FACTORS AND DEVELOPMENTS IN GRADING CUT FLOWERS

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ABSTRACT

Grading and sorting fresh cut flowers are time consuming process. In Korea, cut flowers are sorted mostly by human inspection due to the lack of adequate machinery. In this paper, quality evaluation factors of cut flowers are discussed, and types of sorting machines existing in the market are introduced. Aspects of computer image processing in evaluation the quality of cut flowers are also discussed.

Key words: cut flower, grading, sorter, standards

INTRODUCTION

With economical development of a country, the production and consumption of flowers increase. As the trade of flowers rises, so do the needs for standards of quality evaluation and mechanical means of grading. There have been many efforts to the development of sorting and grading machines for agricultural products such as grains, fruits, and vegetables. Generally, cut flowers are more delicate to handle and they have shorter shelf life than other agricultural products. Therefore, cut flowers are graded and sorted on the day of harvest unless good facilities for cold storage are provided. The Netherlands is the country that shared 59% of world export of cut flowers in 1994, and the top five cut-flower crops in Holland auction are rose, chrysanthemums, tulip, carnation, and lily in descending order of turnover (Flower Council of Holland, 1994). The Netherlands has manufacturers that produce both simple and sophisticated flower processing machinery. In Korea, the cultivation area, number of farm households, production,

and per capita consumption of cut flowers are gradually increasing. As of 1994, there were approximately 7,200 farm households producing cut flowers. Sorting and packaging of cut flowers are very labor intensive, comprising approximately 32% of total labor requirements in cut flower production. Futhermore, the manual sorting of cut flowers is rather complicated including many factors such as stem length, stem diameter, stage of flower openness, and so on. Therefore, the need for mechanized sorters is evolving among domestic cut-flower growers. The objective of this paper is to introduce factors concerning the grading of cut flowers, machines existing in the world market, and some aspects of the application of computer image processing.

STANDARDS OF GRADING CUT FLOWERS

Advantages of implementing standards

Grades and standards are different terms describing products quality. Cut flower grades are different categories, such as small, medium, large and extra large. The factors associated with the evaluation of the quality of cut flowers include: shape and color of flower buds; length, thickness and curvature of stem; damage of foliage by insect or disease; and residue of chemicals (Fig. 1). The standards, on the other hand, are precise attributes of quantifiable parameters associated with each grade.

Some advantages of developing and implementing uniform grading standards for both producers and consumers of cut flowers are (Holstead-Klink, 1991, 1992):

- promotion of better communication (improved efficiency of system) and
- improvement of products consistency throughout distribution.

Grades and standards in Korea

In Korea, there are standard specifications on the quality grade of several crops of cut flowers. The Korean Agricultural and Fishery Marketing Corporation established standard shipping specifications to improve efficiency and to achieve fair trade. The specifications are composed of two categories: three different grades on quality measures and four grades on size. The categories of quality measures are classified as "extraordinary", "excellent", and "good"; and the quality evaluation factors involved are color of bud, thickness and straightness of stem, insect or disease damage, and residue of chemicals. These quality factors are relative and not quantified. On the other hand, the specifications on the size are based on length of stem and they are very straightforward. Table 1 shows standard stem length for some cut-flower crops established by the Korean Agricultural and Fishery Marketing Corporation. Total number of cut-flower

grades is twelve, four size grades in each of the three quality grades.

Even though the grades and standards have been established, both growers and retailers do not follow the standards due to several reasons. Some of the reasons include: 1) the domestic consumers generally do not prefer cut flowers with long stems, 2) the cost of machine grading would not be compensated, and 3) due to the lack of mechanical sorters, flowers are seldom sorted according to the specifications by growers. However, it is well accepted by domestic growers that quality grades should be prevailing in the near future. For export purposes, the shipping standards are described in detailed manner according to crop and cultivar. Currently, the detailed standards are applied to several cultivars of export lily.

Quality evaluation factors

The length of stem is the quality factor that contributes most in determining the price of cut flowers. Maturity (stage of openness) of flower bud is also very important. Flowers picked too early — when flower bud is not properly developed — will not flower completely due to the lack of nourishment. On the other hand, flowers picked too late will not last long and the economical value is reduced. Therefore, flowers with equal and proper degree of maturity will insure adequate and simultaneous flowering result to the customers.

