A generalized production model for potted flowers

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Summary

It is grown as a potted flower, and there are many kinds of the flower shipped by a market. In this study, we propose a generalized production model for potted flowers, in which we propose a notion of "tree" that consist of its vertex and directed edge. We show four different cultivation systems of the cyclamen, the begonia ,the zygocactus and the clivia as an example.

Key words: *potted flower, greenhouse, tree*

Introduction

Many kinds of potted flowers are grown in greenhouse and pipe house, and sold at flower shops, department stores, and open markets in Japan annually. However, there have not been many studies on the production plan of potted flowers, because (1.a) potted flowers are not foods, researchers have had less interest in them, and (1.b) building a suitable model is difficult (each farmer has their own production plan, or know-how's, learnt from their experience, and much data is not available to the researcher). Thus, we believe studies of optimal utilization of greenhouse bench space is necessary, as the study would provide solid deciding basis for a renewal of flower bench, improving work efficiency, and maximizing investments' effect for either building a new greenhouse or reforming existing ones[4],[5],[6],[8],[11].

In this study, we propose a generalized production model for potted flowers[1].

2. Generalized production model for potted flowers by tree T_i

In this paper, we discuss horticultural potted flowers, and define the production process as in; production start → temporary planting (temporary planting 1 → temporary planting 2 →⋯→ temporary planting k (k'th temporary planting (k=1, 2,..., K) → final planting → shipping. Temporary planting means to plant a seedling into a pot temporarily before the final planting, and the pot's capacity used for temporary planting k is larger than that of $k-1$. Final planting means to plant a seedling into a final pot. Considering the generality of production model for potted flowers, we generalize a production model for such plants that meet the following conditions from (2.a) through (2.f):(2.a) outside of greenhouse can be used, (2.b) lower bench can be used, (2.c) production starts with either seeding or cutting, (2.d) plants grow steadily or unsteadily,(2.e) frequently traded at markets,(2.f) the size of final pot.

We use the following symbols.

$i(i=1,2,\ldots,I)$: Production item

$m(m=0,1,2,\ldots,M)$: Production start, transplanting (either temporary or final), shipping, each vertex month (m=0 stands for December, and M stands for Mmod December)

$v_{imk}(k=1,2,\ldots,K)$: vertex of branch k at m month (numbers of plants at vertex k)

e_{imk} : directed edge (we consider the disposal of plants damaged by vermin between vertex v_{imk} and vertex v_{im+1k}, extra-plant rate $\lambda_{imk}(\lambda_{imk} \geqq 1.0)$)

$\partial^-(v_{imk})(\ni e_{im-1k})$: number of plants (number of pots) that goes into vertex v_{imk}, when approaching from $m-1$ month to vertex v_{imk}

$\partial^+(v_{imk})(\ni e_{imk})$: number of plants (number of pots) that goes out of vertex v_{imk}, when approaching from $m+1$ month to vertex v_{imk}

P_0 : The size of plug tray for seeding or cutting(noted as P_0 pot)

$P_j(j=1,2,\ldots,J)$: The size of pot for transplanting

$\lambda_{ijk}(i=1,2,\ldots,I\,;\ j=2,3,\ldots,J;\ k=1,2\ldots,K)$: For the final planting P_j of production item i, extra-plant rate at k'th transplanting($\lambda_{ijk} \geqq 1$)

x_{im+1k} : number of plants (number of pots) at vertex v_{im+1k}

y_{i01} : number of seeds (number of grains) or number of grouped cuttings at vertex v_{i01}(production start)

We represent actual production stating month and mth month from the start for a production item i, q_{i0}, $q_{im}(q_{i0},q_{im}=1,2,\ldots,12)$ respectively. The symbol of q_{im} represents q_{im} month of $t_i(t_i=1,2,\ldots)$ year. The size of flowerpot used for transplanting at vertex v_{imk} of tree T_i is determined by vertex month m and branch k, and is represented as P_{imk}. P_{i01} stands for a plug tray. The generalized production model for pot flowers is shown in Figure 1, and is represented by T_i as in $T_i=(V_i=\{v_{imk}\},E_i=\{e_{imk}\},\partial^-,\partial^+)$. Figure 1 shows the total production processes, from its start to shipping, for an production item i, using symbols △(seeding or cutting), ○(transplanting), and ▽(shipment).

