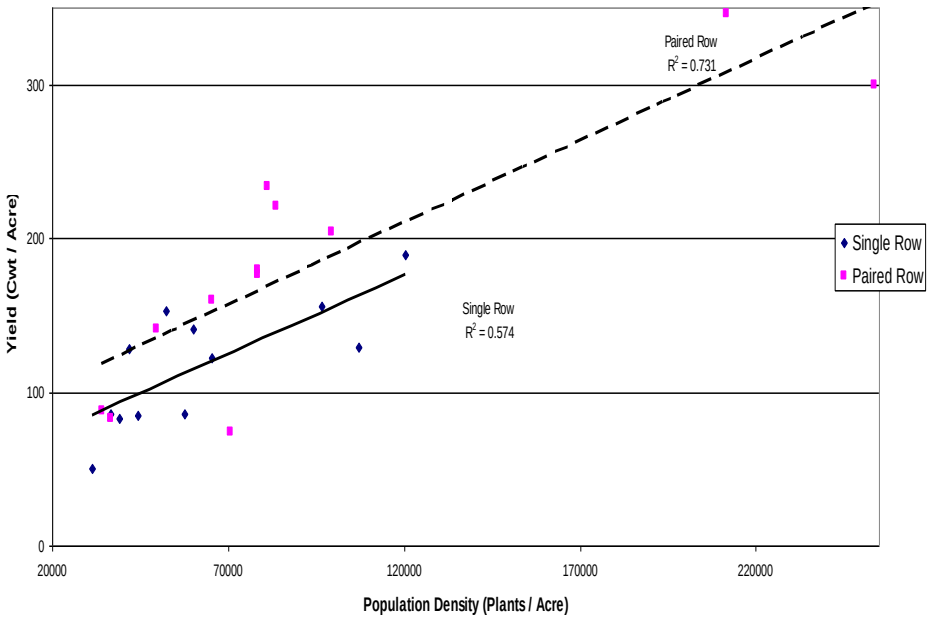

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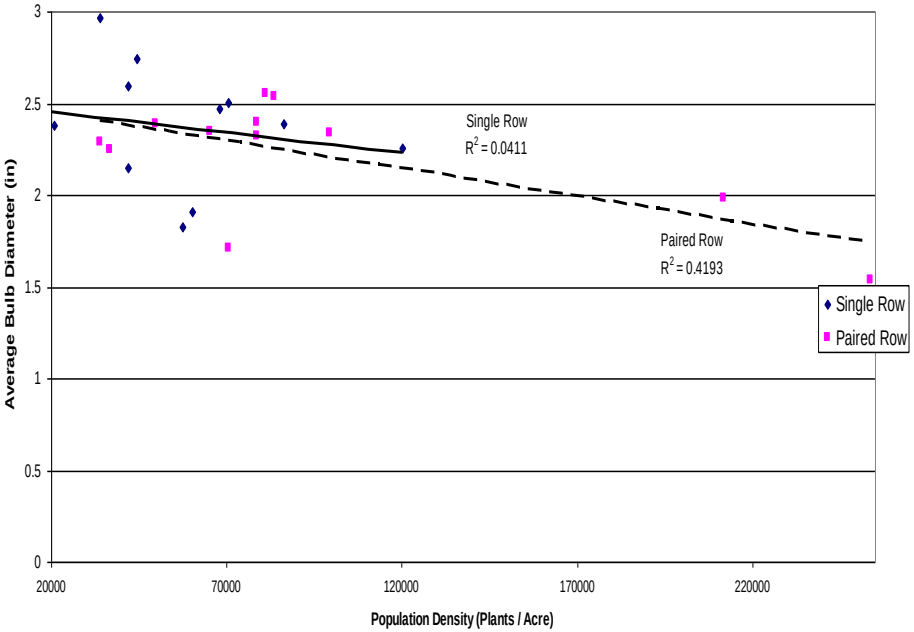

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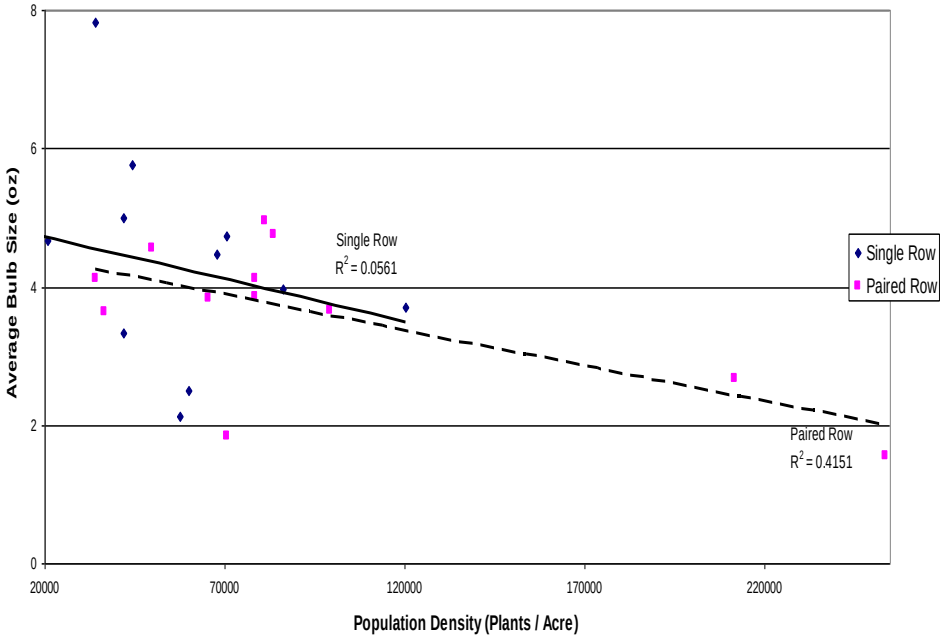

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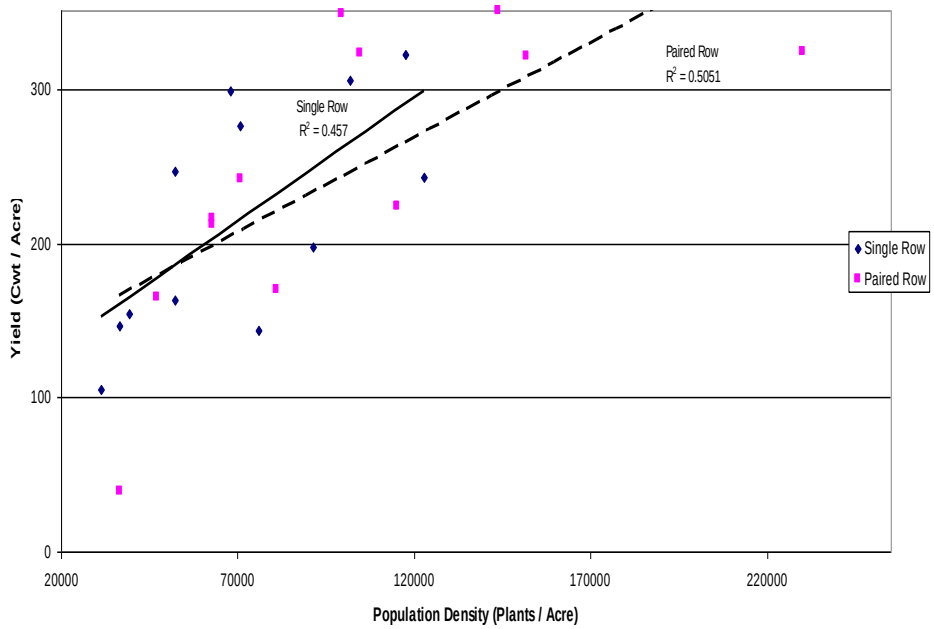

