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Combination Effect of Nitrogen and Sugar on Longevity of Cut Flowers

Takashi HOSOKI*

切花の花もちに及ぼす窒素および糖の複合効果

細 木 高 志*

Introduction

Although effect of sugar on longevity of many cut flowers have been studied 1), effect of inorganic salts have not been well known. Waters 2) reported in relation to water quality problem that high salinity or fluoride in holding solution shortened vase life of gladiolus and chrysanthemum cut flowers. Mayak et al. 3) reported that KNO_3 prolonged vase life of carnation cut flowers through osmotic effect.

It was conceived that short vase life of cut flowers was partly attributable to suspension of nutrient uptake from the soil. This report describes combination effect of inorganic salts and sugar on longevity of gladiolus, rose and chrysanthemum cut flowers.

Materials and Methods

Almost all the experiments were conducted in summer (June to Aug.) when vase life of cut flowers is short. Flower spikes of gladiolus cv. Traveler were harvested from the field when upper one fourth of the first floret appeared from the bracteol. Basal end of spikes (70−80 cm in length) were re-cut in water and flowers were put into test solution (1 or 2 liter per jar) containing 200 mg/liter 8-hydroxyquinoline sulfate (8-HQS) as sterilant, and 5 to 10 spikes with average 8 florets were used for each experiment. Major elements of Murashige Skoog (MS) tissue culture medium (Table 1) 4) were dissolved in holding solution to supply inorganic salts. The temperature during experiment was between 25−31°C. For evaluation of test solution, rate of florets with unwrinkled petal margins to total open florets was calculated 6 days after treatment.

Table 1. Inorganic major salts in MS medium.

Inorganic salts	mg/liter
NH_4NO_3	1650
KNO_3	1900
KH_2PO_4	170
$CaCl_2 \cdot 2H_2O$	440
$MgSO_4 \cdot 7H_2O$	370

Results and Discussion

Effect of addition of inorganic salts alone was not noticed, but synergistic effect was observed when sugar was combined. Rate of decorative florets at 6th day and decorative period increased (Table 2) (Fig. 1, 2). No adverse symptom such as browning or spotting was noticed on the petals or bracteols. The possibility of osmotic effect on longevity of vase

* Laboratory of Vegetable and Ornamental Horticulture, Faculty of Agriculture, Shimane University, Matsue 690, Japan

life was negated since addition of 28.6 g/l polyethylene glycol equivalent to osmotic pressure of MS inorganic salts (2.27 atm) had no effect (Fig. 3).

In order to determine which salt has effect, individual element in MS medium was tested in combination with 4% sucrose. 1900 mg/liter KNO_3 and 1650 mg/liter NH_4NO_3 showed the effect close to the addition of whole majar salts (Fig. 4). Since possibility of potassium ion (782 mg/liter) was negeated (Fig. 5), nitrogen was recognized to be a majar factor of longevity of gladiolus cut flowers. Difference of nitrogen form (NO_3-N, NH_4-N) was tested using $NaNO_3$, NH_4Cl and KCl (for adjustment of K amount) without changing total nitrogen amount, NO_3-N alone or 2 to 1 ratio of NO_3-N and NH_4-N had the same effect as the addition of whole majar salts of MS medium (Fig. 6). Since bend of flower spike was observed in the treatment of NO_3-N alone, 2 to 1 ratio is preferable for practical holding solution. This ratio is almost the same as the ratio of MS medium (NO_3-N : NH_4-N=1.9 : 1). Nitrogen concentration in the holding solution was optimum in MS level (841 mg/liter as N) (Fig. 7) and the double amount induced necrotic spots in 30% of petals.

Table 2. Effect of 5% sucrose and inorganic major salts in MS medium on the decorative period of gladiolus cut flowers (200 mg/liter 8-HQS containing solution).

Treatment	Decorative period (days)[z]
Cont	4.0
Sucrose	5.5
Inorganic major salts	4.2
Sucrose+inorganic major salts	7.1

[z]Days in which half numbers of the total florets wrinkled.

Fig. 2. Effect of sugar and inorganic salts 6 days after treatment (gladiolus) : 5% sucrose alone (left), 5% sucrose + inorganic major salts in MS medium (right).

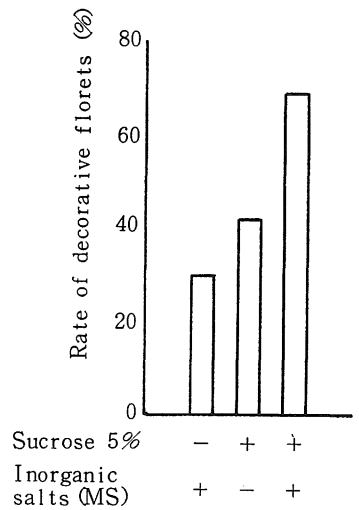

Fig. 1. Effect of 5% sucrose and inorganic major salts in MS medium (gladiolus) (200 mg/liter 8-HQS containing solution).

