

THE DEGREE OF GROWTH FOR GREEN SPEARS FOR THE HARVESTING AND GRADING STANDARDS FOR ASPARAGUS

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Abstract

This experiment studied the different 4 categories of the “degree of growth” of fresh green asparagus spears on the nutritional composition, specific gravity, weight loss, respiration rate and the incidence storage rot. The results show that the degree of growth of the spear is an important morphological characteristic for harvesting and grading fresh green asparagus spears. The 4 “degree of growth” categories described by the authors are useful for harvest criteria and post harvest storage and are based on scientifically measurable physiological and biochemical changes that occur during the growth of the spear.

Keywords

Fresh green asparagus, degree of growth, harvesting and grading standards

1. Introduction

It has been reported in both domestic and foreign literature that the grading of green asparagus is roughly described in categories such as: very tight heads, tight heads, loose heads, open heads, closed head with open foliage, etc. These descriptions are based on previous knowledge of spear grades are not easily utilized by growers, marketers or consumers. There are many examples of commercial advertising that mistakenly show loose headed asparagus as horticultural acceptable specimens. Therefore, it is important and necessary to make an appropriate, simple and easy method of characterizing the standards for grading fresh green asparagus spears for this industry and the consumers.

2. Materials and Methods

Mary Washington 500W and F₂ of UC 157 asparagus cultivar spears were used in this study. The spears were separated into 4 “degree of growth” categories (Fig. 1.) , as standards , depending on the morphological development of the spear. A spear with the “degree of growth 1” had a tight head with overlapping bud scales, a “degree of growth 2” spear had a tight head with bud scales slightly open (a small gap between each bud scale), a “degree of growth 3” spear’s head was elongating and a “grain-like” (florets) between the bud scales, and the “degree of growth 4” spear had an elongated head with branching appearing between the bud scales (the longest branch less than 1 cm)

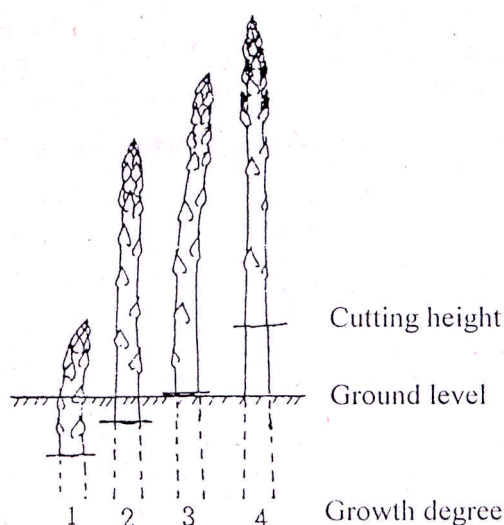


Fig. 1. Degree of Growth Categories

The spears were harvested and graded into uniform spear diameters for each of the 4 “degree of growth” categories and then trimmed to a 10 cm length. Spear samples of each “degree of growth” category were analyzed for the effect of “degree of growth” on spear quality characteristics when stored under the following conditions: Exp. I, 1 kg of pre-cooled green spears were sealed in 0.03 mm polyethylene plastic bags and stored in a ventilated storage room at 8°C to 11°C ; Experiments II and III, 200 g of green spears were sealed in 0.015 mm polyethylene plastic bags and stored in a mechanically cooled room at a temperature of $0^{\circ} \pm 1^{\circ}\text{C}$; Exp. IV, 200 g of green spears were sealed in 0.015 mm polyethylene plastic bags and stored in a ventilated room with a temperature of 16°C to 18°C.

2.1 Methods of analysis

The nutritional content of the spear were analyzed for dry matter, raw protein, raw ash, raw fat, carbohydrate, carotene, vitamin C and Fe (Huang, 1991). The specific gravity was determined by weight in grams divided by volume of water displaced at three times following harvest using 2 replications. Weight loss percentage was calculated after 8 hours at 23°C. Rate of respiration of the spears was measured on 3 replicates of 200 grams of spears using a gas-circulation method at 23° C. Spear rot was classified into 4 grades: Grade 0, no spear rot; Grade 1, rot area less than 0.5cm² ; Grade 2, rotted area between 0.5 to 2.0 cm² ; Grade 3, rotted area between 2.0 to 4.0 cm² and Grade 4, rotted area greater than 4cm². The rot index was calculated as follows:

Spear Rot Index = rot grade X spear number in the rot grade ÷ 4 X number of spears

3. Results and Analysis

3.1 Analysis of nutrient composition of spears in “degree of growth” categories.

Water content and raw protein decreased as “degree of growth” increased. Dry matter, raw fat, carbohydrate, raw ash, carotene and vitamin C increased with “degree of growth”. Little change in the Fe content was found between the “degree of growth” categories.

Table 1. Nutritional analysis of green asparagus spears from 4 “degree of growth” categories

Degree of Growth	Water %	Dry Matter %	Raw Protein %	Raw Fat %	Carbo-hydrate %	Raw Ash %	Carotene mg/100g	Vitamin C mg/100g	Fe mg/100g
1-2	92.75	7.25	2.27	0.29	4.04	0.65	0.25	27.4	0.80
3	92.24	7.76	1.80	0.40	4.90	0.66	0.26	27.9	0.75
4	91.75	8.25	1.48	0.76	5.18	0.83	0.27	33.2	0.77

3.1 Specific gravity of “degree of growth” categories

The specific gravity of the spears decreased as the “degree of growth” categories increased. Using “degree of growth” category 2 as a base, the specific gravity of “degree of growth” category 1 was found to be higher and the specific gravity’s of “degree of growth” categories 3 and 4 were lower.

