Evaluation of Five Cultivars of Asian Greens Under Open Shade and High Tunnel Production Systems During the 2017 Spring Season in North Florida

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Additional index words: hydroponic, protected agriculture, season extension,

Footnote: This research was supported by Enza Zaden Seeds, and Johnny's Selected Seeds (specialty crop seeds). The authors wish to thank Dr. Edzard van Santen, Director of the IFAS Statistical Consulting Unit, University of Florida, for conducting the statistical analysis.

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Introduction

Consumers in the United States are increasingly concerned about the nutritional quality and the sources of the food they are eating. Consumers are focusing on "powerhouse" foods with higher nutrient density. Asian greens, a group of popular Asian vegetables, are one of the highest nutrient-dense vegetables available, second highest in a recent Center for Disease Control article by Jennifer Di Noia (2014). Asian greens are an excellent source of vitamin A, B, C, E, and K, and are also a great source of fiber, beta carotene, iron, calcium, potassium, lutein, folate and chlorophyll (http://www.healthiestfoods.com/healthy-foods/vegetables/asian-greens/) (http://www.medicalnewstoday.com/articles/280948.php) . In addition to families, restaurant chefs are also looking for unique, healthy additions to add subtle flavor or spice to their culinary specialties. Asian greens flavors vary from sweet to mildly pungent and peppery. Chefs are turning to this family of healthy vegetables to add that special taste and/or garnish to their offerings.

Asian greens are in the very diverse Brassicaceae (mustard) family and include: chinese cabbage (*Brassica rapa ssp. pekinensis*), tatsoi **(***Brassica rapa ssp. narinosa***)**, bok choi **(***Brassica rapa ssp. chinensis***)**, mizuna (*Brassica rapa ssp. nipponosica*), and komatsuna (*Brassica rapa ssp. Perviridis*). Asian greens grow best in short day, cool conditions and in Florida, these conditions occur fall thru spring. Protected agriculture structures such as high tunnels, open shade structures and greenhouses offer the ability to protect crops from weather extremes and extend our already long growing season in Florida. Asian greens also have a short shelf life, which lends them to be favored by direct market growers. Considering the diverse varieties of Asian greens and their mainstream acceptance in direct marketing venues, such as farmer's market, farm to school, CSAs (Community Supported Agriculture), restaurants, and chefs; this category of leafy greens presents itself as an important niche for Florida's hydroponic/protected ag system specialty crop growers.

The value and importance of the protected ag and hydroponic sector of the agriculture industry in Florida is rapidly expanding and the industry needs new research-based information to sustain steady growth. Florida growers with our unique challenges of high humidity, high temperatures and high pest pressure need information on Asian greens cultivars that will grow well in our mild climate. This trial was conducted to evaluate five cultivars of Asian greens grown under an open shade structure and under a high tunnel at the University of Florida, North Florida Research and Education Center- Suwannee Valley in Live Oak, FL.

Materials and Methods

The trials were conducted under an open 40 x 40 ft. commercial shade structure (Atlas, Alapaha, GA) covered with 30% silver shade material (ChromatiNet, Signature Supply, Lakeland, FL)

(Fig. 1) and a simple 20 ft. x 40 ft. high tunnel (hoop house) covered with a single layer of clear polyethylene and Aluminet 50% shade material. Five cultivars of Asian greens were selected for trial. Two separate trials consisted of an early spring planting with whole heads harvested on April 3, 2017 and a late spring planting harvested May 16, 2017.

The shade structure was made from galvanized pipe and covered with a 30% silver shade cloth (Signature Supply). The peak of the structure was 10 ft. tall. The high tunnel was a simple unheated 20 ft. x 40 ft. high tunnel (hoop house) with single layer clear polyethylene cover, with side and end walls that can be opened. Side walls were left down during trial, end walls were open. Aluminet 50% shade material was placed over the high tunnel's plastic covering.

Under the shade structure, each cultivar was grown in above ground plastic troughs that were 5 feet long and 2feet wide (Fig 2). One trough was one plot. Plants were spaced 6-inches apart, three rows within each trough resulting in 30 plants per plot. Five troughs placed end-to-end in a row representing one replicate block. Each block had a 4-foot spacing between the centers of the blocks. Asian greens were grown in troughs arranged in a randomized complete block design with three replications (Fig 3). Media used was 100% aged and composted pine bark. The composted pine bark was obtained from a local source (Georgia Florida Mulch, Perry, FL). The pine bark was composted and aged for over ten years. It is important that the pine bark be well composted for successful use as a soilless media.

Within the high tunnel, in-ground troughs were constructed 25 feet long, 15inches deep, and 24 inches wide and filled with the same aged and composted pine bark (Fig 4). Troughs were spaced 4 feet apart from center to center. Each 25-foot long trough was divided into five 5 foot sections. Each

5-foot section was a plot. Plants were spaced 6 inches apart, three rows within each plot resulting in 30 plants per plot. Each 25 foot long trough was a replicate block. Asian greens were grown in the in-ground troughs arranged in a randomized complete block design with three replications. The first trial was transplanted into the troughs on February 14, 2017 and harvested on April 3, 2017. The second trial was transplanted into the troughs on April 14, 2017 and harvested on May 16, 2017.

