Phosphorus absorption and redistribution in *Cymbidium* as effected by light intensity and temperature

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Abstract

Phosphorus absorption and redistribution in 1 year-old *Cymbidium* Victoria were investigated using ^{32}P tracer, as effected by the different light intensities and temperature regimes. Phosphorus absorption was higher in 25% of full sunlight than in 50%, 12.5%, or 6.25% of that and 73% of absorbed-P were distributed to the bulb(60%) and the leaves(13%). Phosphorus absorption and redistribution were also greatly governed by temperature. With increase of root zone temperature phosphorus absorption was increased and absorbed-P was more accumulated in roots and bulb than in leaves. However, higher ambient temperature over 25℃ inhibited phosphorus absorption by roots and distribution to bulb and leaves.

Key words : *Cymbidium*, phosphorus, absorption, translocation, light intensity, temperature

Introduction

In fact, mass production of mericloned orchids by tissue culture technique has greatly contributed to evoking more public popularity for them as pot flowers and cut flowers. In contrast, the understandings of practical cultivation of orchids in terms of their nutritional physiology do not have been well documented. In general it is believed that orchids can grow well only with supplement of water. It is attributed to less requirement to nutrients corresponding with slow growth of orchids. Small amounts of balanced fertilization and optimal cultivation environment are essential for their normal growth and flowering. In particular, the bulb growth and flowering induction of western *Cymbidium* are known to be governed by light intensity and temperature[3]. Phosphorus as one of three major essential nutrients causes the retardation in growth when it is deficient[5,6]. It is reported that *Cymbidium* protocorms grown on phosphorus-free media are yellow-grey-green, covered with black spots and do not survive for long periods[1] As phosphorus absorption by plant roots is metabolic-dependent[5,6], light and temperature may affect phosphorus absorption by *Cymbidium* root and distribution to the organs. Therefore, this experment was carried out to investigate the characteristics of phosphorus absorption and distribution in *Cymbidium* as exposed to the different light intensities and temperature regimes.

Materials and Methods

1. Effect of light intensity

One year-old mericloned *Cymbidium* victoria was placed in a stainless beaker including 100 ml of 1/10 strength of Hoagland with 3 μCi of $KH_2{}^{32}PO_4$ for 4 hrs under the different light intensities and temperature regimes in a glass house. For light treatments plants was given 6.25, 12, 25 or 50% of full sunlight reduced using black nets.

2. Effect of temperature

One year-old mericloned *Cymbidium* victoria was placed in the same as experiment 1 for 4 hrs under the combination treatment of ambient(15, 25, 35℃) and root zone temperature(15, 25, 35℃) in a growth chambers with 30,000 klux. Root zone temperature was

controlled by circulating water adjusted to 15, 25 or 35 ℃ in a cupper tube coiled around beaker.

3. ^{32}P measurement

At the end of light or temperature treatment root parts were washed in a running tap water for 5 min. and placed on the tissue papers to remove water. Leaves, bulb and roots divided were cut into small pieces and digested in H_2SO_4-H_2O_2. The digests were transferred to counting vials. ^{32}P activities were counted for 2 min. in a liquid scintilation counter (Packard 2700TR, USA) by Cerenkov counting method. ^{32}P absorbed per fresh weight was expressed as P absorbed per fresh weight by calculating with conversion factor[8].

Results and Discussion

1. Effect of light intensity

Although *Cymbidium* belongs to mono-coteledon plants, its morphological and physiological properties differs greatly from those like as barley. *Cymbidium* roots are enveloped by a fleshy velamen layer acting like sponge when it is wet [7], thus being able to hold water and nutrients for a long time. The bulb also functions as nutrient reservoir. Therefore, nutrients absorption by roots and their redistribution to the bulb and leaves in *Cymbidium* could not be considered to be the same as those in the general monocotyledon plants.

Absorption and redistribution of phosphorus(^{32}P) of *Cymbidium* were examined, as effected by the different light intensities(table 1). In general as *Cymbidium* has the relatively lower light saturation point[3], it is grown conventionally under 30~50% of sunlight-shaded vinyl house with black nets. But in particular in spring and autumn adult *Cymbidium* is exposed to full sunlight to accumulate more assimilates in the plant to give better vegetative growth and flowering induction. phosphorus absorption and redistribution to bulb in 1-year old *Cymbidium* was the highest in 25% of sunlight. It is appeared that light requirement of young *Cymbidium* plant is not as high as adult one[3].

2. Effect of temperature

In general plant roots are capable of absorbing phosphate from solution of very low phosphate concentrations[4]. The absorption is active. Phosphate absorption is considered to be mediated by H^+ cotransport[9]. Phosphate absorbed by plant cells rapidly becomes involved in metabolic processes. Thus Jackson and Hagen(1960)[2] reported that after a period of only 10 min. following uptake, 80% of the phosphate absorbed was incorporated into organic compounds. Phosphate is readily mobile in the plant and can be translocated in an upward or downward direction. Therefore, phosphorus absorption is related with metabolic activity and is temperature-dependant[5,6].

As shown in table 2 phosphorus absorption and redistribution in *Cymbidium* were greatly governed by temperature. With increase of root zone temperature phosphorus absorption was increased and absorbed-P was more accumulated in roots and bulb than in

Table 1. Phosphorus absorption by roots and redistribution in the leaves, roots and bulb of 1-year old *Cymbidium*, as effected by different light intensities for 4 hrs.

Light treatment	Leaves (pg P/g fresh weight)	Bulbs (pg P/g fresh weight)	Roots (pg P/g fresh weight)	Total absorption (pg P/g fresh weight)
6.25% of sunlight	37.1	133	173	343
12% of sunlight	97.0	333	160	590
25% of sunlight	127	582	283	992
50% of sunlight	127	305	229	661

Table 2. Phosphorus absorption by roots and redistribution in the leaves, roots and bulb of 1-year old *Cymbidium*, as effected by different temperature regimes for 4 hrs.

Temperature treatment		Leaves (pg P/g fresh weight)	Bulbs (pg P/g fresh weight)	Roots (pg P/g fresh weight)	Total absorption (pg P/g fresh weight)
Ambient (℃)	Root zone (℃)				
15	15	95.2	245	211	551.2
	25	176	503	408	551.2
	35	199	692	856	551.2
25	15	100	249	215	564
	25	219	524	407	564
	35	355	792	988	564
35	15	95.6	253	206	554.6
	25	150	570	532	554.6
	35	215	564	820	554.6

leaves. However, higher ambient temperature over 25℃ inhibited phosphorus absorption by roots and redistribution to bulb and leaves. It may be related with the optimal growth temperature of *Cymbidium*. When ambient temperature is over 25℃ the metabolic activity(e.g. the fixation of carbon dioxide) may be remarkably inhibited[3].

In conclusion, phosphorus absorption and redistribution in *Cymbidium* were effected by the light intensity and the ambient and root zone temperature. Young *Cymbidium* did not require light intensity as high as adult one. It is considered that increased temperature in root zone can help phosphorus absorption by roots as well as redistribution to bulb and leaves. It is recommended that light intensity is about 25% of full sunlight and the combination of ambient and root zone temperature is 25/35℃ to enhance the nutrients absorption of one-year old *Cymbidium*.

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