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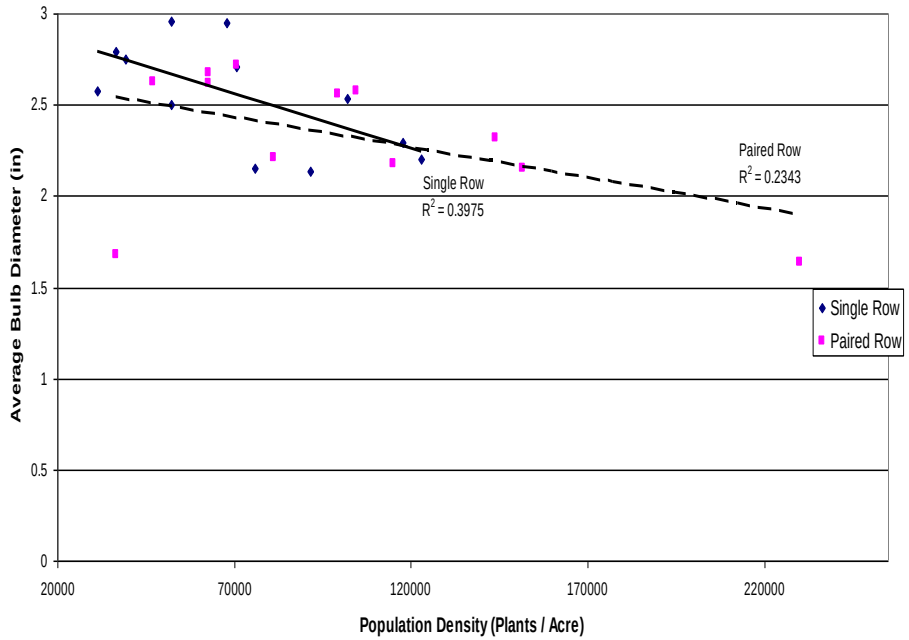

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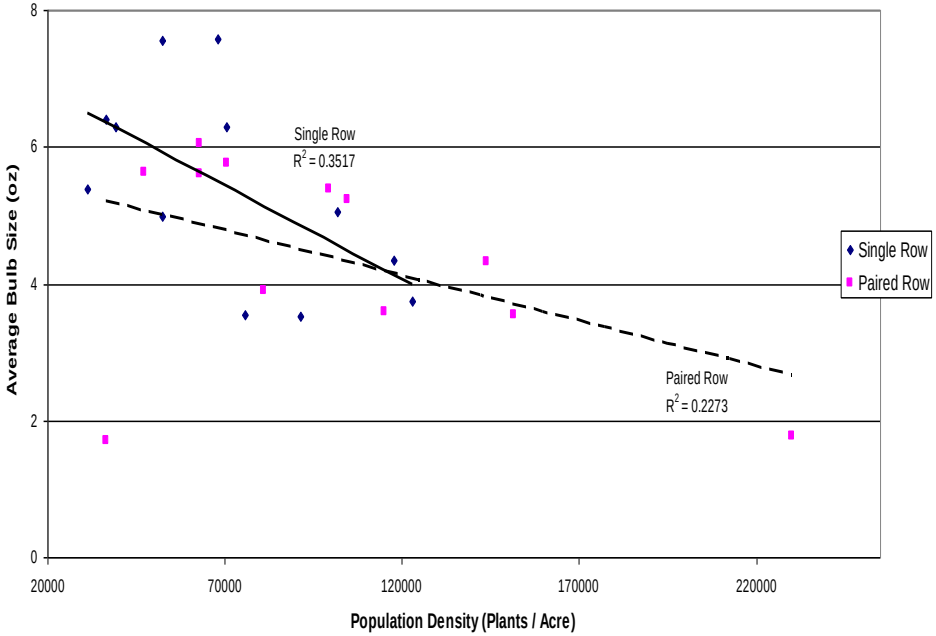

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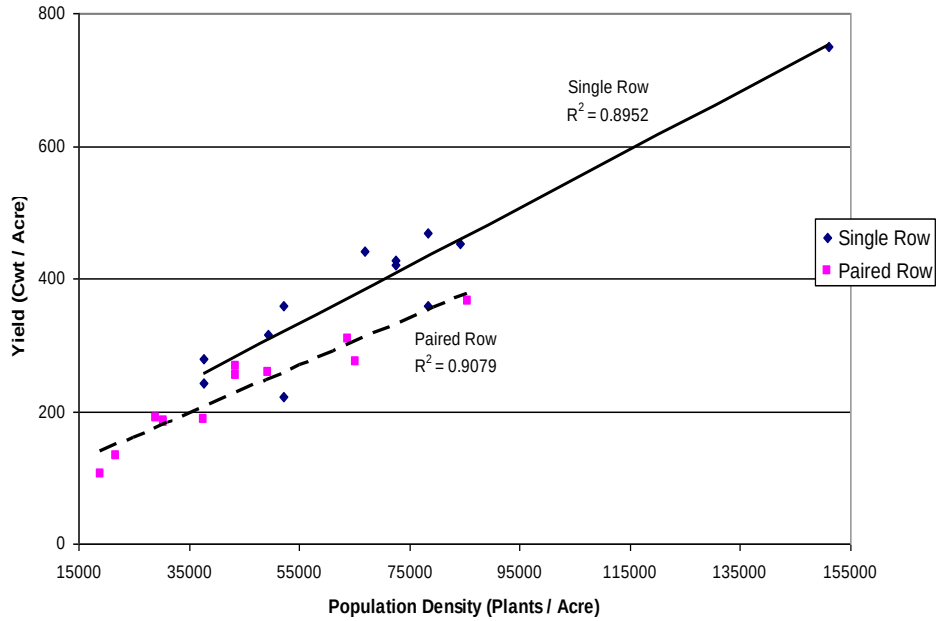

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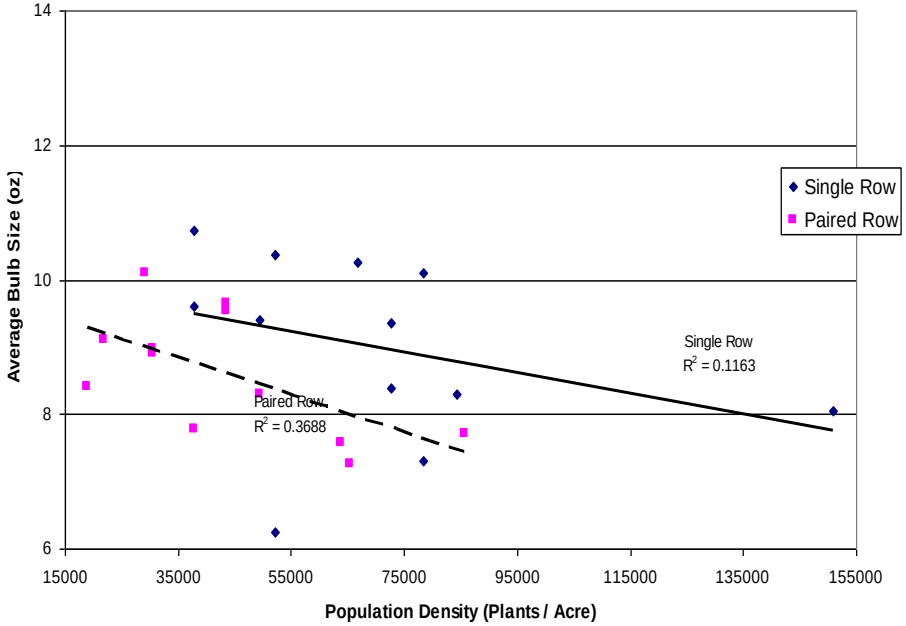

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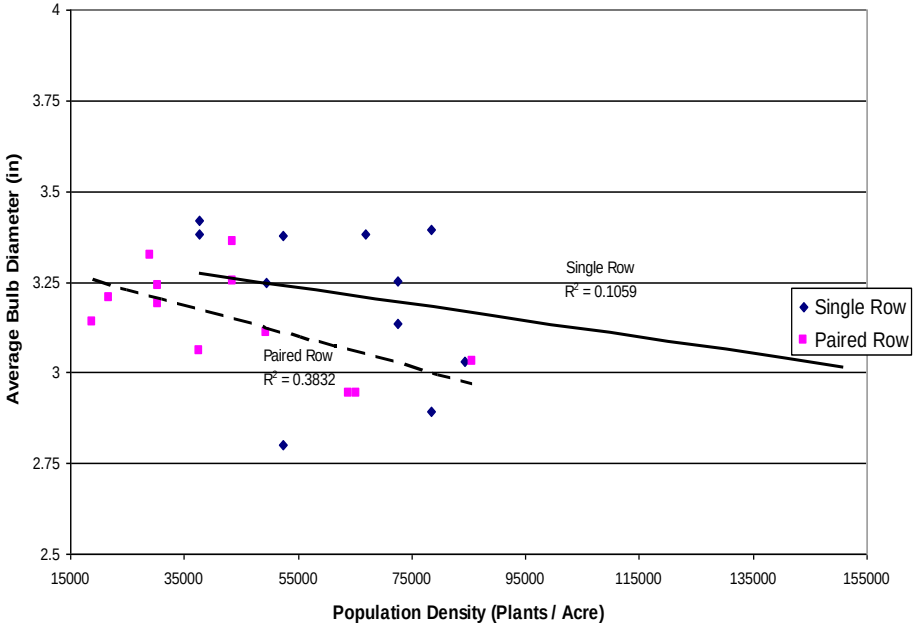

