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Effect of Gibberellin and Kinetin on Bud Dormancy Breaking and Growth of Korean Ginseng Root (*Panax ginseng* C.A. MEY.)*

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高麗人蔘의 根芽休眠타파와 生育에 대한 Gibberellin과 Kinetin의 効果

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Abstract

Effect of gibberllin on the breaking of bud dormancy of root and growth of aerial parts were investigated under laboratory and field condition for the prolongation of shoot growth duration, shortening of fruit bearing age and the increase of root yield.

Drop application of GA (0.5ml of 50ppm) on rhizome of one year old root broke bud dormancy better than by low temperature. Soaking for one hour of one year old roots which wintered in the field in GA (50-200ppm) greatly accelerated the emergence of new buds while kinetin was only effective at low level (50ppm). GA substantially increased stem length in early stage and petiole length later on while kinetin increased stem diameter.

Under the field condition with polythylene film tunnel(PET) in early spring the soaking in GA (50ppm for 1 hour) of rhizome of 4 year old root with replanting and dropping GA (50ppm, 1ml) on rhizome without replanting brought earlier emergence (29days) in comparison with that in the usual field. PET alone caused 14 day-early emergence.

GA increased the length of stem and petiole only in early stage and replanting decreased only petiole length in later stage. Soaking in GA with replanting caused the pronounced decrease in peduncle length, percentage of fruit set and dry weight of reprocuctive organ (fruits and peduncle). Dropping without replanting showed significant decrease only in dry weight of reproductive organ. Fruit maturing was 20 days earlier than in usual field with little difference between GA and PET.

It is well expected that GA could be used for early emergence of bud, shortening of root dormancy period, thinning of fruit and higher root yield according to application amount and methods.

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I. INTRODUCTION

Korean ginseng (*Panax ginseng* C.A. Meyer.), perennial root, has so frequently been appeared in the recipes of herb medicine in the Orient (1) that it deserves the king of medicinal plants. Aerial stems emerge from underground rhizome in spring and die in autumn. It is harvested six years after sowing due to very slow growth. It has first flowers at three years old and seeds germinate in the second spring after harvest.

Gibberellin (GA) was tested for development of embryo and splitting of the kernel(7). Report on breaking of bud dormancy by GA is rare (1) and the effect of GA to the old roots is still unclear. It is more so under the field condition due to environmental factors.

GA was tested only for the purpose of accelerating growth of bud by soaking root (8), for root yield increase by spraying to aerial part (8) and by mixing to nutrient solution (6). But GA effects on ginseng are inconsistent. Trials under field condition and using older roots are hardly to be found. Effect of kinetin on bud dormancy and growth thereafter is not assessed yet.

For the increase of ginseng yield and earlier seed collection of desired line in prologation of duration per aerial growth cycle and repetition of growth cycle per annum are needed. In some instance there are 32% of long dormant ginseng root, so called sleeping ginseng, in the field (5). GA or other growth regulators may break such perennial dormancy. In this paper the effects of GA and kinetin on growth of bud and breaking dormancy, and application methods of GA under field condition are presented.

II. MATERIALS AND METHODS

Effect of GA and low temperature on breaking of bud dormancy: One year-old seedlings (purple stem var.) were transplanted to sand pot on 14th November 1979, and kept in the room (15°C-20°C). Other seedlings kept low temperature during winter were transplanted in sand on 30th January 1979. Three roots were planted per pot and 0.5ml of 50 ppm GA solution was dropped on rhizome. There were 3 pots (replicates) per treatment.

Effect of GA and kinetin on early growth of ginseng bud: One year old ginseng seedlings (purple stem var.) treated with low temperature during winter in the field were taken on 15th January 1979, soaked in 50, 100 and 200ppm solution of GA or kinetin for one hour, transplanted into pots with soil and kept in the room(15°C-20°C)

Prolongation of aerial growth under the field condition: Four year-old roots (purple stem var.) were digged out on 24th February 1979 and rhizome was soaked in 50ppm solution

of GA for one hour and replanted.