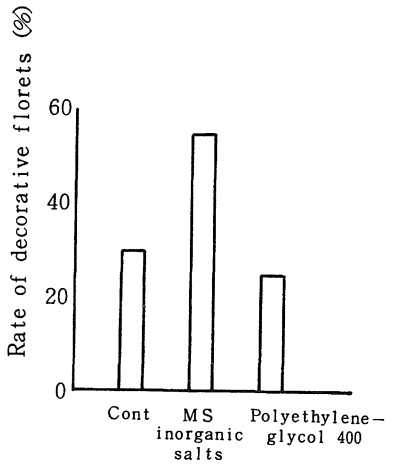

Fig. 3. Fffect of 28.6 g/liter polyethylene glycol 400 equivalent to the osmotic pressure of inorganic major salts in MS medium (gladiolus) (4% sucrose and 200 mg/liter 8-HQS containing solution).

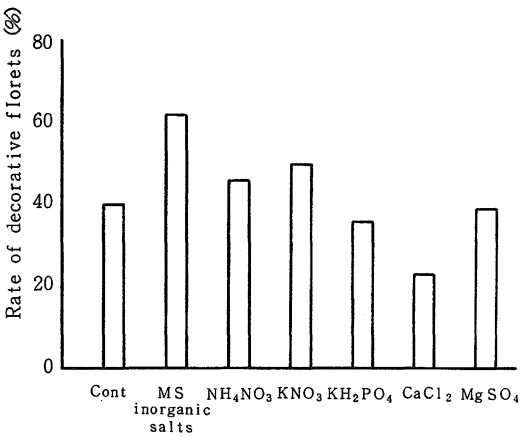

Fig. 4. Effect of individual inorganic major salts in MS medium (gladiolus) (4% sucrose and 200 mg/liter 8-HQS containing solution).

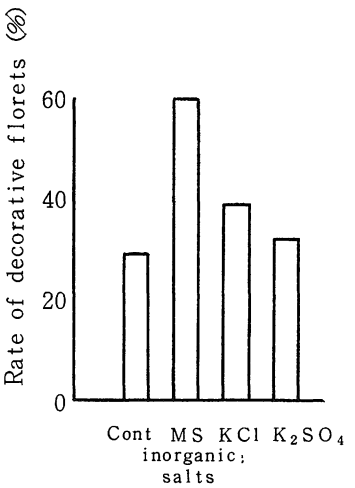

Fig. 5. Effect of potassium (782 mg/liter as K) in MS inorganic major salts (gladiolus) (4% sucrose and 200 mg/liter 8-HQS containing solution).

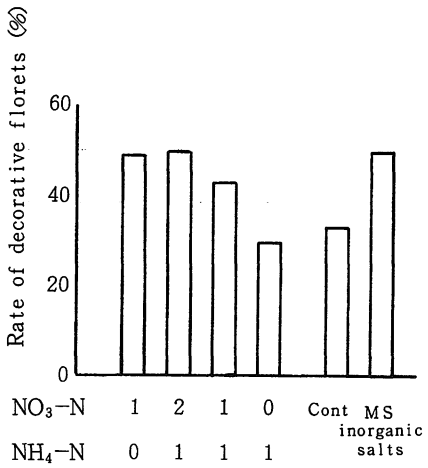

Fig. 6. Effect of NO_3-N and NH_4-N ratio (gladiolus) (4% sucrose and 200 mg/liter 8-HQS containing solution).

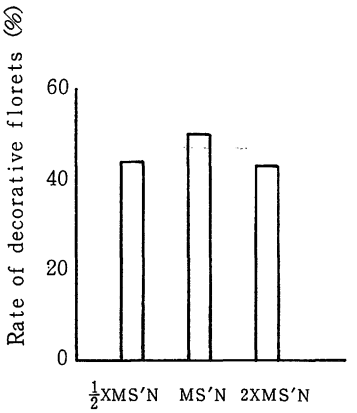

Fig. 7. Effect of nitrogen concentration (gladiolus) ($NaNO_3$ and NH_4NO_3 in MS medium were supplemented to 4% sucrose and 200 mg/liter 8-HQS containing solution without changing the ratio of nitrogen form.).

Five mg/liter cyclohyximide (protein synthesis inhibitor) partly suppressed effect of nitrogen (Fig. 8). Supplement of amino acids (500 mg/liter glutamic acid+500 mg/liter asparatic acid) also had a measurable effect on prolonging vase life (Fig. 9). Therefore, it is conceived that nitrogen is utilized for protein synthesis in coexistence of sugar. Addition of 5 mg/liter cycloheximide suppressed extension of petals which was promoted by addition of nitrogen (5101 mg/liter $NaNO_3$) (Table 3), and nitrogen was not so effective when applied to fully opened flowers. Therefore, it seems that nitrogen relates not to retardation of senescence of petals but to enhancement of protein synthesis activity at early stage of petal extension.

Table 3. Effect of 5101mg/liter $NaNO_3$ and 5 mg/liter cycloheximide on extension of floret petals of gladiolus (200 mg/liter 8-HQS containing solution).