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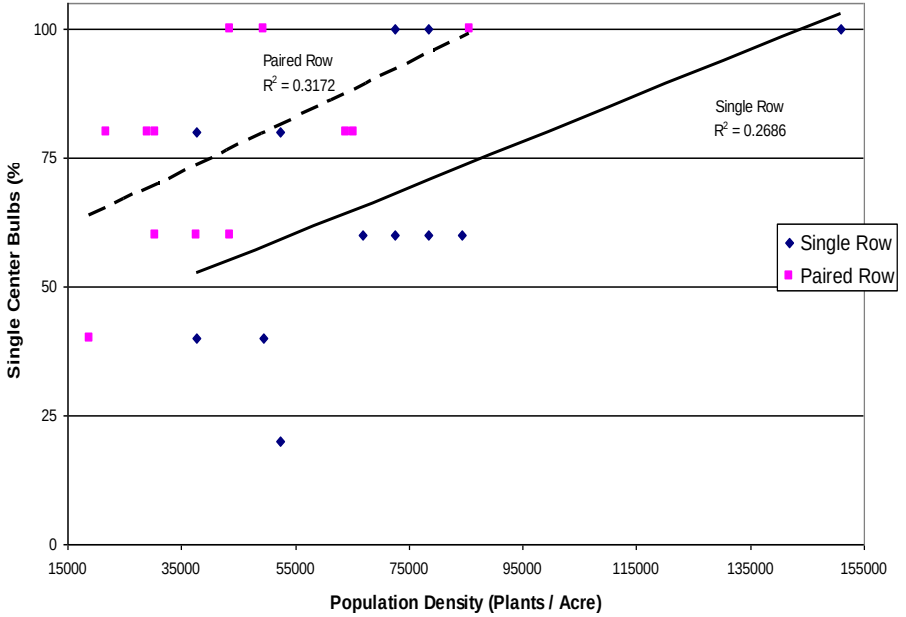
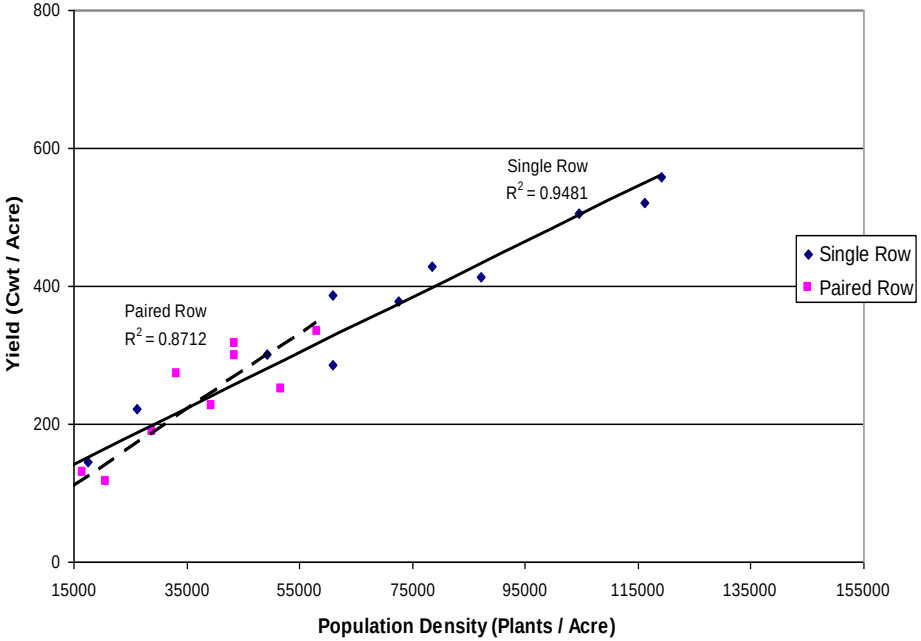


2006 Onion from transplants (Var: Vaquero) bulb density effect on yield. Palmyra, WI. A.J. Bussan, M.E. Copas, and M.J. Drilias.



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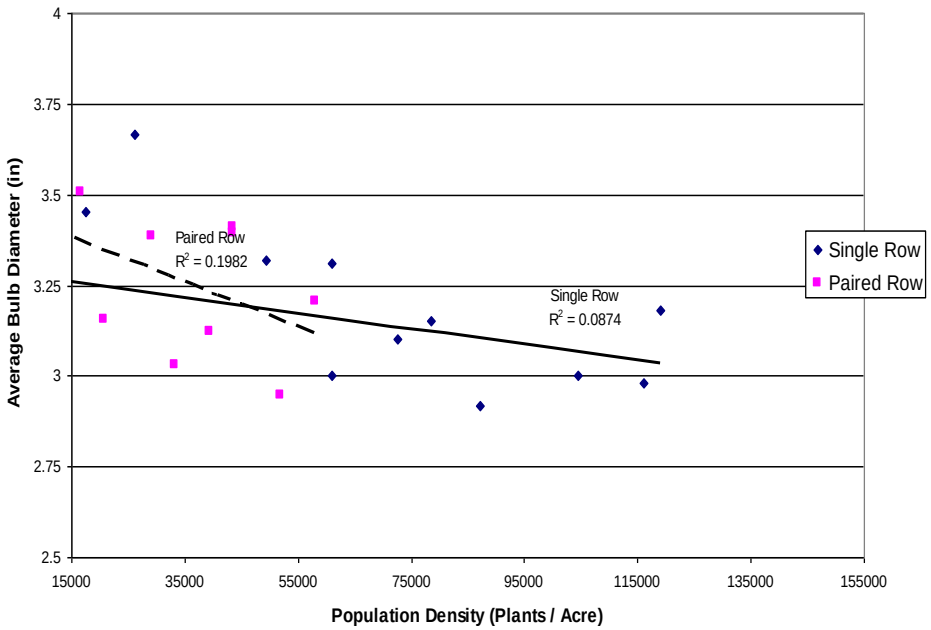

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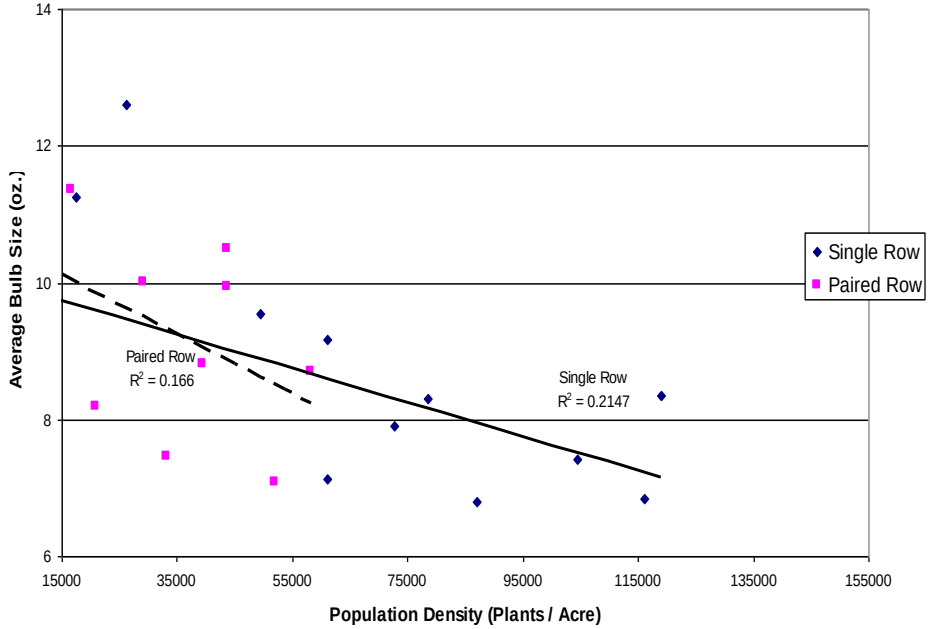