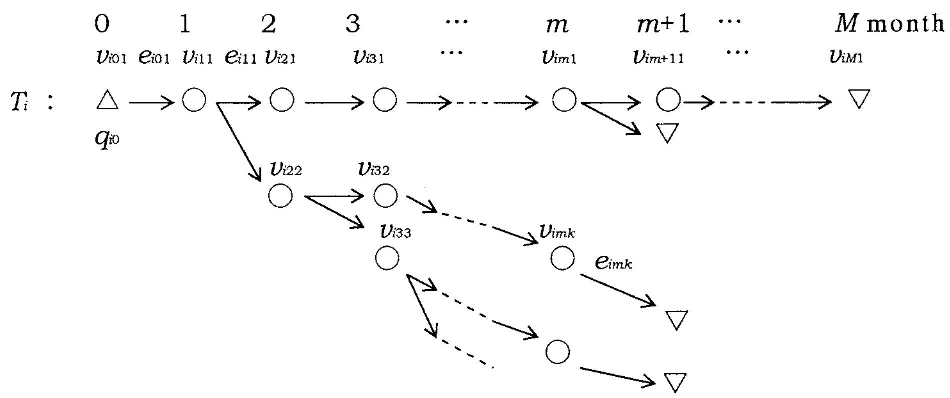

Figure 1: Generalized production model for potted flowers by tree T_i

In Figure 2, numbers of plants that go into vertex v_{imk} and numbers of plants that go out of vertex v_{imk} are equal to numbers of plants at vertex v_{imk} (that is, production is continuous at vertex v_{imk}, $\partial^-(v_{imk}) = \partial^+(v_{imk})$(=numbers of plants transplanted at vertex v_{imk}). We assume that $\partial^+(v_{imk}) = y_{i01}$(number of seeding or cutting) at the initial vertex, and that $\partial^-(v_{imk}) = x_{im+1k}$(amountof shipping) at the terminal vertex.

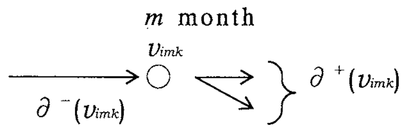

Figure 2: Continuous production

3. Number of plants at each vertex including extra-plant rate

Since some plants may not grow new buds, may not grow well, or may be killed by insects, we assume numbers of plants at vertex $v_{im-1k}(x_{im-1k})$ as in $x_{im-1k} = \lambda_{imk} x_{imk}$, including extra-plant rate, and show the numbers of plants at each vertex in Figure 3. In Figure 3,directed edges are shown with reverse arrows against the flow of production processes. The numbers of plants (1) and (2) in Figure 3 show that the sizes of final pots P_{mk} for production item i are either one size or more than one size (here, numbers of plants at temporary planting 1 are y_{i01}/λ_{i01}).

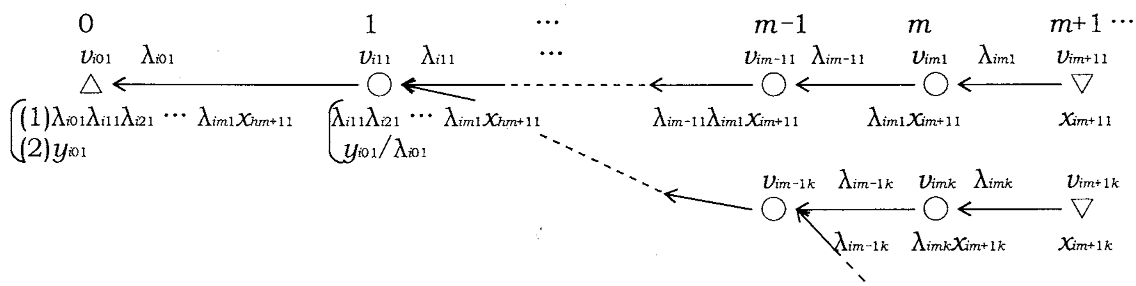

Figure 3: Number of plants at each vertex including extra-plant rate

4. Production schedule and abandoned seedlings.

The production schedules for the involved production items are shown in Figure 4. In Figure 4, we assume, for begonia and zygocactus, that both plants repeat the same production schedules, and that both of them grow steadily. For begonia, the seeds are planted in autumn, and transplanted to P_2 pots for shipping in order to make better use of upper bench spaces from January to April. For zygocactus, joints from two-year old seedlings (temporary planting 1) are cut and used for cuttings. We grow new buds from the seedlings after cutting the joints, and transplant them to P_3 pot for shipping. Extra cuttings are abandoned. Cyclamen, and clivia do not grow steadily after budding, and profits differ depending upon the pot sizes. Cyclamen repeats the same production schedule, and, after temporary planting 1, the slowest group of seedlings is transplanted to P_3 pot for shipping. The fastest group of seedling is transplanted to P_3, P_5 pot at temporary planting 2 and 3 respectively, and final-planted to P_6 pot for shipping. For other