Treatment	Floret size (cm) Long diam. × Short diam.
Cont	7.8 × 6.1
$NaNO_3$	9.0 × 7.2
$NaNO_3$+Cycloheximide	6.8 × 6.3
Cycloheximide	7.2 × 5.5

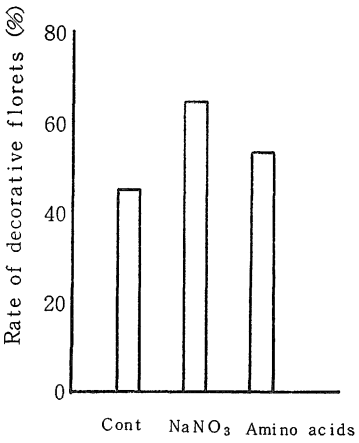

Fig. 9. Effect of 5101 mg/liter $NaNO_3$ and amino acids (500 mg/liter glutamic acid+ 500 mg/liter asparatic acid) (gladiolus) (4% sucrose and 200 mg/liter 8-HQS containing solution).

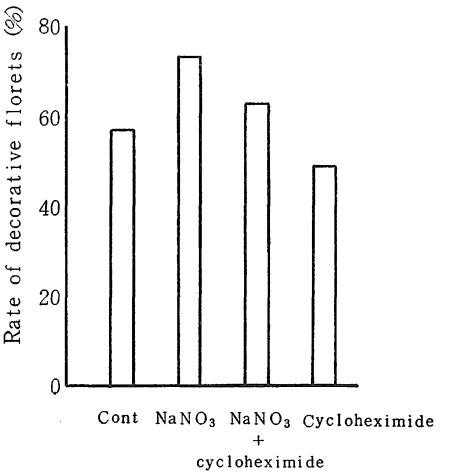

Fig. 8. Effect of 5101 mg/liter $NaNO_3$ and 5 mg/liter cycloheximide (gladiolus) (4% sucrose and 200 mg/liter 8-HQS containing solution).

Holding solution containing MS inorganic majar salts with 5% sucrose was superior to Cornell solution 5) in gladiolus cv. Traveler, rose cv. Super Star and carnation cv. Scania 3C (Fig. 10). Nitrogen seems effective only to species in which sugar takes effect since it did not prolong vase life of Easter lily which did not respond to supplement of sugar (preliminary experiment).

In conclusion, supplement of MS inorganic majar salts (particularly, NH_3NO_4 and KNO_3) to holding solution containing 4−5% sucrose prolonged vase life of gladiolus, rose and carnation cut flowers.

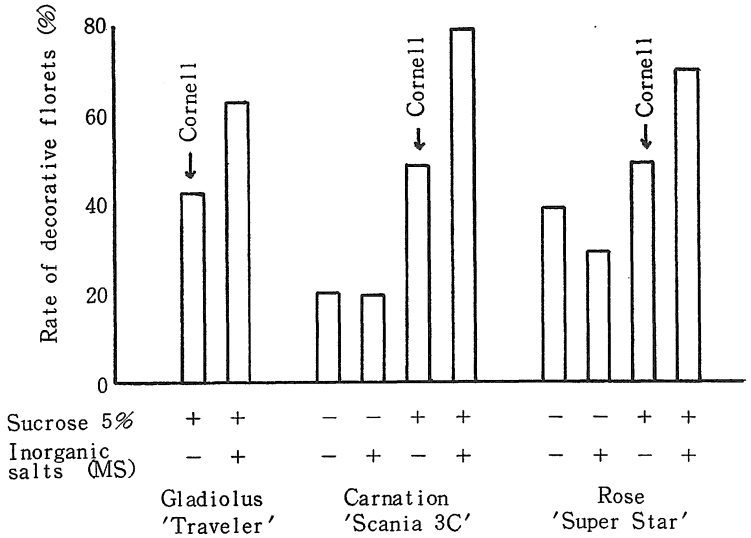

Fig. 10. Comparison between Cornell solution and MS inorganic major salts containing solution with 200 mg/liter 8-HQS and 50 mg/liter silver acetate in gladiolus, carnation and rose cut flowers.

Summary

Inorganic salts in Murashige Skoog(MS) tissue culture medium prolonged vase life of gladiolus, rose and carnation cut flowers when supplemented to holding solution with sugar. Effective major element was nitrogen and its optimum level and ratio of NO_3 to NH_4 ion were the same as those of MS medium. Nitrogen seems to take effect through enhancement of protein synthesis activity not through retardation of senescence nor through osmotic effect. Nitrogen effect was limited to species in which sugar took effect for longevity of their cut flowers.

References

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摘　　要

糖を含む花もち保存液に Murashige Skoog (MS) 組織培養培地の無機塩類を添加すると，グラジオラス，バラおよびカーネーションの切花の花もち期間が延びた．花もち効果をもつ主要成分は窒素で，その最適濃度および NO_3-N と NH_4-N の最適比率は MS 培地のそれらとほぼ等しかった．窒素は，花の老化や浸透圧を介して働くのではなく，たん白質の合成の促進を介して働いているようである．窒素の効果は，糖が花もちに有効であった植物種に限られていた．