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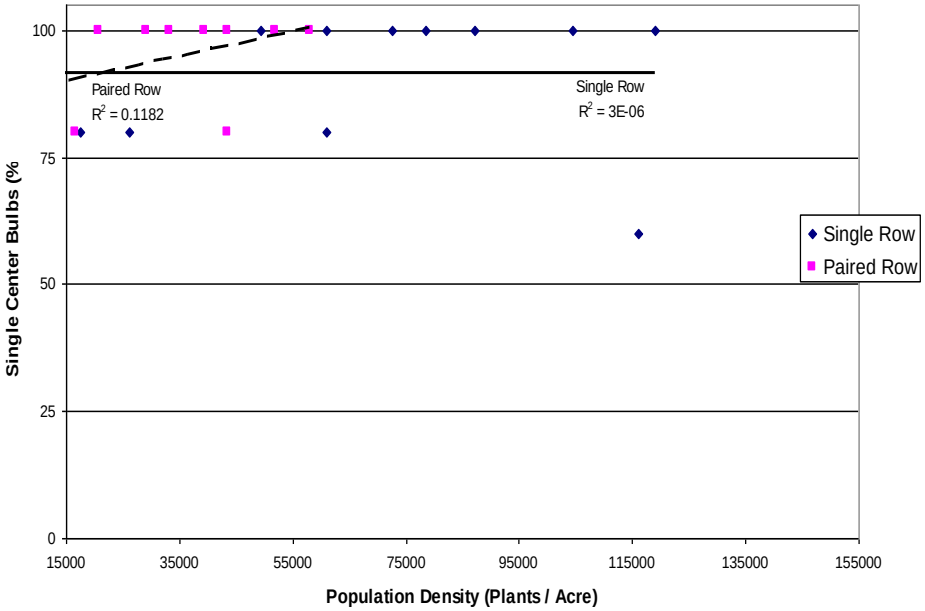

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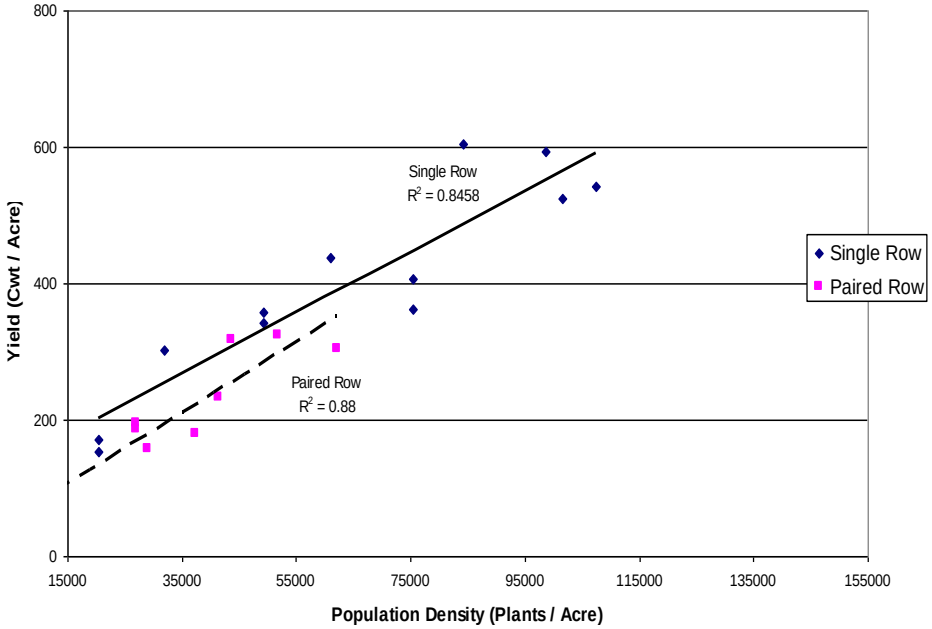

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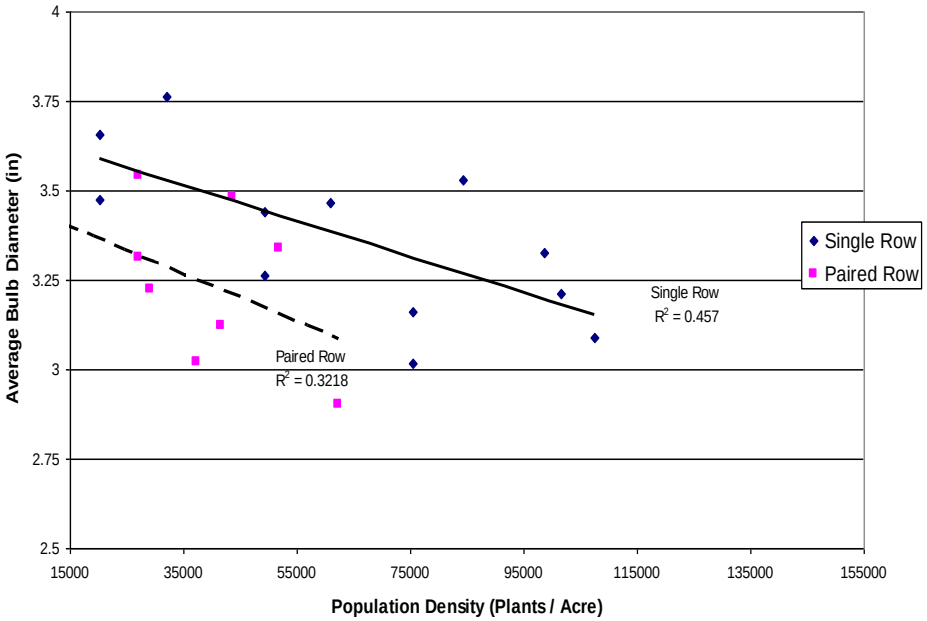

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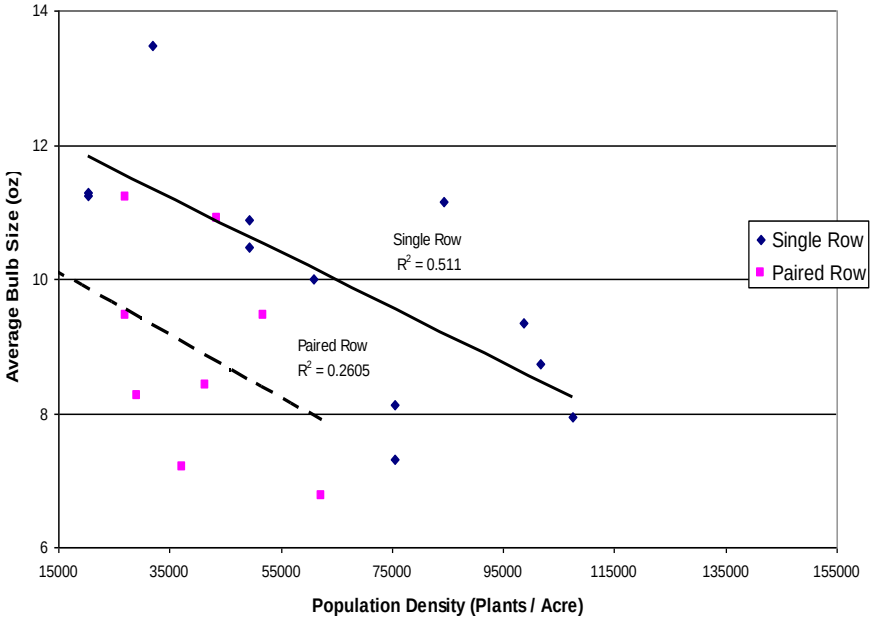