A survey of cut-flower growers was conducted in 1996 to study their views on the development of mechanical sorter. Table 2 presents the summary of factors considered important in quality evaluation of several major crops of cut flowers according to the results of the survey. The results indicated that the length of stem is an important quality factor for every crop, and thickness of stem and size of bud should also be considered for several crops.

CUT-FLOWER SORTERS IN THE MARKET

There are some cut-flower sorters available in the world market. The Netherlands and Japan are two leading countries in the production of the sorters. In this section, several different types of cut-flower sorters are introduced.

Sorters based on stem length

Simple sorting machines determine the length of stem and they sort cut-flowers into four or more size groups with the capacity up to 3,600 flowers per hour. This type of machines utilize a number of micro switches or photo sensors to detect stem length and solenoid valves to turn the feeding bucket (or similar feeder) over at the designated location according to the result of grade

determination (Fig. 2). A flower laid down flat on a tipping-bucket conveyor touches a number of micro switches in the course of transportation according to the stem length. The length intervals for different groups are set by the locations of the micro switches or photo sensors. Usually, a deleafing machine (to detach foliage in the lower part of stem, Fig. 3), a binding machine (to bind a number of flowers to make a bunch, Fig. 4), and a cutter (to cut stems to make a bunch equal in length) accompany this type of sorters.

Sorters utilizing color image processing

Computer image processing technique is utilized in cases where the stage of bud openness and color of flower buds are included as factors of quality evaluation. A few manufacturers in the world produce processing machines for cut flowers utilizing image processing. Dutch manufacturers such as Olimex and Aweta developed sophisticated rose processing machines. These machines utilize color image processing for quality grading and robot mechanisms to process flower bunches. The quality factors include: stem length, stem thickness, ripeness, bud size/form, deviation in color, bent stems, and crooked neck. In addition to the sorting mechanism, they also have binding and trimming mechanisms to make bunches of uniform stem length within one centimeter. The final result of the process is roses of equal ripeness with uniform length and stem thickness. The work capacity of these machines ranges from 8,000 to 9,500 roses per hour. Figure 5 shows the schematics of the optical system for color image processing of a rose bud by Olimex, Netherlands (Anonymous, 1995). For three-dimensional recording and analysis, this arrangement allows one top view and three side views of individual rose bud.

Sorters for spray-type cut flowers

Spray-type flowers have multiple buds on one stem whereas standard-type flowers have only one bud per stem. Therefore, different methodologies should be applied for quality evaluation of spray-type flowers. A flower processing facility in Japan installed separate sorting line for spray-type flowers such as carnations and chrysanthemums. The flowers are graded based on weights measured by loadcells.

SOME ASPECTS OF COMPUTER IMAGE PROCESSING

In developing cut-flower sorters utilizing computer image processing technique, several aspects must be considered: crop, quality evaluation factors, image resolution, and processing time. For standard-type flowers, the quality grade factors should include information on both stem (length, thickness, and

straightness) and bud (color, size, and stage of openness). As most natural products, the size and shape of flowers are not easily quantifiable. There have been few reports on the algorithm developments for roses. Steinmetz et al. (1994) developed image processing algorithms to grade roses by evaluating stem and bud. Ikeda and Sawada (1993) developed a neural network based algorithm to evaluate maturity of rose buds.

The following factors deteriorate the performance of computer image processing:

Stem

- coverage of stem by foliage provides only partial information on stem
- some leaves may hanged below the end of stem which makes accurate measurement of stem length (and also straightness) difficult
- in some flowers such as roses, the thorns in stem create complexity in thickness measurements
- maximum stem length depends on crop (as shown in Table 1), in the case of roses it exceeds 70 cm, which makes pixel resolution very poor (larger than 1 mm)

Bud maturity

- in many cases, flower buds are not symmetrical
- petals may be covered by sepals, and the coverage patterns may differ for each crop, cultivar, and degree of maturity
- the change in bud shape as opening progresses also depends on crop and cultivar