Dropping treatment was done on the rhizome with 1ml of 50ppm GA solution after removing soil on top of rhizome and earthed up. Distilled water was used for control. Area was 1.65m^2 (40 plants) per replicate and each treatment had two replicates. After GA treatment the bed was covered with polyethylene film tunnel to protect against low air temperature. Tunnel was removed on 5th April. It was opened for air circulation when temperature was high.

III. RESULTS AND DISCUSSION

Effect of GA and low temperature on bud dormancy breaking: Effect of low temperature and GA was shown in Table I.

Table 1. Effect of GA on bud emergence of one year-old ginseng root.

Treatment	Low Temp.	Low Temp.+GA	Room Temp.	Room Temp.+GA
Days requied to emergence	12.8	7.0	Dormant	9.9

Low Temp.: Overwintered in the field. Room Temp.: Stored at 15°C-20°C
GA: 50ppm, 0.5ml dropping.

Low temperature and GA were equally effective on breaking dormancy of buds. Days to emerge was 9.9 for GA alone and 12.8 for lower temperature alone but 7.0 for both GA and low temperature suggesting synergetic interaction of GA and low temperature. GA alone was effective for dormancy breaking and GA mixed with abscisic acid or benzyladenine was not different from GA alone and it took 14 days at 15°C (3).

Ginseng root overwintered at room temperature (15°C-20°C) did not emerge. For the breaking of dormancy no less than 2 months were required at 2C-4C (4). It is not known whether the longer period than 4 months over 4°C could break dormancy.

About two months later dormant roots made one or two new buds around rhizome but this new buds did not continue to grow. The second and third primordium of bud seemed to grow up (4). When GA was treated on it new buds were continue to grow.

Effect of GA and kinetin on early growth of buds: Number of day required to emerge in each treatment was shown in Table 2.

GA accelerated sprouting most effectively and there was no difference between levels.

Kinetin accelerated only at 50ppm. It seems that kinetin has retardation effect at higher concentration.

It takes 20 days for bud to emerge under optimal condition as shown in the control. Optimum temperature for new bud growth was reported as 18C-20C (4).

Table 2. Effect of GA and kinetin on bud emergence of one yearold ginseng.

Treatment	Control (Distil.w.)	GA(ppm)			Kinetin(ppm)		
		50	100	200	50	100	200
Days to emerge	19.5	8.7	8.2	8.0	15.4	17.9	20.8

LSD 0.05=2.53, 0.01=3.51

Bud primordium was formed two years before and in August one year before differentiation terminated. In the last autumn when air temperature drops to 18°C-20°C buds start to grow and then fall into dormancy by decreasing temperature (4). In spring when air temperature rises to the optimum range, buds free from dormancy by cold winter start to grow again. Above results indicates that GA is not only effective on dormancy breaking but also on growth stimulation of active bud.

Effect of GA on the growth of each part was shown in Table 3. and 4. Stem length and stem length+petiole length were significantly different between control and GA and among GA levels 30 days after treatment. However petiole length alone showed significant difference 45 days after treatment and thereafter. GA treatment on root showed overgrowth of stem and petioles. Soaking the stratified seeds with GA stimulated the growth of petiole and the leaf but difference was observed only in the early stages (8).

Temporal difference of GA effect seems to be related with growth phase of each organ of plants. Stem grows first very rapidly and followed by petiole growth. GA may move from root to stem and then to petiole resulting highest concentration of GA at petiole. Kinetin treatment increased diameter of young shoot by 3mm in comparison with 1mm in the control.

Effect of GA on emergence under field condition: Effect of GA on days to bud emergence of four year-old root was shown in Table 5. Replanting of roots did not affect days to emergence. Only GA treatment made emergence by 15 days earlier than polyethylene film

Table 3. Effect of GA on the growth of one year-old ginseng.