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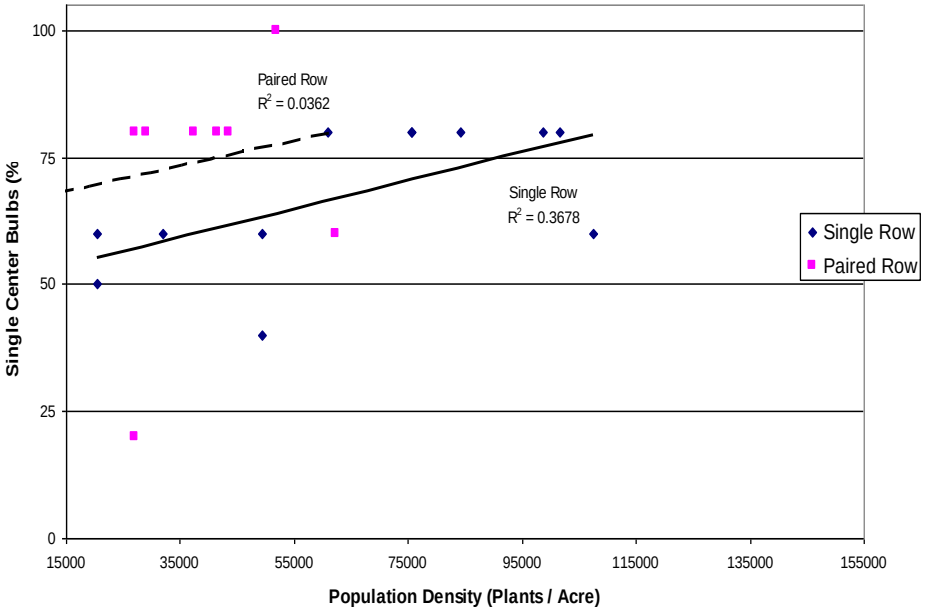

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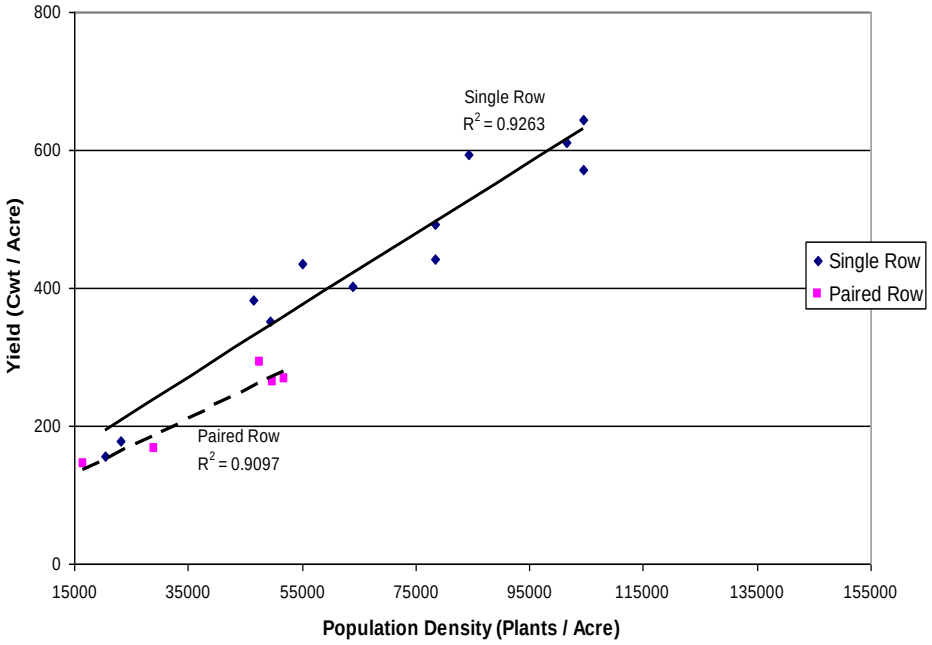

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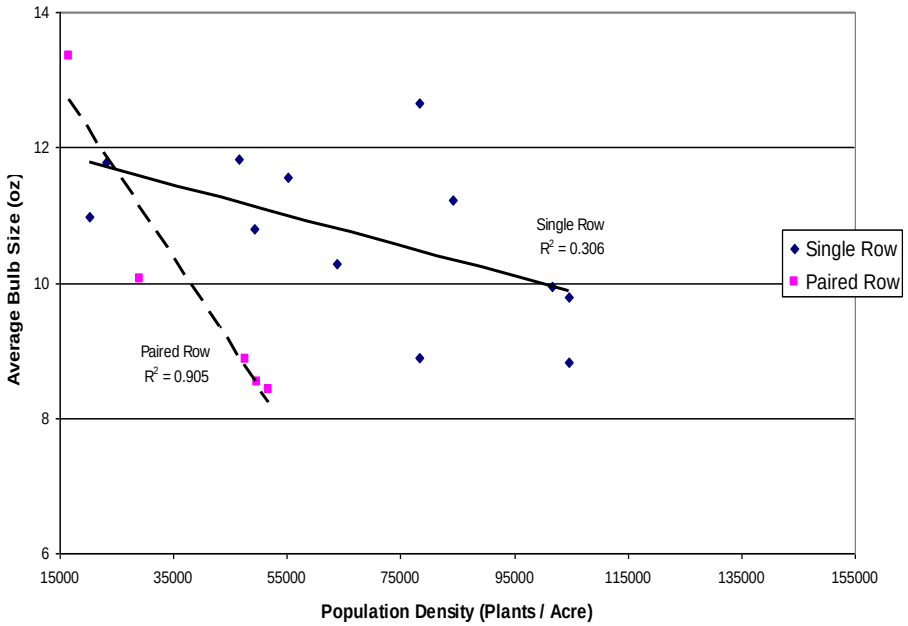

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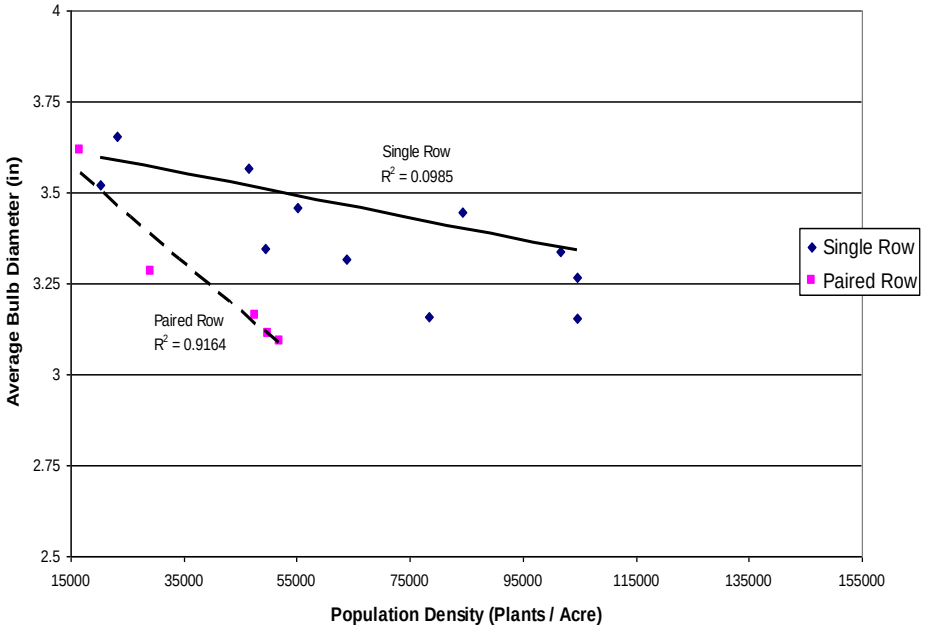