A study on the shape characteristics of several rose cultivars showed that the average ratio of visual portion of stem free of foliage ranged from 55.8 to 71.2 percents depending on cultivar. Average size of thorns in the direction of stem thickness is 5.4 cm, which is 33% larger than the average stem thickness. The average numbers of thorns per 10 cm interval of stem length are 2.1 to 10.7 depending on cultivar. The thorns are distributed more densely in the lower part of stem. We propose a simple algorithm that utilizes the length and measurements on width at three different locations of a bud to evaluate the stage of bud openness. The weighted sum of three measurements on bud width divided by total length of bud is expected to provide information on the stage of bud openness. The time required to process one flower should be shorter than 1.8 second so that the machine can process at least two thousand flowers per hour. Since the stem and bud are not symmetrical, an optical arrangement with reflecting mirrors is necessary to increase the accuracy in the measurements on length, straightness of stem, and maturity of bud (Fig. 6).

CONCLUSION

The factors to be considered in grading fresh cut flowers are length, thickness and curvature of stems; and color and maturity of flower buds. The maturity of buds (stage of openness) is rather difficult to identify and to quantify. Cut-flower sorters existing in the market vary widely in complexity. The simplest type utilizes a number of switches or photo sensors to grade cut flowers according to stem length. Very sophisticated machines utilizing color image processing techniques are also commercially available. Few algorithms have been reported by researchers to evaluate quality of both stem and bud. It is necessary to develop algorithms and mechanisms applicable to economically feasible cut-flower sorters for domestic growers.

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Table 1. Standards on stem length for several crops of cut flowers in Korea

Crop	Length of stem (cm)			
	grade 1	grade 2	grade 3	grade 4
Chrysanthemums	> 85	75 - 85	65 - 75	< 65
Carnation	65	50 - 65	40 - 50	40
Rose	70	60 - 70	50 - 60	50
Lily	90	80 - 90	70 - 80	70
Gladiolus	120	100 - 120	80 - 100	80

Source: Korean Agricultural and Fishery Marketing Corporation, 1993

Table 2. Growers' opinion on the quality factors of several cut-flower crops

Factor / Crop	Size of bud	Appearance of buds	Number of buds	Length of stem	Thickness of stem	Appearance of foliage
Rose				○		
Carnation	○		○	○	○	
Chrysanthemums	○	○		○	○	○
Lily	○			○	○	
Gladiolus			○	○		

○: factors considered important

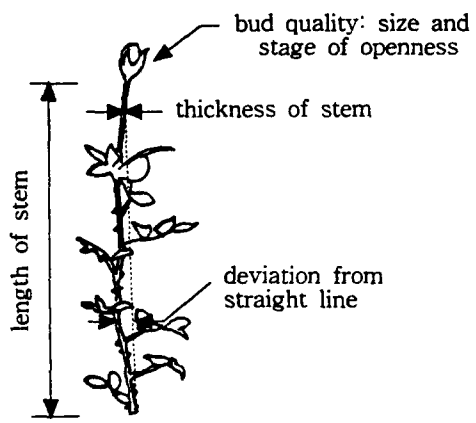

Fig. 1. Quality evaluation factors of standard-type cut flowers

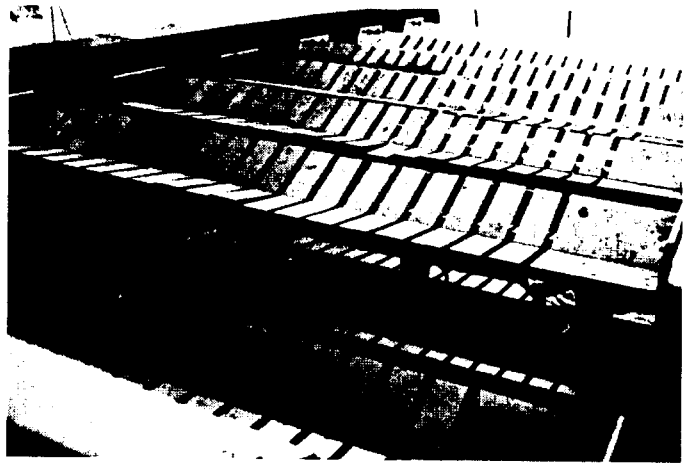

Fig. 2. Sorting machine based on stem length (Olimex)