GA Treatment	30 Days (cm)			40 Days (cm)		
	SL	PL	SL+PL	SL	PL	SL+PL
0	—	—	4.2	6.3	2.7	9.0
50ppm	5.9	4.3	9.9	6.2	5.2	10.2
100ppm	6.1	5.2	11.3	6.6	5.7	11.3
200ppm	8.5	6.3	14.9	8.5	7.1	15.6
LSD 0.05	2.2	NS	1.34	NS	2.21	NS
0.01	NS	—	2.02	—	NS	—

NS: None Significant SL: Stem Length PL: Petiole Length

Table 4. Effect of GA on the growth of one year-old ginseng (cm, 60 days after)

GA Treatment	SL	PL	SL+PL	SD	LL
0	7.0	4.0	11.0	0.17	3.7
50ppm	6.5	5.6	12.1	0.18	3.5
100ppm	6.8	6.1	13.0	0.17	4.4
200ppm	8.5	7.6	16.1	0.18	4.7
LSD 0.05	NS	1.88	NS	NS	NS

NS: None significant SL: Stem length PL: Petiole length
SD: Stem diameter LL: Leaf length

tunnel alone did. There was no difference between application methods.

Polyethylene film tunnel accelerated bud emergence by 14 days earlier than normal field condition. Thus new buds emerged 29 days earlier by GA application under polyethylene film tunnel on February 24. Emergence could be made much earlier than 29 days if GA application under polyethylene film tunnel could be done in the end of January or in early February.

Table 5. Effect of GA on days to emergence under polyethylene film tunnel in field.

	Soaking and replant		Dropping without replant	
	Control	GA (50ppm 1hr.)	Control	GA (50ppm 1ml)
Days to emergence	41	27	41	26
Date of emergence	April 6	March 23	April 6	March 22

Emergence without polyethylene film tunnel: On April 20.

Effect of GA on shoot growth was shown in Table 6. GA effect appeared on the length of stem and petiole in early stage, 45 days after treatment,. But in later stage, 130 days after treatment, there was no GA effect on stem, and replanting after digging out for GA treatment affected only on petiole. Length and width of center leaflet tended to be greater in GA dropping treatment indicating greater leaf area.

Effect of GA on reproductive organ growth: Effect of GA application on peduncle length, percentage of fruit set, dry weight of reproductive organ and fruit reddening date were shown in Table 7. Peduncle length and percentage of fruit set decreased by replanting and highly significantly by GA application with replanting. Replanting after soaking, application of 2-3 drops daily for 18 days and spraying on aerial shoots effect on fruit set (8).

GA dropping on rhizome alone did not show any significant difference in peduncle length and percentage of fruit set but in the dry weight of reproductive organ (fruit and peduncle). Soaking of rhizome with 50ppm of GA for one hour substantially decreased

Table 6. Effect of GA on the growth of 4 year-old ginseng(cm)

Days after treat.		Stem Length		Stem Diameter		Petiole Length		Largest Leaflet Length		Largest Leaflet Width	
		45	130	45	130	45	130	45	130	45	130
Soakin with replant	Control	16.1	30.4	0.66	0.79	2.1	8.3	NM	14.7	NM	6.3
	GA(50ppm, 1hr.)	30.4	31.5	0.66	0.69	4.9	7.6	7.4	13.2	3.2	5.9
Dropping without replant	Control	15.8	35.9	0.53	0.81	1.9	11.4	NM	15.7	NM	7.0
	GA(50ppm, 1ml)	25.8	35.6	0.58	0.75	3.9	11.4	6.4	16.5	2.5	7.6
LSD	0.05	6.44	NS	NS	NS	1.6	1.91	NS	2.22	NS	1.15
	0.01	10.68	—	—	—	NS	NS	—	NS	—	NS

NM: Not measurable due to incomplete opening of leaves.

dry weight of reproductive organ.

The supply of GA to nutrient solution in water culture of ginseng decreased dry weight of root (6). However replanting after soaking of the roots of 4-5 years old ginseng plant in a 25ppm solution of GA for 5 or 30 minutes resulted in a greater accumulation of dry matter in both aerial mass and roots (8). In this experiment dry weight will be investigated at harvest in October.