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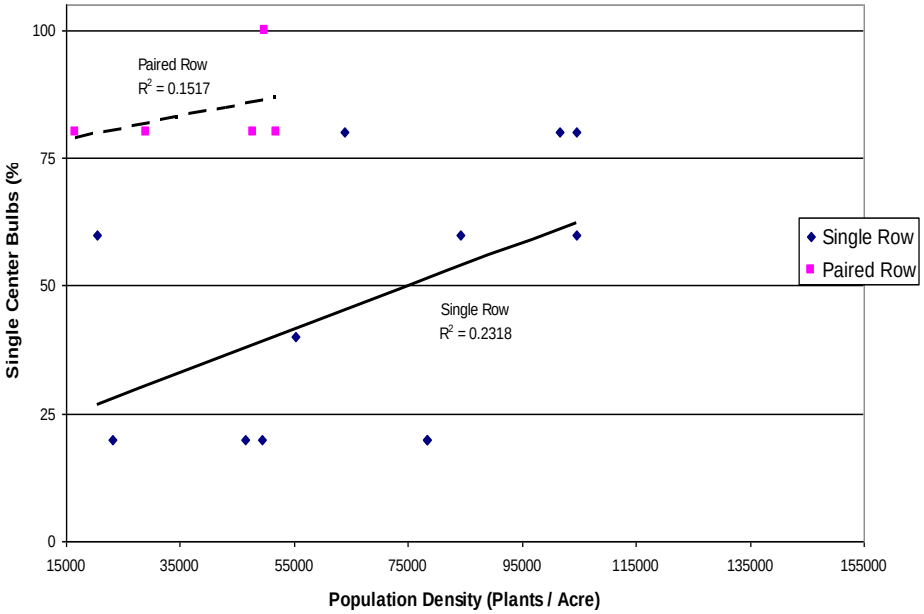

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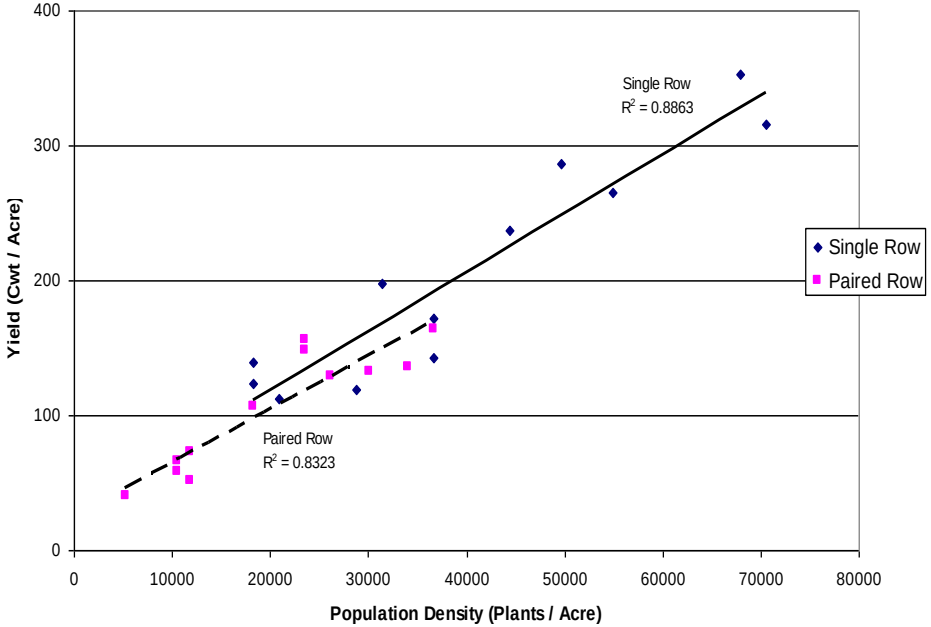

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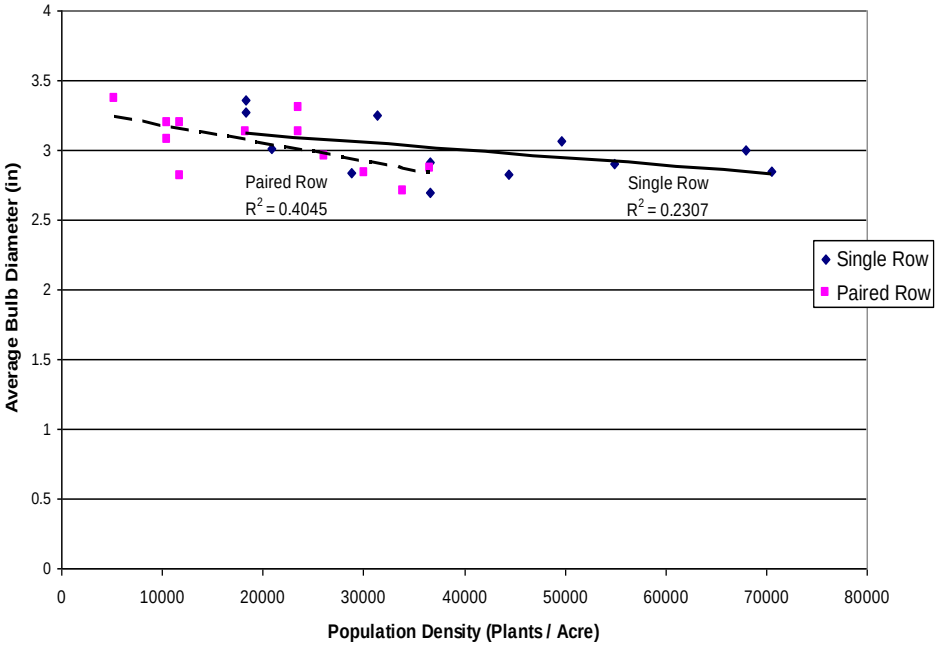

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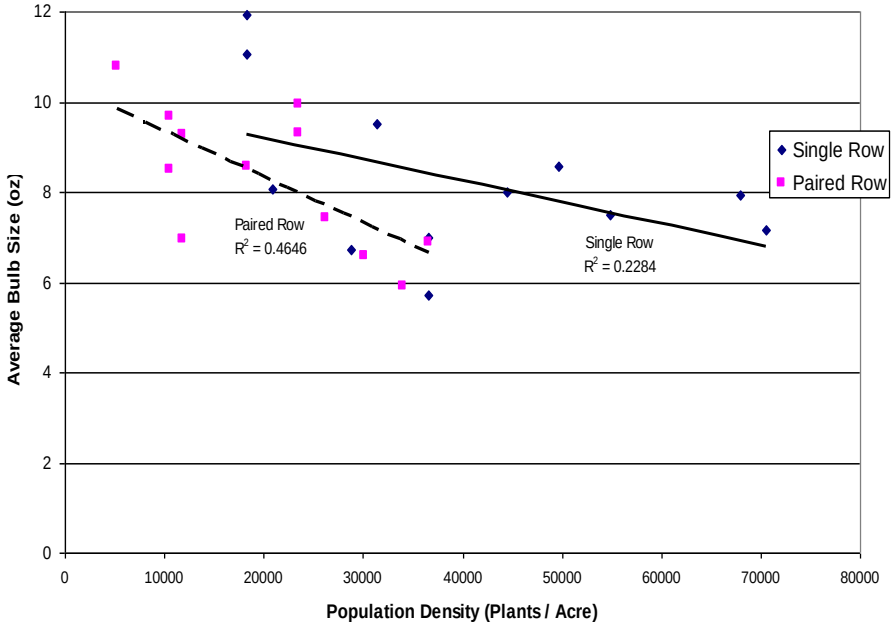

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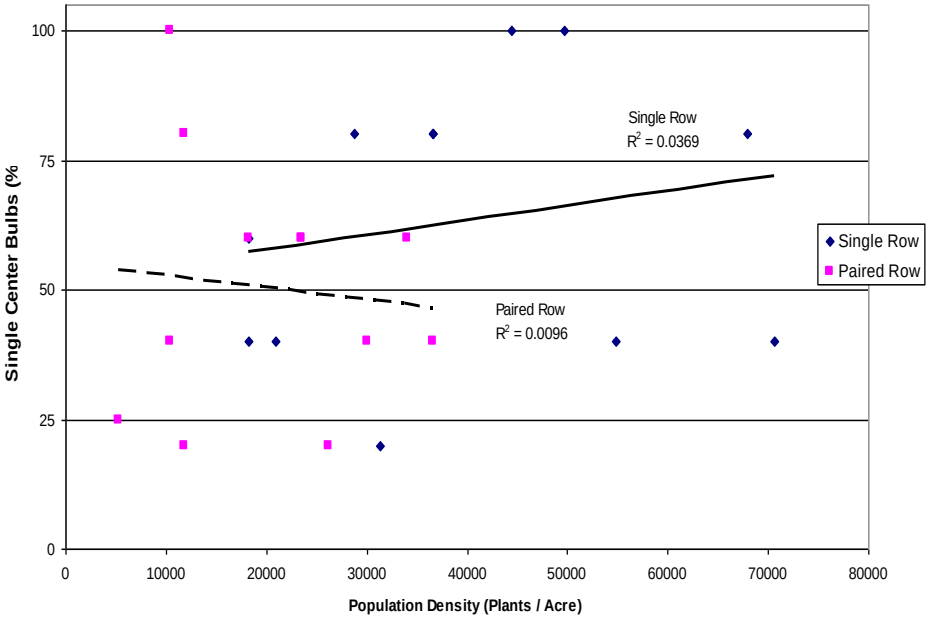