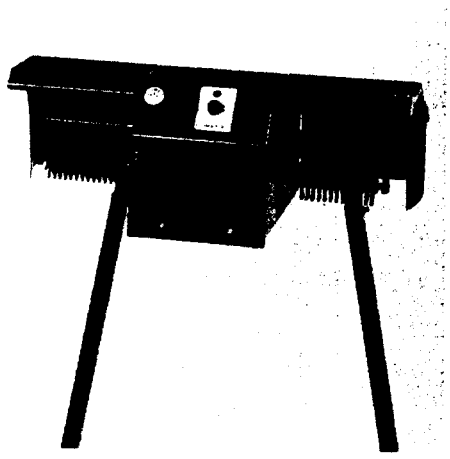

Fig 3. Deleafing machine (Olimex)

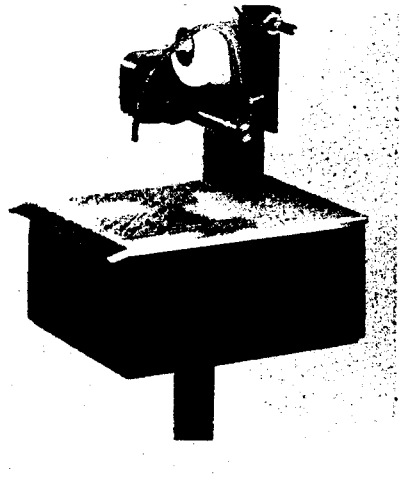

Fig. 4. Binding machine (Olimex)

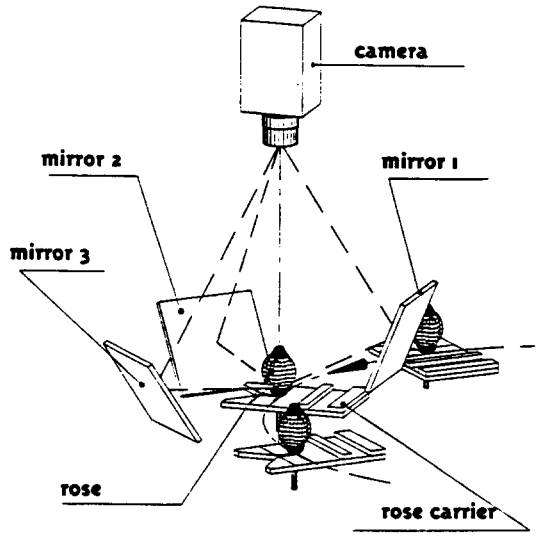

Fig. 5. Three-dimensional recording of a rose bud by Olimex

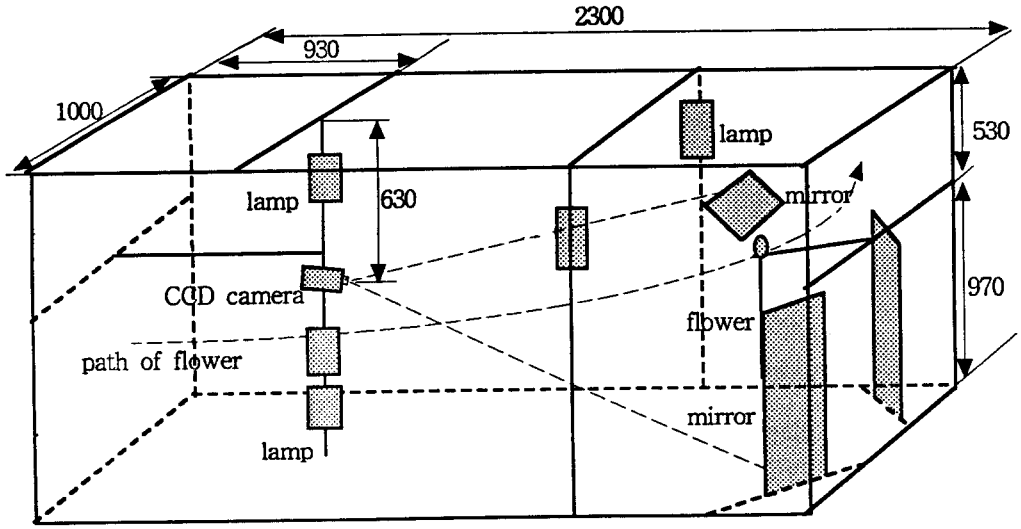

Fig. 6. An optical arrangement with reflecting mirrors to analyze both flower bud and stem