The crop was irrigated and fertilized using a hydroponic nutrient solution and low volume delivery system using drip tape. Two rows of John Deere Ro-Drip tape with 4-inch emitter spacings were placed on the tops of each trough and secured in position on the surface on the pine bark with metal nursery cloth staples. The pH of the nutrient solution was set at 6.2-6.5 and the EC was set at 1.8 millimos. The nutrient solution provided approximately 120 ppm N, 50 ppm P, 200 ppm K, 48 ppm Mg, 220 ppm Ca, 60 ppm S, 3.5 ppm Fe, 0.3 ppm Cu, 1.3 ppm Mn, 0.3ppm Zn, 0.7 ppm B, and 0.05 Mo (Hochmuth and Hochmuth, 2008). The number and duration of irrigation events increased as the crops grew, starting with three short events per day at transplanting and increasing to six events per day at peak crop demand. Irrigation scheduling during the trial was set to provide 10-20% leaching at each irrigation event (Hochmuth, et al., 2015).

Insects and pests were managed using a weekly scouting program and treatment as needed. Plots were 'whole head' harvested for the two trials on April 3, 2017 and May 16, 2017, respectively (Fig 5). Number of marketable and unmarketable heads and weights per plot were recorded (Table 1). Plants within the plots were rated for tip burn, chlorosis, bolting, and pest damage. (Table 2). Comparisons were made between production under the high tunnel and under the open shade structure (Table 3). Data were analyzed using Generalized Mixed Models methodology as implemented in SAS PROC GLIMMIX (SAS/STAT 14.2) using the appropriate distribution function, i.e., normal for

marketable weight and plant height and binomial for proportions. Interaction means were calculated; the link option in the above-named procedure was use to generate means on the data scale.

Results and Discussion

Top performing cultivars under the high tunnel were ‘Koji’ and ‘Carlton’, while ‘Rosie’ was the poorest performer. ‘Tatsoi’ and ‘Yukina’ were intermediate performers under the high tunnel (Table 1). The cultivars under shade all had lower production than under the high tunnel except ‘Rosie’ which had similar yield under both structures. When the percentage of marketable yield was analyzed, ‘Carlton’ performed very well under both the high tunnel and shade structure. ‘Koji’ and ‘Yukina’ also performed well under the high tunnel, whereas, only ‘Yukina’ performed at the top under the shade structure.

‘Carlton’ was typically the tallest of the cultivars (Table 2). ‘Rosie’ and ‘Tatsoi’ were the two cultivars most likely to bolt regardless of production structure. Tip burn was typically low or not present in all cultivars for the first trial, however ‘Koji’ showed a high level of tip burn when grown under shade on the May 16 harvest date. Damage due to armyworms was also documented in this trial only on the May 16 harvest, showing a much higher level of damage across all cultivars when grown under the open shade structure, in comparison to the closed sidewall high tunnel (Table 2). Based on overall yield and quality, ‘Carlton’ was the top performer, although ‘Yukina’ also performed well.

Overall, the marketable yield was much higher and the plants were taller when these leafy green vegetables were grown under a high tunnel (Table 3). However, the percentage of the total yield as marketable yield was similar between the two production structures.

Tables

Table 1. Marketable yield of five Asian green cultivars as measured in weight and percentage of total yield.

	Marketable weight (lbs/plot)		Marketable Yield (% of Total)	
	High Tunnel	Shade House	High Tunnel	Shade House
Carlton	15.38 ab [z]	6.30 ab	96 a	86 a
Koji	17.68 a	6.87 ab	89 b	66 c
Rosie	7.35 d	5.92 b	49 d	66 c
Tatsoi	12.65 c	9.00 a	61 c	76 b
Yukina	13.88 bc	7.38 ab	84 b	88 a
Level of Significance	*	*	*	*

[z] Means with the same letter within a column are not significantly different (NS), Means with different letters are significantly different at the 5% level of significance (*).

Table 2. Average plant height and susceptibility to bolting, tip burn and worm damage in five Asian green cultivars grown under high tunnel or shade production.

	Plant height (in) Mean over both dates		Bolting (%) Mean over both dates		Tip Burn (%) May 16		Worm Damage (%) May 16	
	High Tunnel	Shade House	High Tunnel	Shade House	High Tunnel	Shade House	High Tunnel	Shade House
Carlton	15.47 a [z]	11.75 a	0 a	0 a	0	0 b	0	60 b
Koji	10.03 b	7.42 b	0 a	1 b	3	48 a	0	80 a
Rosie	10.28 b	10.39 a	38 d	27 d	0	0 b	0	33 c
Tatsoi	9.56 b	8.22 b	30 c	15 c	3	0 b	0	37 c
Yukina	10.56 b	8.47 b	6 b	0 a	0	0 b	0	38 c
Level of Significance	*	*	*	*	NS	*	NS	*

[z] Means with the same letter within a column are not significantly different (NS), Means with different letters are significantly different at the 5% level of significance (*).

Table 3. Effect of production structure (high tunnel vs shade house) on marketable weight and percentage of total yield as marketable, and plant height.

	Marketable yield lbs/plot	Marketable yield (% of total)	Plant Height (in)
High Tunnel	13.39 a [z]	.76 a	11.18 a
Shade house	7.09 b	.76 a	9.25 b
Level of significance	*	NS	*

[z] Means with the same letter within a column are not significantly different (NS), Means with different letters are significantly different at the 5% level of significance (*).

Figure 1. Open shade structure used for Asian greens cultivar trial at Live Oak, FL

Figure 2. Asian greens being prepared to be planted into above ground troughs under shade structure.

Figure 3: Asian greens in troughs under shade structure with two irrigation lines.

Figure 4: High tunnel with in-ground troughs used for Asian greens cultivar trial at Live Oak, FL

Figure 5: Whole-head harvesting of Asian greens under high tunnel.

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