Effect of Nutrient Composition and GA_{4+7} on Flower Quality and Bulb Development in Hydroponics of Cut *Tulip*

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Abstract

This study was carried out to research the effect of nutrient composition and GA4+7 on growth, flower quality and bulb development in special hydroponics of cut tulip. Flowering of 'Cassini' was markedly accelerated by standard+GA4+7, K200+GA4+7, N250+GA4+7 treatment, last internode was increased by N250 as compared with other treatment. For 'Christmas Marvel', flowering was promoted by K250+GA4+7, last internode and total length were also increased with K250+GA4+7 as compared to other treatment. For 'Golden Apeldoorn', flowering was accelerated by K200+GA4+7, last internode was increased with N300+GA4+7 treatment and total length was increased in N250+GA4+7 treatment as compared with the standard plants. Bulb weight and number of 'Cassini', 'Christmas Marvel' and 'Golden Apeldoorn' were decreased by GA4+7 as compared to non-treatment, and bulb diameter was not affected by GA4+7.

1. Introduction

Until recently in domestic area, most of cut tulip has been produced in soil condition of greenhouse. therefore this cultural program put a limitation on one time within the year.

Especially, programed production of cut tulip by hydroponic system was rapidly required because increasing of flower exporting continuously, unbalanced problems of nutrient management, a high soluble salts and protecting of pathogenic diseases in soil conditions. But there was any data of nutrient and/or gibberellins application to improvement of cut tulip quality in hydroponics. Hydroponic system of cut tulip can be solved for these several problems. It is well known that high quality tulip require a specific duration of low temperature for optimal growth and flowering before bulb planting, and environments control of greenhouse and application of plant growth regulators after bulb planting. Stem elongation and flowering response of *Tulipa* cultivars as influenced by cold treatment duration, plant growth regulator application, and light quality during tulip forcing, and the flowering percentage was more than 90%, regardless of low temperature and GA treatment (Suh, 1997). Several physiological mechanism that are involved in tulip flower stalk elongation have been proposed. These studies show that cold treatment of bulbs and GA treatments accelerate flowering, stimulate stem elongation and prevent flower bud blast(Hanks, 1982; Suh et al., 1992). However, the effects of GA treatment depend on bulb cooling treatments, as well as the timing and method of application.

The aim of this research was to determine the effect of nutrient composition and GA treatment on flower quality and bulb development of tulip.

2. Materials and Methods

2.1 Plant material

Bulbs of tulip(Tulipa gesneriana L.) cv. 'Cassini', 'Christmas Marvel' and 'Golden Apeldorn', 10~12cm in circumference, were obtained from a commercial grower in Onyang, Korea on Oct. 13, 1999, and were grown at the farm of the Dankook University and Floriculture Lab., Cheonan, Korea. bulbs were stored at 20℃ until the start of treatments, and at 5℃ for 12 weeks until the planting.

2.2 GA_{4+7} treatment and Nutrient composition

All possible combinations of the following nutrient treatment were applied:

- Nutrient treatment

  Basic solution : Macro element(P:Ca:Mg=3.0:8.0:4.0me/L)

  Micro element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)

  Standard : (T-N:K=15.0:6.0 me/L), K150 : (T-N:K=12.5:3.8 me/L)

  K200 : (T-N:K=13.8:5.1 me/L), K250 : (T-N:K=15.1:6.4 me/L)

  N200 : (T-N:K=14.3:3.8 me/L), N250 : (T-N:K=17.9:5.1 me/L)

  N300 : (T-N:K=21.5:6.4 me/L)

- T-N: Total nitrogen, K: Potassium, P: Phosphorus, Ca: Calcium, Mg: Magnesium

  Cu: copper, Mo: Molybdenum, Fe: Iron, Zn: Zinc, B: Boron, Mn: Manganese

- Nutrient solution : pH 6.5~6.7, EC 1.3~1.4mmho

Solutions of 200 ㎎ · L-1 Gibberellin(GA_{4+7}) were made up with distilled water. Bulbs were injected with GA_{4+7}. One ㎖ Gibberellin(GA_{4+7}) 200 ㎎ · L-1 was injected into the flower-bud at 2 weeks after bulb planting. Tulip plants were cultivated in circulation deep flow system after planted in plug-tray and grown in a greenhouse maintained at 20/15℃, day/night temperature. At flowering, days from planting to flowering, length of internode, total stem length and bulb development(number, diameter and weight) were recorded for 36 plants, three replication, for each treatment. Data were subjected to analysis of variance and means were separated with LSD(Least Significant Difference) at p=0.05.

