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Effect of Defoliation and Fertilizing Time on the Growth and Flowering of Kyoho Grapes after Summer Pruning

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Summary

In tropical countries, grapevines grow as evergreen and they are pruned in the time of active growing. In such summer pruning, defoliation of mature leaves and application of fertilizers are recommended for promoting bud bursting. Using the cultivar Kyoho, we conducted summer pruning and tested the effect of defoliation and fertilizing time on the growth of new shoots and flowering. On the basis of the results, we discussed the nutritional condition of the vine.

1. When all leaves were defoliated from the primary shoot at summer pruning, bud bursting was delayed and the growth of new shoots was much reduced. The development of flower clusters was restricted severely, and the berries set were only few.

2. Chemical analysis of the leaves developed on new shoots showed that defoliated vines contained less starch than un-defoliated vines. Nitrogen content was also lower in defoliated vines at the early stage of shoot growth. The nitrogen content decreased rapidly as the shoot grew in un-defoliated vines, while it increased until blooming in defoliated vines. Sugar content was also higher in defoliated vines than in those of un-defoliated. These results may be an indication that the nutrient movement to growing shoot tip or flower cluster was inactive in defoliated vines.

3. Application of fertilizers in two weeks before pruning to the un-defoliated vines resulted the longest shoot growth, though the flower development was best in the vines applicated on the same day with pruning. The highest berry setting percentage was obtained by application in two weeks after pruning.

Introduction

Some deciduos fruit trees like grapevine grow as evergreen in tropical countries. NAKAGAWA[13,14] has reported the way of grape growing in such countries, where grapes are harvested twice a year by practicing summer pruning conbined with the defoliation of mature leaves after the first harvest. Although pruning or defoliation is necessary for successful bud bursting and shoot growth for the second crop, the capacity of the vine is lowered through the removal of leaves, its chief manufacturing organ[21].

The function of leaves as a manufacturing organ depends on many factors. One of these factors is the condition of mineral nutrients in soil, which affects the nutritional condition of the plant. The availability of the mineral nutrients in soil depends mostly on the total amount and the time of application of fertilizers. Both of them influence the nutrient status and the distribution in fruit trees[18].

Some investigators have observed the effect of defoliation and pruning[1,10,11,16] and the effect of application of fertilizers[3,8] on the growth of fruit trees, but their observations are not done with the vines pruned in summer.

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In this study we asseyed the effect of defoliation and fertilizing time on the growth and flowering of Kyoho grapevines after summer pruning.

Materials and Methods

Own rooted vines of Kyoho (*Vitis labruscana B.* × *Vitis vinifera L.*, tetraploid) of two years old were planted in a plastic house during the winter of 1980, and were pruned to have two or three basal buds. Vines were devided into three blocks, which consisted of 16 vines in each. They were allowed to grow only one shoot per vine in spring, 1981. In July 13th, when vines were growing actively, the primary shoot was pruned at the fourth internode.

The defoliation treatment, removing all of the four leaves attaching to the primary shoot, was conducted to a half number of the vines at the time of pruning.

Application times of fertilizers consisted of (a) two weeks before, (b) on the same day with, and (c) two weeks after pruning. The first application was done on June 29th, the second on July 13th, and the third on July 27th, respectively. All vines received the same amount of complete fertilizers containing 5 g of nitrogen as ammonium sulfate.

One or two new shoots, which bursted from axillary buds of primary shoot, were allowed to grow.

Chemical analysis

Old leaves and new leaves were used for analysing. Old leaves were sampled only from the vines of un-defoliated. Small parts of the third and fourth leaves of primary shoot were cut off with scissors seven times at intervals of one week from the start of the treatment until flowering. New leaves which developed on the basal part of new shoot were collected from the vines of both defoliated and undefoliated four times at intervals of one week from bud bursting until flowering.

For total N, 100 mg of dried and powdered sample was analyzed according to Semi-micro Kjeldahl method. Soluble N, using also 100 mg of dry matter, was extracted three times with 80% ethanol at 70 ℃ for every 30 minutes, then filtrated and diluted to 50 ml. The 2 ml of the extract was decomposed by boiling with sulfulic acid containing 16% K_2SO_4 and 0.8% $SeOCl_2$ for three hours, then filled up to 15 ml with water. The 5 ml of the mixture was added with 2 ml of Nesller's reagent, and the concentration of N was determined colorimetry.

For sugar content, 20 ml of the 80% ethanolic extract was evaporated to near dryness. The residue was dissolved in water, and clarified with $Ba(OH)_2$ and $ZnSO_4$. The concentration of sugar was determined by Somogyi's method.

