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STUDY FOR TRANSPLANT MECHANIZATION OF LILY BULBS WITH BOX CULTIVATION

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ABSTRACT Cut flower lilies are the main export-oriented crops but recently their export has decreased. To boost export, we need to improve quality through intensive management using box cultivation. This study's objective was to conduct a factory test for transplanting mechanization of cut flower bulbs using cultivation boxes to reduce labor. The system consists of the soil supply part, transplanting part, soil covering part ,and irrigation part. The performance of the machine is 120boxes/hour.

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Keywords: flower bulb, lily, sorting, mechanization

INTRODUCTION Cut flower lilies are the main flower crop in Korea, accounting for 10 percent of production and 8.8 percent of cultivation area(MAFRA, 2020). Lilies have a high proportion of exports, but exports have decreased due to the recent slump in the flower industry. To improve exports, various sales channels and quality control is implemented, although the Covid-19 has hampered efforts. Also, climate change, such as low and abnormal temperatures, significantly affects crop quality and production. In the case of lilies exported, the quality is reduced due to falling flowers or decreasing hardness(Harm et al., 2007, Park et al., 2020, Identification, 2007). An active alternative to environmental changes is needed to improve the quality of lilies, and to achieve this, the introduction of cultivation technology using boxes is necessary. Box cultivation can be managed intensively by controlling the environment of each box, enabling the production of high-quality standardized flowers. It also has the advantage of controlling the shipping time, and production can be done throughout the year(Park et al., 2020). Most of Korea's flower cultivation is done by soil cultivation inside greenhouses. However, the recent trend is changing to box cultivation using artificial soil due to the

adverse effects of soil insects and salt disturbances. Most plant cultivation work is not mechanized, so it is labor-intensive. In particular, the bulb transplanting work is a repetitive task done in a short period, and requires the most mechanization. Therefore, in this study, we wanted to develop a system that could reduce time and effort by mechanizing several manual steps.

MATERIALS AND METHODS

Basic survey for mechanization of bulbs and cultivation box To collect basic data for mechanization of transplanting work, cultivation boxes and bulb characteristics used by farmers were investigated. Two hundred specimens with the four types of bulb limbus were examined: long diameter, short diameter, height, limbus, weight, and root length(Fig.1). To minimize measurement error, the same researcher measured using Vernier Calipers.

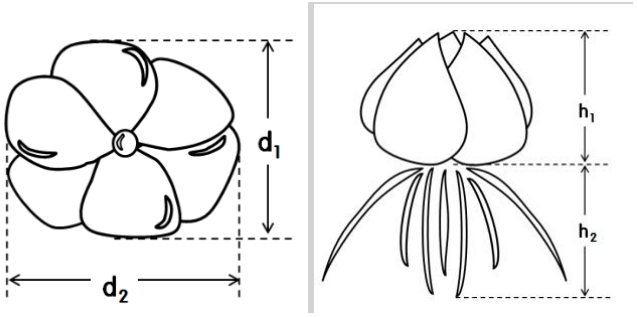
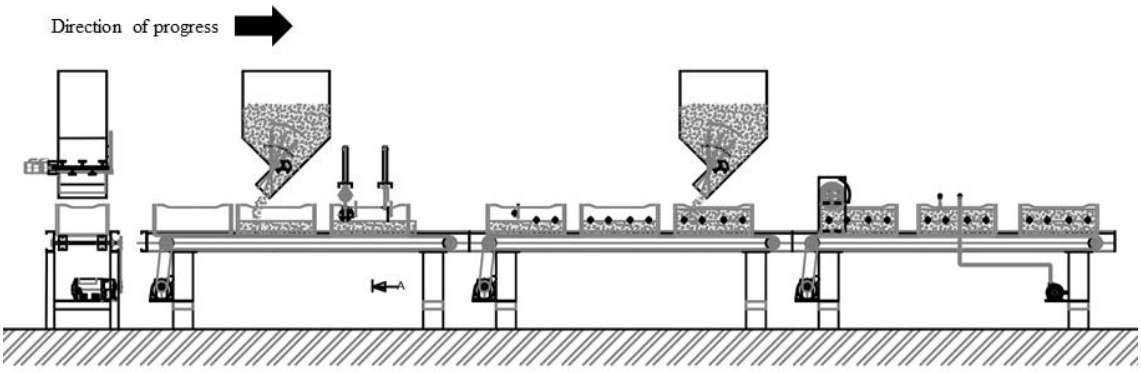


Figure 1. Measured parts of lily bulls.