Table 2. Specific gravity of spears in 4 “degree of growth” categories

“Degree of Growth” categories				
Date	1	2	3	4
August 14	0.917	0.896	0.875	0.803
August 15	0.897	0.870	0.852	0.819
August 16	0.900	0.883	0.864	0.811
average	0.905	0.883	0.864	0.811
Percent of “2”	102.5 %	100 %	97.85 %	91.85 %
± %	2.5 %	0.0 %	-2.15 %	-8.15%

3.2 Weight loss of spears in 3 “degree of growth” categories

The weight loss of spears in 3 “degree of growth” categories was higher in those spears with the greater “degree of growth” as shown in table 3. Conversely the specific gravity of the spears was less as the “degree of growth” increased. These two characteristics of the spears indicate that spears at the 1 or 2 “degree of growth” have a greater capacity to maintain water content and density than the 3 or 4 “degree of growth” spears which improves the maintenance of quality during post harvest storage.

Table 3. Weight loss of spears stored at 23°C for 8 hours.

“Degree of Growth”	Sample Weight (g)	Weight after 8 hours (g)	Weight loss (%)
2	200	198.0	1.0
3	200	196.0	2.0
4	200	194.0	3.0

3.4 Respiration rate

The respiration rate of green spears increased with the “degree of growth” of the spears. Spears in the 3rd and 4th “degree of growth” categories had respective respiration rates of 10.1 % and 27.5 % higher than the 2nd “degree of growth” spears (table 4). However, the rate of change in the respiration rate of the spears between the “degree of growth” categories decreased with time.

Table 4. Respiration rate of spears (mg/kg hr⁻¹) in the “degree of growth” categories at 23°C

Hours after harvest	“Degree of Growth” categories		
	2	3	4
4	633.6	682.0	745.6
8	589.6	651.2	710.2
12	426.6	462.0	620.4
28	354.2	411.4	470.8
Average	501.2	551.7	639.0
% difference of 2nd Degree of growth	100 %	110.1%	127.5%

2.1 Spear Rot Index as a measurement of post harvest quality

The spear rot index increased with the “degree of growth” categories when the spears were stored under different storage conditions of temperature and time, (table 5). The 4th “degree of growth” category had the highest spear rot index under all of the storage conditions and is considered to be unacceptable for any extended post harvest storage or shipping. The average of the 1st, 2nd and 3rd degree of growth” categories were significantly different than the 4th “degree of growth” category average at the 1% and 5% level. A significant difference was found between the 1st and 3rd “degree of growth” categories at the 5% level.

Table 5. Spear Rot Index of green spears in 4 “degree of growth” categories after storage at 4 different conditions of temperature and time.

Storage Temp (°C) and time (days)	“Degree of Growth” categories			
	1	2	3	4
8 –11 °C, 10 days	0.118	0.140	0.138	0.974
0 ± 1 °C, 30 days	0.296	0.101	0.349	0.804
0 ± 1 °C, 47 days	0.276	0.373	0.502	0.738
16 – 18 °C, 51 days	0.057	0.206	0.406	0.699
Average	0.187	0.205	0.349	0.838
% of 2 nd “degree of growth” category	91 %	100 %	170 %	392 %
Significance test 5%	c	bc	b	a
Significance test 1%	B	B	B	A

2. Discussion

As the “degree of growth” of the spears increased, the dry matter, raw fat and ash, carbohydrate, carotene and vitamin C increased while the water content and raw protein decreased. These physiological and biochemical changes resulted in spears that became less suitable for long term post harvest storage as “degree of growth” increased. The 2nd “degree of growth” spear had the highest specific gravity and best post harvest storage characteristics and is considered to be the “degree of growth” for harvesting green asparagus spears. Second “degree of growth” spears yielded less than the 3rd and 4th “degree of growth” spears but because of the 2nd “degree of growth” spears’ higher quality the improved marketability of spears the provides both the grower and the marketer with a better product. Because the spears in the 3rd and 4th “degree of growth” categories did not have the physiological/ biochemical characteristics necessary for extended post harvest storage, these spears should not be marketed in situations where they need to be shipped.

The utilization of a “degree of growth” category by the grower for harvesting and the use of a “degree of growth” by the marketers of asparagus to grade green asparagus spears into marketable categories has been shown to be worthwhile. Scientific determinations of the physiological and biochemical changes that take place when a green spear is harvested at different “degree of growth” has been shown. The “degree of growth” categories can be easily related to grower, marketer and consumer by pictorial means. The use of “degree of growth” categories as standards in the green spear industry in China will help to improve the acceptance of green asparagus spears into the Chinese market. The use of high yielding, tight headed asparagus cultivars will improve the yield of spears that can be harvested by a grower thus increasing his income while providing the Chinese market with high quality green asparagus spears.

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