Starch was extracted from the residue of ethanolic extraction with 4.6 N of $HClO_4$ three times. The extract was diluted to 0.56 N of $HClO_4$, and boiled for two hours to hydrolize starch to sugars. The concentration of starch was determined from the value of sugar concentration.

Results

1. Bud bursting and shoot growth

The effect of defoliation and fertilizing time on bud bursting is shown in Fig. 1. The buds of un-defoliated vines sprouted earlier than those of defoliated. Among the vines of un-defoliated, the earliest and latest bud bursting was observed when fertilizing was done on pruning day and two weeks after pruning, respectively. Among the vines of defoliated, on the other hand, the reverse was found.

The shoot growth after bud bursting was more vigorous for the vines of un-defoliated than those of defoliated (Fig. 2). The longest shoot was observed in the vines of un-defoliated and fertilized two weeks before pruning.

2. Flower development and berry setting

The percentages of vines bearing flower clusters and the types of the cluster are shown in Table 1. Clusters are devided into five types ; A (very good), B (good), C (poor), D (very poor),

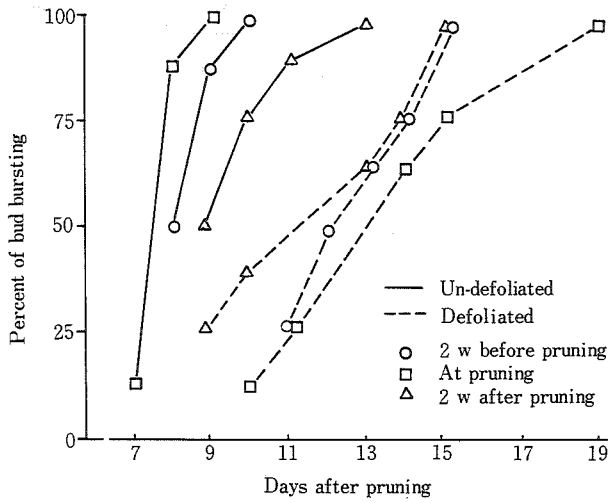

Fig. 1 Effect of defoliation and fertilizing time on bud bursting after summer pruning in Kyoho grapes.

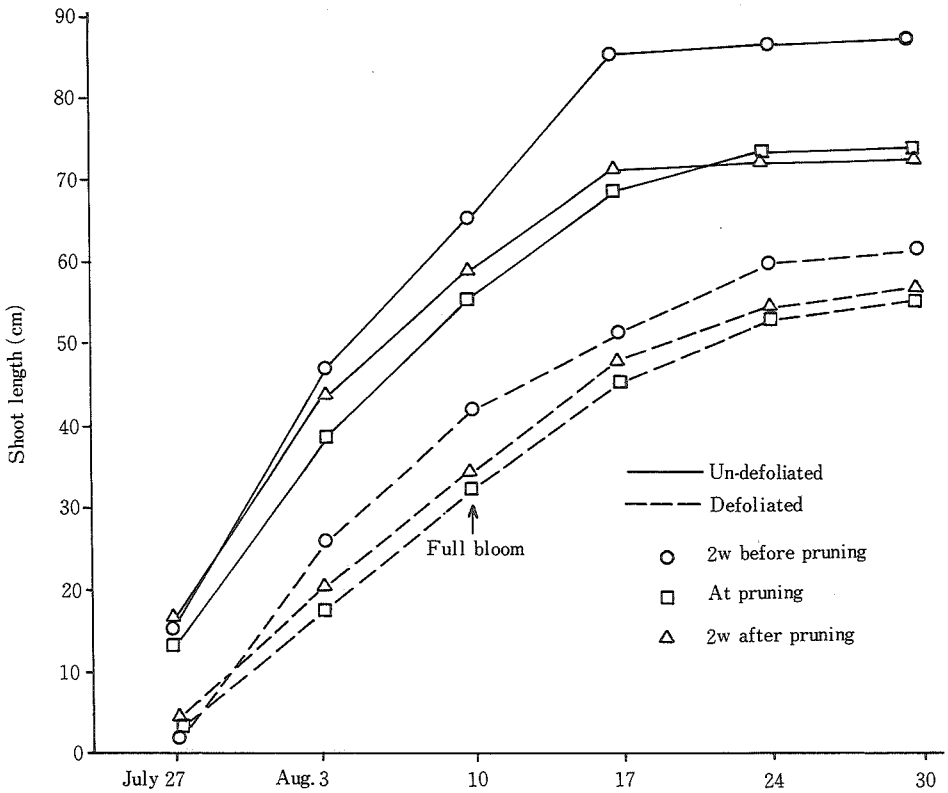

Fig. 2 Effect of defoliation and fertilizing time on the growth of the new shoot arising from the primary shoot after summer pruning in Kyoho grapes.

and T (tendril). Normal types A and B were found in all vines of un-defoliated, regardless of the time of fertilizing, while most clusters of defoliated vines were abnormal types C and D or tendril.