Design of transplanting mechanization system Fig.2 shows the design of transplanting mechanization based on the farming transplanting process. The system designed consisted of a soil supply part, a bulb transplanting part, a covering part, and an irrigation part. First, the box is transferred to the soil supply part through the conveyor. Secondly, the soil is uniformly crushed through the hopper's stirrer. The supply volume of the soil can be adjusted using the soil control lever and motor. The transplanting part is marked with a cylinder at regular intervals. In addition, if the official location is displayed, the operator will directly formulate the bulb. The covering part has the same principles and structure as the soil supply part. The irrigation part used a water supply motor and nozzle to sufficiently water the box where the soil covering was complete.



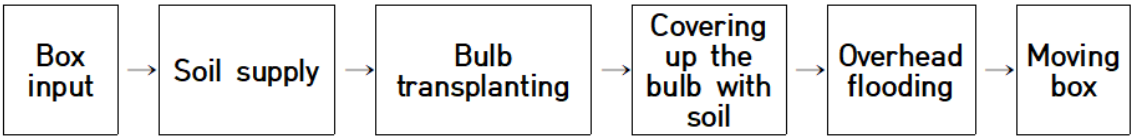


Figure 2. Design of transplanting mechanization based on the farming process.

RESULTS AND CONCLUSION

Basic survey for mechanization of bulbs and cultivation box All cultivation boxes used by farmers were packed with bulbs when they were imported. The standard of the cultivation box is 395 × 590 × 210 (L × W × H, mm). The bulb's transplanting was found to vary depending on the bulb's limbus and the farmhouse's experience. Because it is vital to have the roots of the bulb face down for flower, it was found that all transplanting work had to use human resources. The bulb's characteristics examined are shown in Table 1. The larger the bulb size, the larger the measured value, and bulb's limbus appeared uniformly. There was a tendency to increase weight according to the long diameter, short diameter, height, bulb's limbus, and in the case of root length, differences were depending on the cultivation environment. Therefore, the transplanting system should be designed considering the direction and bulb's root when it is fixed.

Table 1. Growth characteristics of the lily bulb.

Size (cm)	Long diameter (d1, mm)	Short diameter (d2, mm)	Height (h1, mm)	Limbus (cm)	Weight (g)	Root length (h2, cm)
a)10–12	35.1~39.2 (36.9 ± 1.5)	31.3~35.6 (32.8 ± 1.5)	28.6~29.8 (29.2 ± 0.4)	10.5~12.0 (11.2 ± 0.5)	15.7~21.4 (18.6 ± 2.4)	6.0~14.9 (9.8 ± 3.0)
b)13–15	42.3~48.1 (45.1 ± 1.8)	36.0~43.6 (40.4 ± 2.7)	34.0~40.7 (37.1 ± 2.2)	12.8~14.1 (13.4 ± 0.4)	26.5~34.7 (30.7 ± 3.3)	5.0~9.0 (6.6 ± 1.7)
c)16–19	55.9~65.7 (61.2 ± 3.6)	46.4~60.2 (53.2 ± 4.4)	39.8~44.4 (41.3 ± 1.6)	17.0~20.0 (18.3 ± 1.0)	60.8~81.3 (69.2 ± 8.3)	10.2~20.0 (13.1 ± 3.6)
d)20–22	68.0~70.5 (69.0 ± 0.9)	58.9~69.0 (64.1 ± 4.0)	45.4~51.0 (48.1 ± 1.9)	18.8~22.0 (20.2 ± 1.1)	97.6~122.8 (110.2 ± 8.9)	10.3~29.9 (22.1 ± 7.0)
e)22–24	69.7~84.5 (77.7 ± 6.0)	65.8~80.2 (73.1 ± 5.5)	54.1~59.4 (56.5 ± 2.0)	21.5~6.6 (23.8 ± 1.9)	141.5~49.2 (180.0 ± 3.8)	17.0~29.0 (22.8 ± 5.0)

Transplanting mechanization system The transplanting system has been developed for the mechanization of floriculture work. The system consists of the soil supply, the bulb transplanting, the soil covering, and irrigation. Each part may be separated. It is also configured to change the order according to the user's convenience. The performance of the machine is 120boxes/hour. This transplanting system can save 37% of the labor force, and costs can be reduced by 10%.

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