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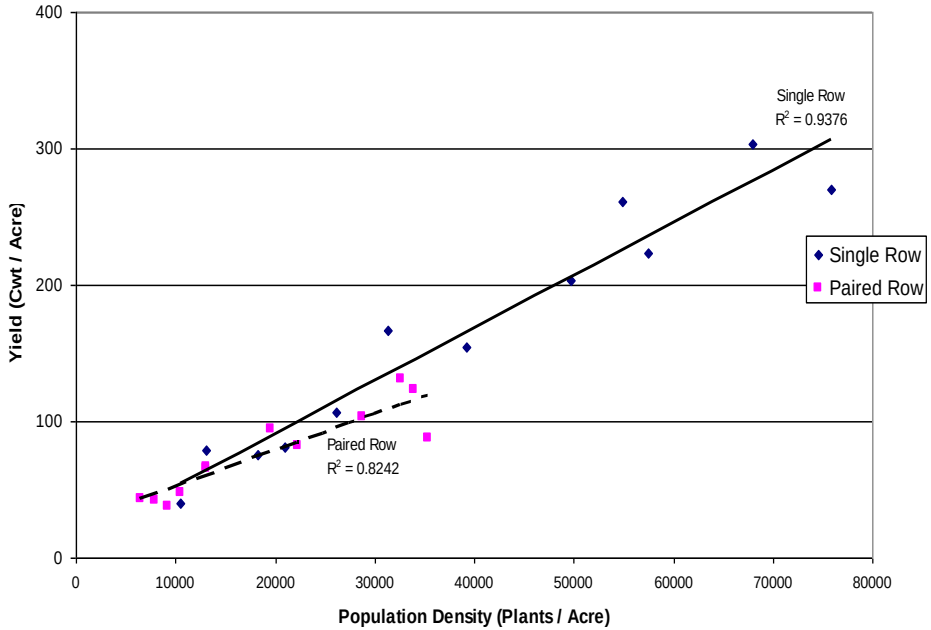

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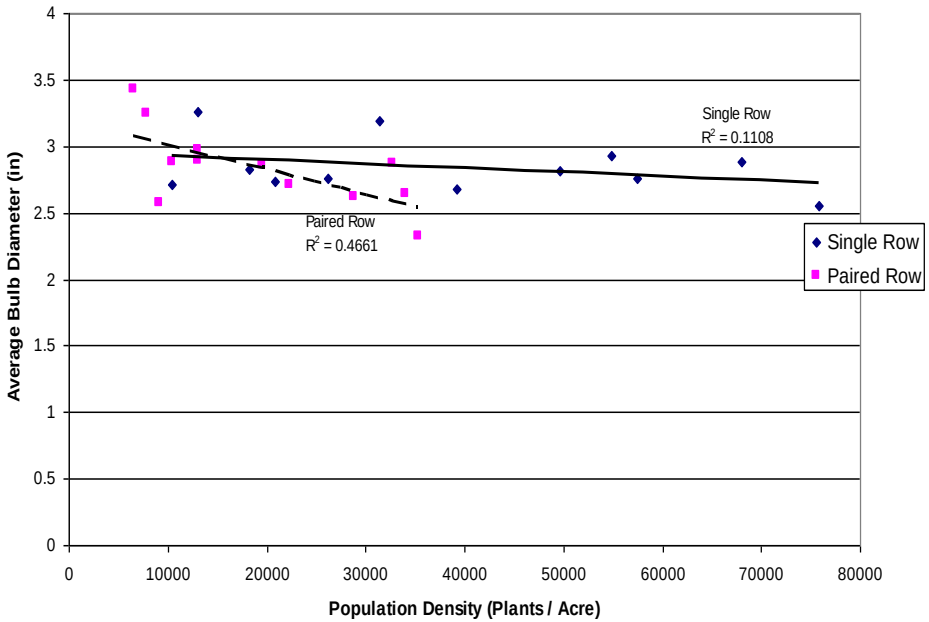

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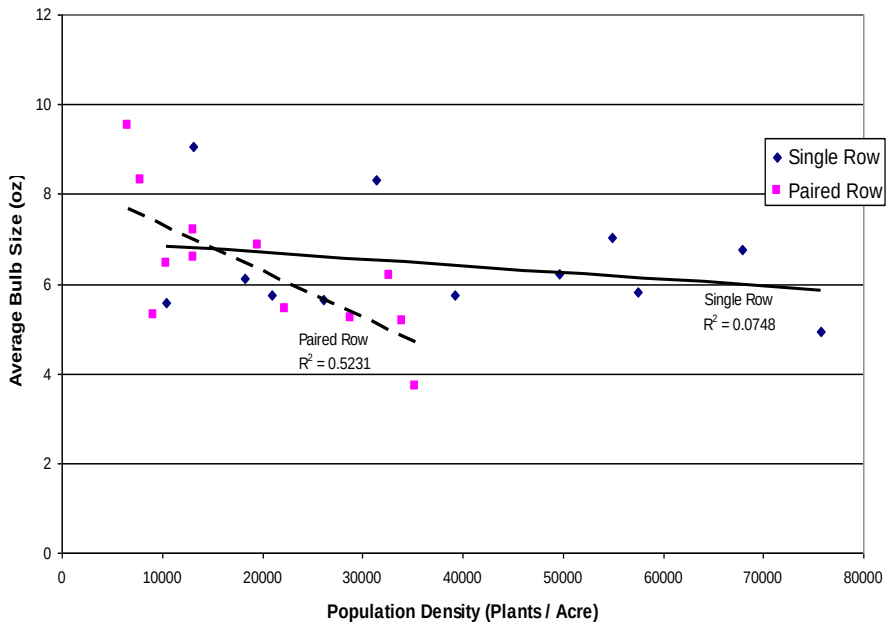
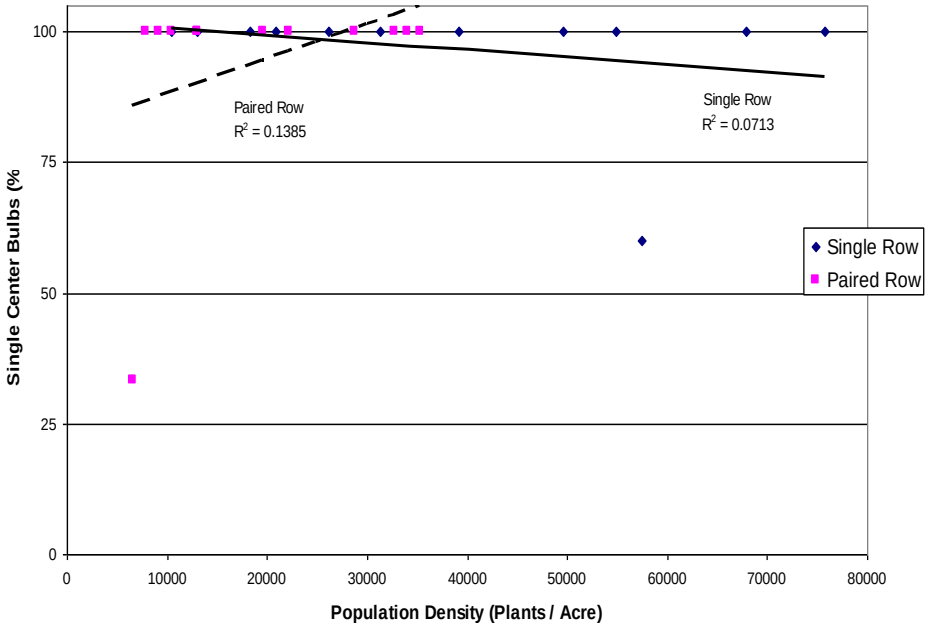
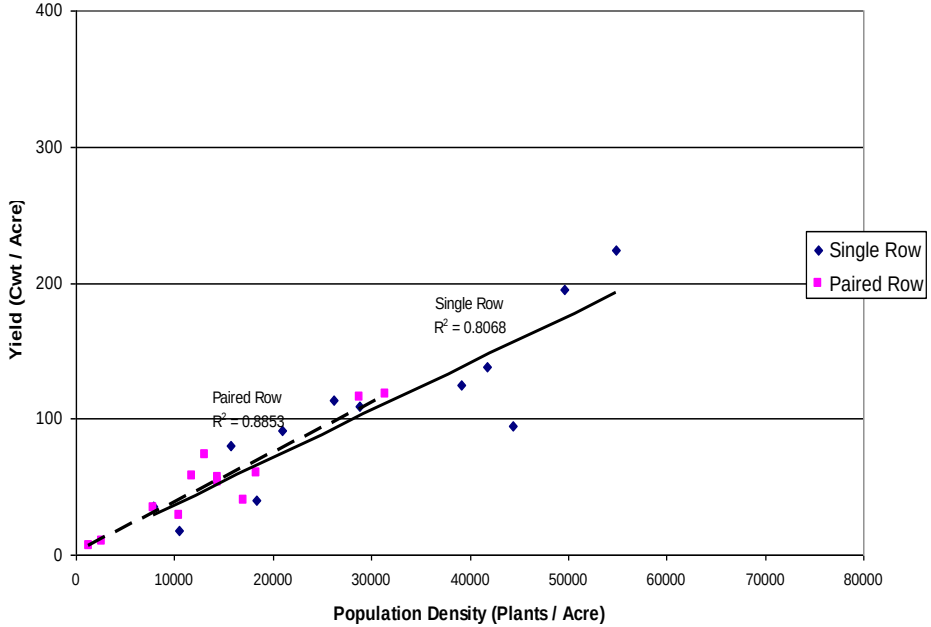