3. Results and Discussion

Flowering of 'Cassini' was accelerated after GA_{4+7} was injected into flower-bud as compared to non-treatment. standard+GA_{4+7}, K200+GA_{4+7} and N250+GA_{4+7} treatment promoted flowering. 1st internode was increased by N200+GA_{4+7}, Last internode was increased by N250 treatment as compared with other treatment(Table 1).

For 'Christmas Marvel', flowering was promoted by K250+GA_{4+7}, 1st internode was increased by N300+GA_{4+7} and last internode and total length were also increased with K250+GA_{4+7} as compared to other treatment(Table 2).

For 'Golden Apeldoorn', flowering was accelerated by K200+GA_{4+7} and 1st internode was increased by N200+GA_{4+7}. Last internode was increased by N300+GA_{4+7} treatment and total length was increased by N250+GA_{4+7} treatment as compared with Standard.

Bulb weight and number of 'Cassini', 'Christmas Marvel' and 'Golden Apeldoorn' were decreased by GA_{4+7} as compared to non-treatment, and bulb diameter was not affected by GA_{4+7} treatment(Table 3).

According to this results, stem elongation was increased by GA_{4+7} injecting to flower-bud, and our results show that administration of GA_{4+7} accelerated flowering and reduced total stem length and that of last internode. These results are in agreement with those of Suh et al(1992).

Mainly, growing and flowering response of cut tulip was influenced by nitrogen and GA_{4+7} treatment, even though effects depend on nutrient composition and tulip cultivars. However, potassium and micro elements were slightly affected on cut tulip quality in hydroponics.

Weight and number of bulbs were decreased by GA_{4+7} treatment, this results assumed that storage nutrients in bulb was rapidly utilized to development of flower bud. Therefore, it is concluded that hydroponic system can successfully produced for high quality of cut tulip if nutrient composition and environmental control according to cultivars can be manipulated.

Hydroponic system of cut tulip is very important for flower quality and bulb production, so further studies required to elucidate that tulip cultivars and nutrient composition in hydroponics.

Table 1. Effect of nutri-composition on flower quality and bulb development in hydroponics of cut *tulip* 'Cassini'

Treatment[z]	Day to[x] Flowering (days)	Length of internode(cm)						Bulb		
		1st	2nd	3rd	last	tepal	total	Number(ea)	Diameter(cm)	weight(g)
Standard	47.2	9.5	7.2	6.9	11.5	5.2	40.3	4.6	1.6	3.1
Standard + GA_{4+7}[y]	42.0	10.2	7.1	8.1	9.6	5.2	40.2	2.8	1.4	3.0
K 150	46.5	10.2	6.7	9.3	10.7	5.2	42.1	4.7	1.4	2.9
K 150 + GA_{4+7}	42.3	9.7	6.4	9.4	9.0	5.1	39.6	3.8	1.4	2.5
K 200	47.5	10.6	7.1	9.4	11.5	5.2	43.8	5.2	1.4	2.8
K 200 + GA_{4+7}	42.0	10.3	7.3	9.6	9.2	5.3	41.7	5.0	1.4	2.4
K 250	46.4	10.1	6.3	8.4	12.5	5.0	42.3	5.2	1.4	2.7
K 250 + GA_{4+7}	42.5	9.2	6.6	9.4	7.7	5.2	38.1	4.5	1.2	2.4
N 200	48.0	10.3	6.2	8.7	8.0	5.1	38.3	4.3	1.5	2.8
N 200 + GA_{4+7}	42.3	12.2	8.1	8.7	8.6	5.2	42.8	3.7	1.3	2.3
N 250	47.2	7.2	5.3	7.6	13.8	5.0	38.9	5.4	1.3	3.3
N 250 + GA_{4+7}	42.0	10.7	8.0	10.1	9.5	5.9	44.2	4.2	1.3	1.9
N 300	44.6	10.6	6.8	8.5	9.0	4.8	39.7	4.6	1.6	3.4
N 300 + GA_{4+7}	42.5	10.8	7.7	10.1	8.9	5.2	42.7	5.0	1.3	2.4
Level of significance	2.0	0.6	0.7	2.3	0.9	NS	1.3	0.4	NS	0.4
LSD 5%										