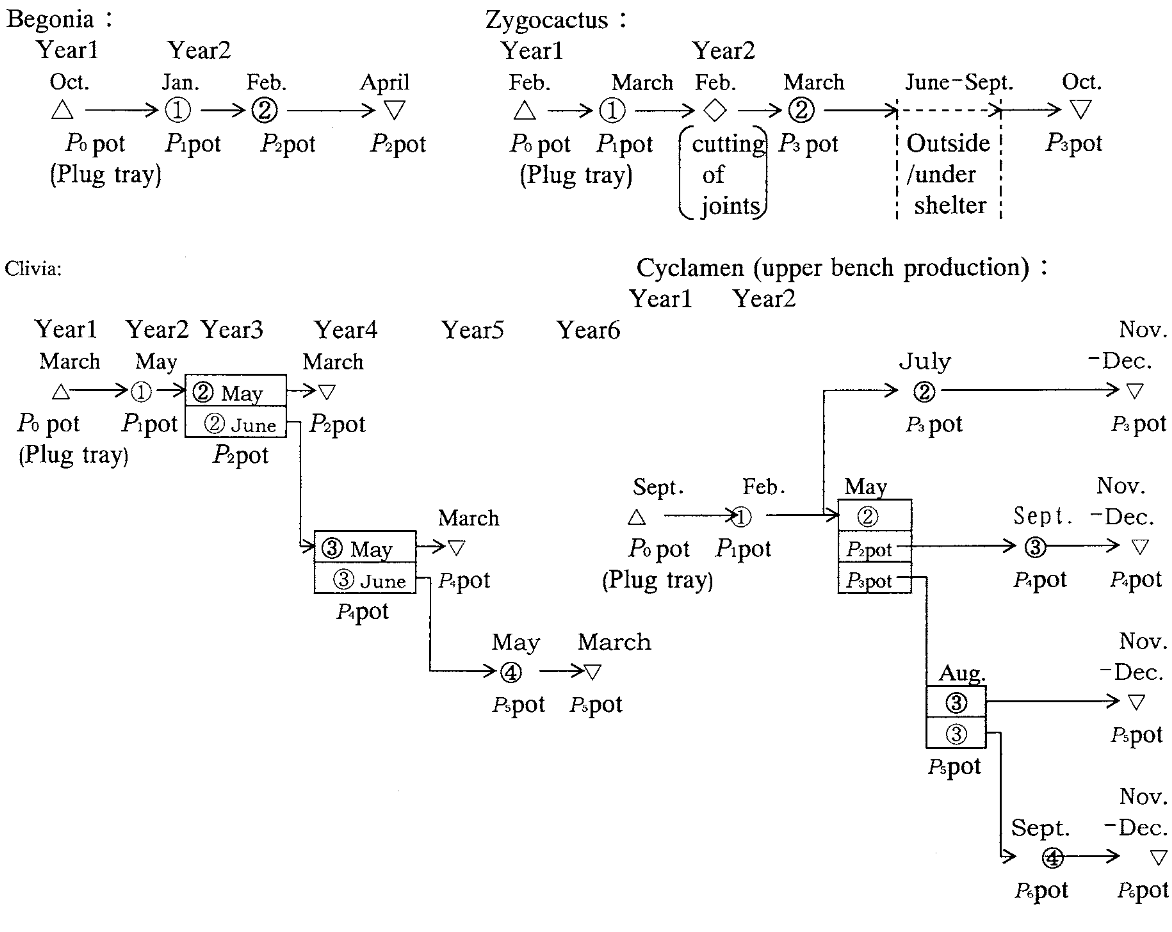

Figure 4 Production schedules for the 4 flowers(Numbers ① through ③ : temporary planting, bold numbers ② through ④ : final planting, △ : seeding or cutting, ▽ : shipping)

plants,please refer to Figure 4. Some clivia need more years before they bloom after budding than others. The production period for clivia lasts until the slowest clivia flowers are shipped. After temporary planting 1, the fastest clivia flowers can be final-planted to P_2 pots for shipping at temporary planting 2. The slowest clivia flowers are transplanted to P_2, P_4 pots at temporary planting 2 and 3 respectively. We assume that seedlings transplanted to P_4 pots are in bloom by the shipping period of the 6th year, and final-planted to P_5 pots at temporary planting 4. The number of seedlings that can be final-planted to P_j pots are given "p_{ij}* number of seedlings at temporary planting 1" in the productions for cyclamen and clivia. Other seedlings in temporary planting 1 that cannot be final-planted to P_j pots are abandoned if they are not transplanted to any pots to achieve maximum profit[2],[3],[7],[9],[10].

5. Conclusion

In this study, we propose greenhouse utilization plans for potted flower production that seeks maximal profits, and that are free from markets' demands and / or farmers' experiences. We first generalize the involved processes for potted flower production with the generalized notion of "tree" that consist of its vertex and directed edge. Based on this generalized production model, we showed an example that can be applicable for general use with our data for such flowers as begonia, cyclamen, zygocactus, and clivia as its production items.

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鉢花生産モデルの一般化

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鉢花として栽培し市場に出荷される花の種類は数多くある。
本研究は、市場に出荷される鉢花の生産システムを、有向辺と頂点から成る「木」により一般化した。この(鉢花の)生産システムで、タイプの異なるシクラメン、ベゴニア、シャコ(葉)サボテン、君子蘭の栽培を例として示す。

キーワード：鉢花、温室、木