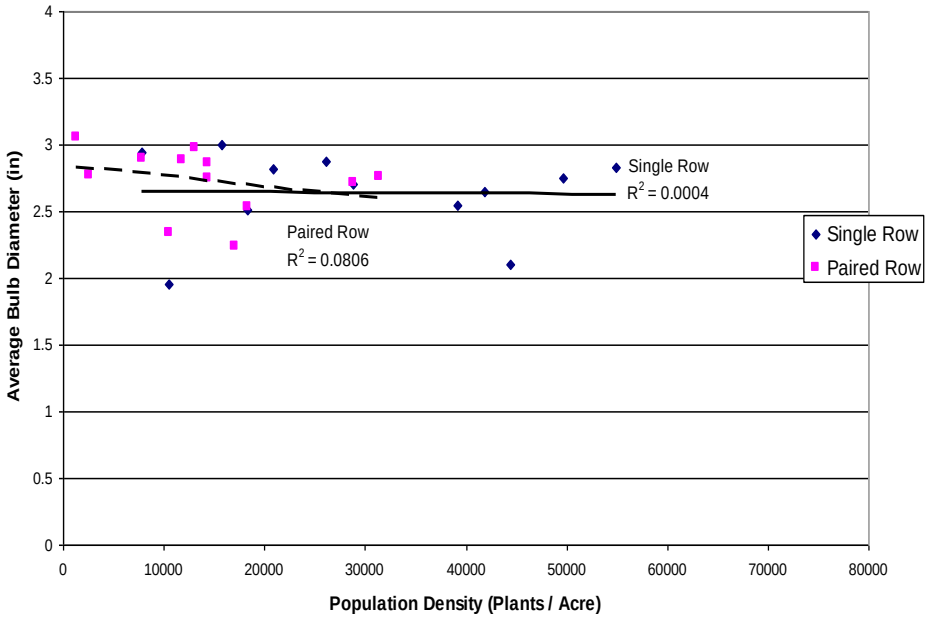
2006 Onion from transplants (Var: Vaquero) bulb density effect on percentage of single centered bulbs. Hancock, WI. A.J. Bussan, M.E. Co
Drilias.



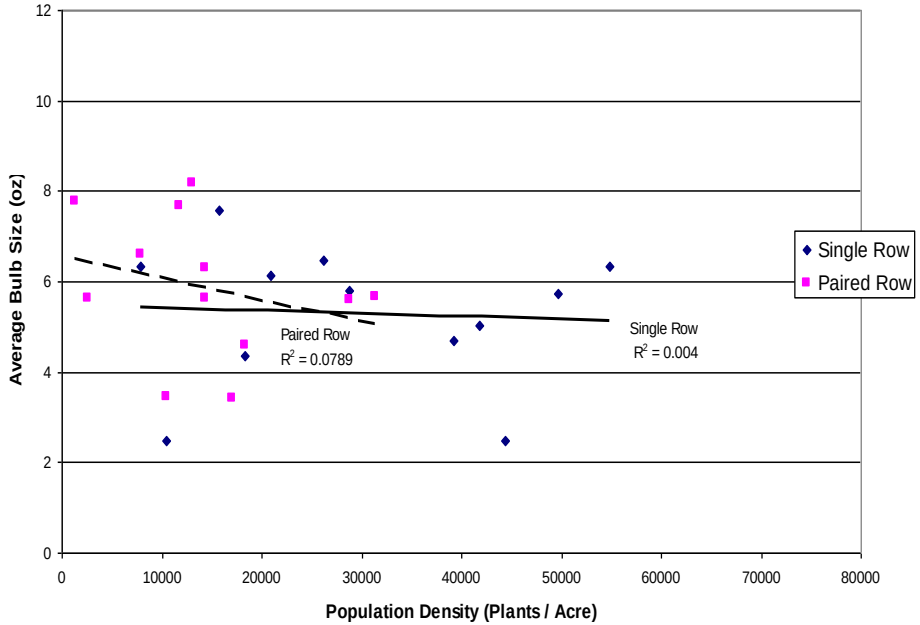
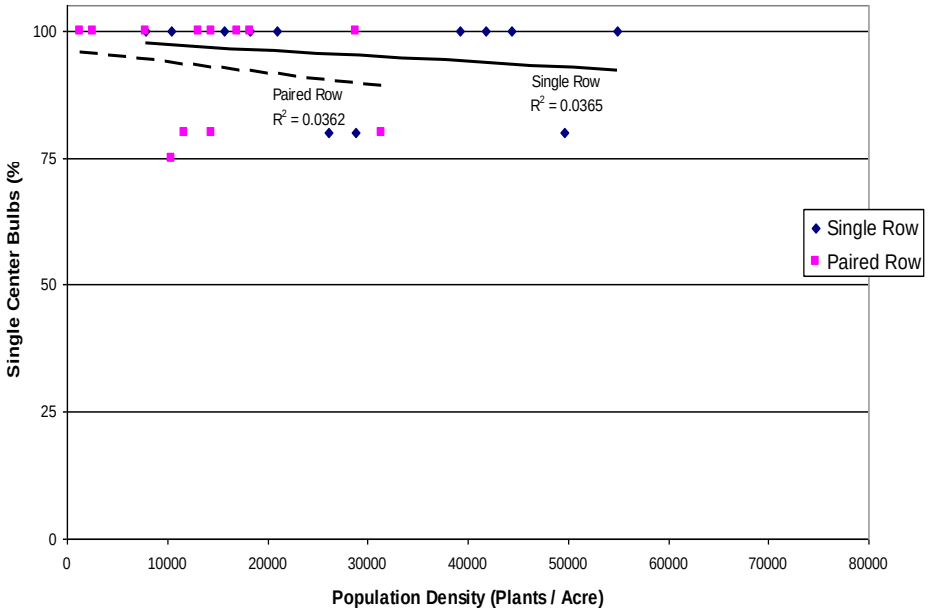
2006 Onion from transplants (Var: Montero) bulb density effect on yield. Hancock, WI. A.J. Bussan, M.E. Copas, and M.J. Drilias.



2006 Onion from transplants (Var: Montero) bulb density effect on average bulb diameter. Hancock, WI. A.J. Bussan, M.E. Copas, and M.J. Dr



2006 Onion from transplants (Var: Montero) bulb density effect on average bulb w eight. Hancock, WI. A.J. Bussan, M.E. Copas, and M.J. Drili



Onion from transplants (Var: Mon) bulb density effect on percentage of single centered bulbs. Hancock, WI. A.J. Bussan, M.E. Copas, and M