[z] Standard : Macro Element(T-N:P:K:Ca:Mg = 15.0:3.0:6.0:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)

K 150 : Macro Element(T-N:P:K:Ca:Mg = 12.5:3.0:3.8:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
K 200 : Macro Element(T-N:P:K:Ca:Mg = 13.8:3.0:5.1:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
K 250 : Macro Element(T-N:P:K:Ca:Mg = 15.1:3.0:6.4:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
N 200 : Macro Element(T-N:P:K:Ca:Mg = 14.3:3.0:3.8:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
N 250 : Macro Element(T-N:P:K:Ca:Mg = 17.9:3.0:5.1:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
N 300 : Macro Element(T-N:P:K:Ca:Mg = 21.5:3.0:6.4:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)

[y] GA : One ㎖ of GA4+7 200 ㎎ · L-1 was injected into the flower-bud of plant

[x] Days to flowering was calculated from planting on Dec 13. 1999

Table 2. Effect of nutri-composition on flower quality and bulb development in hydroponics of cut *tulip* 'Christmas Marvel'

Treatment[z]	Day to[x] Flowering (days)	Length of internode(cm)						Bulb		
		1st	2nd	3rd	last	tepal	total	Number(ea)	Diameter(cm)	weight(g)
Standard	43.3	5.5	7.0	10.2	10.8	4.7	38.2	4.5	1.5	3.2
Standard + GA_{4+7}[y]	41.3	6.4	7.3	10.4	10.5	5.1	39.7	5.0	1.5	3.1
K 150	42.2	5.5	6.2	8.6	10.3	4.7	35.3	5.3	1.4	2.7
K 150 + GA_{4+7}	40.5	4.8	7.9	10.9	9.9	5.1	38.6	5.3	1.3	2.3
K 200	41.8	5.4	6.6	9.1	12.8	5.1	39.0	4.0	1.6	3.7
K 200 + GA_{4+7}	40.4	5.8	7.2	11.8	11.1	5.3	41.2	4.7	1.4	2.6
K 250	42.3	5.4	7.1	9.5	9.9	4.9	36.8	5.0	1.5	3.3
K 250 + GA_{4+7}	40.2	5.6	7.5	10.9	13.0	5.3	42.3	5.0	1.4	2.3
N 200	42.4	5.5	7.0	8.8	11.2	4.9	37.4	4.8	1.6	3.6
N 200 + GA_{4+7}	41.2	5.8	7.0	11.1	11.1	5.1	40.1	4.8	1.5	3.2
N 250	42.6	5.0	6.8	10.5	10.0	4.9	37.2	4.6	1.5	3.7
N 250 + GA_{4+7}	41.2	6.1	7.3	10.8	12.2	5.4	41.8	5.2	1.4	2.7
N 300	43.3	5.5	6.7	10.0	10.7	5.0	37.9	5.0	1.5	3.3
N 300 + GA_{4+7}	41.2	6.6	6.8	10.8	11.9	5.1	41.2	5.0	1.5	2.9
Level of significance	1.3	0.6	0.4	0.6	0.3	NS	1.5	0.4	NS	0.3
LSD 5%										