Table 7. Effect of GA on peduncle length and fruit set of 4 year-old ginseng.

Treatment		Peduncle Length (cm)	Fruit Set (%)	Number of Fruit /Plant	Fruit and Peduncle/ Plant(g)	100 Fruits (g)	Frurit Maturing Date
Soaking and Replant	Control	20.4	63.9	31.0	2.38	4.75	June 29
	GA 50ppm 1 hour	14.2	1.3	8.0*	0.62	6.39	June 28
Dropping without Replant	Control	27.3	74.7	39.6	3.17	6.96	Jnue 29
	GA 50ppm 1 ml	27.4	81.4	41.4	2.42	6.35	June 27
LSD	0.05	5.89	25.6	—	1.69	—	July 20
	0.01	9.77	42.4		—		(Normal)

*Mean of 6 fruit bearing plants. g: dry weight

Replanting considerably decreased number of berry per plant and weight per berry (Table 7). In dropping treatment GA tended to increase number of berry per plant but to decrease weight per berry. Fruit reddening date was not much different among treatments though there was certain tendency of acceleration by one or two days in GA treatment. Thus it seems that the maturing of fruit is not much affected by 15 days earliness of emergence. Only for early ripening of fruits polyethylene film tunnel alone may be enough.

Optimal GA levels for each physiological activity seems to be quite different according

to physiological status of ginseng plant since emergence was not different between soaking and dropping (Table 5) but percentage fruit set was quite different (Table 7).

Since elimination of peduncle in early stage increases root weight (2) GA treatment may increase root yield and could be used for such purpose. Each root weight was measured just before replanting in soaking treatment but could not in dropping treatment. Thus GA effect on root yield will be clear in soaking treatment but it is difficult in dropping treatment unless a convenient method of in situ measurement of root weight is developed. Methods and time of GA application appear to have high potential for the control of ginseng growth in useful way.

要 約

고려인삼의 地上部生育期間의 연장과 着果年限의 短縮 및 根重增加를 목적으로 한 根芽의 發芽 및 地上部生育에 對한 gibberellin(GA) 및 kinetin에 대한 효과를 실험실 및 포장조건하에서 조사하였다.

1年根 地下莖의 GA의 滴下(50ppm液 0.5ml)는 低溫에 依한 것보다 휴민타파에 좋았다. 露地越冬한 1年根을 GA液 (50~200ppm)을 1시간 침지한 것은 新芽의 出芽를 크게 촉진시켰으며 kinetin은 다만 低溫度(50ppm)에서 효과가 있었다. GA는 초기에 莖長을 현저히 증가 시켰으며 후기에는 葉柄長을 증가시켰으나 kinetin은 줄기의 굵기를 증가시켰다.

이른 봄에 polyethylene 턴넬의 포장 조건에서 4年根地下莖의 GA침지 (50ppm 1시간) 후 再植과 뇌두에 GA滴下(50ppm액 1ml)는 일반 포장조건보다 출아를 29일간 촉진시켰고 PE 單用은 출아를 14일간 촉진시켰다.

GA처리는 초기에만 莖 및 葉梗長을 증가시켰고 再植은 後期에 葉柄長만 감소시켰다. GA浸漬後 再植은 花梗長 着果率 및 생식기관(果實 및 花梗)의 乾重을 현저히 감소시켰고 滴下 처리는 다만 생식기관의 乾重을 감소시켰다. 과실의 숙기가 보통 포장의 경우보다 20일간 빨랐으며 GA 처리와 PE설치 시험구 간에는 차이가 없었다.

GA는 根芽에 發芽를 촉진 시키고 휴민기간을 단축시키며 摘果 및 根重증가에 GA의 사용량과 사용방법에 따라서 인삼의 조기 출아, 휴민기간의 단축 및 根重을 증가시킬 수 있다.

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