[z] Standard : Macro Element(T-N:P:K:Ca:Mg = 15.0:3.0:6.0:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
K 150 : Macro Element(T-N:P:K:Ca:Mg = 12.5:3.0:3.8:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
K 200 : Macro Element(T-N:P:K:Ca:Mg = 13.8:3.0:5.1:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
K 250 : Macro Element(T-N:P:K:Ca:Mg = 15.1:3.0:6.4:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
N 200 : Macro Element(T-N:P:K:Ca:Mg = 14.3:3.0:3.8:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
N 250 : Macro Element(T-N:P:K:Ca:Mg = 17.9:3.0:5.1:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
N 300 : Macro Element(T-N:P:K:Ca:Mg = 21.5:3.0:6.4:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)

[y] GA : One ㎖ of GA4+7 200 ㎎ · L-1 was injected into the flower-bud of plant

[x] Days to flowering was calculated from planting on Dec 13. 1999

Table 3. Effect of nutri-composition on flower quality and bulb development in hydroponics of cut *tulip* 'Golden Apeldorn'

Treatment[z]	Day to[x] Flowering (days)	Length of internode(cm)						Bulb		
		1st	2nd	3rd	last	tepal	total	Number(ea)	Diameter(cm)	weight(g)
Standard	42.8	6.3	5.6	7.2	13.6	5.1	37.8	3.5	1.5	4.4
Standard + GA_{4-7}[y]	42.0	8.1	5.6	7.4	15.4	5.2	41.7	3.8	1.4	3.8
K 150	42.3	6.7	6.4	8.4	15.0	5.4	41.9	3.5	1.4	3.6
K 150 + GA_{4-7}	41.0	7.6	6.3	7.6	14.7	5.4	41.6	3.3	16	4.7
K 200	41.5	7.8	5.8	7.8	16.0	5.2	42.6	3.5	1.6	3.8
K 200 + GA_{4-7}	40.6	7.9	6.7	9.5	12.7	5.6	42.4	2.8	1.6	4.4
K 250	42.5	7.5	6.3	8.0	15.1	5.0	41.9	3.5	1.5	3.8
K 250 + GA_{4-7}	40.6	7.1	5.5	7.8	13.1	5.8	39.3	2.8	1.6	5.0
N 200	42.6	6.9	5.8	7.5	12.0	5.2	37.4	4.0	1.6	4.3
N 200 + GA_{4-7}	41.8	8.2	6.2	7.6	13.6	5.1	40.7	3.7	1.4	3.6
N 250	43.2	6.5	5.1	7.5	14.5	5.0	38.6	2.0	1.8	5.3
N 250 + GA_{4-7}	40.8	8.0	6.2	8.1	15.0	5.3	42.6	4.0	1.5	3.7
N 300	41.8	7.4	6.6	8.7	13.7	5.4	41.8	3.3	1.6	4.2
N 300 + GA_{4-7}	41.4	7.2	5.8	7.5	16.3	5.4	42.2	3.4	1.5	3.6
Level of significance										
LSD 5%	1.4	0.7	0.5	1.1	1.0	NS	3.7	0.4	NS	0.5

[z] Standard : Macro Element(T-N:P:K:Ca:Mg = 15.0:3.0:6.0:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
K 150 : Macro Element(T-N:P:K:Ca:Mg = 12.5:3.0:3.8:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
K 200 : Macro Element(T-N:P:K:Ca:Mg = 13.8:3.0:5.1:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
K 250 : Macro Element(T-N:P:K:Ca:Mg = 15.1:3.0:6.4:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
N 200 : Macro Element(T-N:P:K:Ca:Mg = 14.3:3.0:3.8:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
N 250 : Macro Element(T-N:P:K:Ca:Mg = 17.9:3.0:5.1:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)
N 300 : Macro Element(T-N:P:K:Ca:Mg = 21.5:3.0:6.4:8.0:4.0me/L), Micro Element(Cu:12, Mo:48, Fe:840, Zn:68, B:92, Mn:100ppm)

[y] GA : One mℓ of GA4+7 200 mg · L-1 was injected into the flower-bud of plant

[x] Days to flowering was calculated from planting on Dec 13. 1999

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