The number of florets per cluster was largest for the vines fertilized at pruning (Table 2),

Table 1 Effect of defoliation and fertilizing time on the development of flower cluster in Kyoho grapes pruned in summer*

Defoliation and fertilizing time	Types of cluster*					% vines bearing cluster
	A (very good)	B (good)	C (poor)	D (very poor)	T (tendril)	
Un-defoliated						
2 w before	25.0	37.5	37.5	0	0	100.0
At pruning	37.5	37.5	25.0	0	0	100.0
2 w after	12.5	37.5	25.0	25.0	0	100.0
Defoliated						
2 w before	0	0	0	37.5	25.0	62.5
At pruning	0	12.5	0	62.5	12.5	87.5
2 w after	0	0	0	12.5	12.5	25.0

* Figures represent the percentages of vines that formed each type of cluster.

Table 2 Effect of defoliation and fertilizing time on the development of flower cluster and berry setting in Kyoho grapes pruned in summer

Defoliation and fertilizing time	No. of days until blooming	No. of frolets /cluster	No. of berries /cluster*	% set*
Un-defoliated				
2 w before	27	134.4	24.1	17.9
At pruning	26	173.6	32.3	18.6
2 w after	27	155.3	39.0	25.1
Defoliated				
2 w before	—	43.3	0	0
At pruning	27	71.6	13.0	18.1
2 w after	—	0	0	0

* Estimated two weeks after full bloom.

though this treatment did not show the highest berry setting. The vines of defoliated and fertilized two weeks before or after pruning set no berry.

The size of floret is shown in Table 3. The vines fertilized two weeks after pruning had the biggest floret.

Table 3 Effect of fertilizing time on the size of floret* of Kyoho grapes pruned in summer**

Fertilizing time	Style	Ovary		Calyx	
	length (mm)	length (mm)	diam. (mm)	length (mm)	diam. (mm)
2 w before	0.52	1.16	0.88	0.42	1.10
At pruning	0.49	1.14	0.85	0.43	1.06
2 w after	0.58	1.24	0.92	0.47	0.96

* Values are the average of 20 florets collected at full bloom.

** Data show only for un-defoliated vines because of very few number of blooming florets in defoliated vines.

3. Nutritional conditions of the vine

As shown in Fig. 3, regardless of the time of applicating fertilizers, insoluble N in the old leaves of un-defoliated vines increased rapidly after pruning until blooming and then decreased. The soluble N was much less than insoluble N, and was fairly constant for all fertilizing treatments.

In the new leaves of un-defoliated vines, the level of insoluble N was highest on the first sampling day (Aug. 3rd, 1 week before full bloom), then decreased gradually (Fig. 4). Soluble

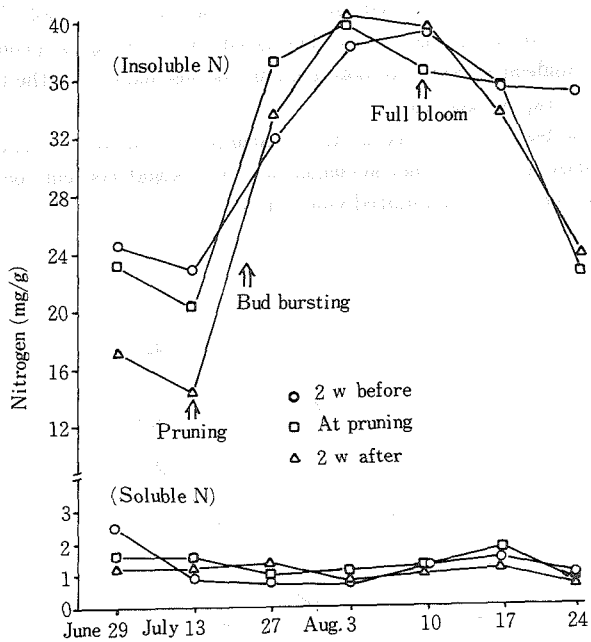

Fig. 3 Effect of fertilizing time on N content of old leaves attaching to the primary shoot of Kyoho grapes.

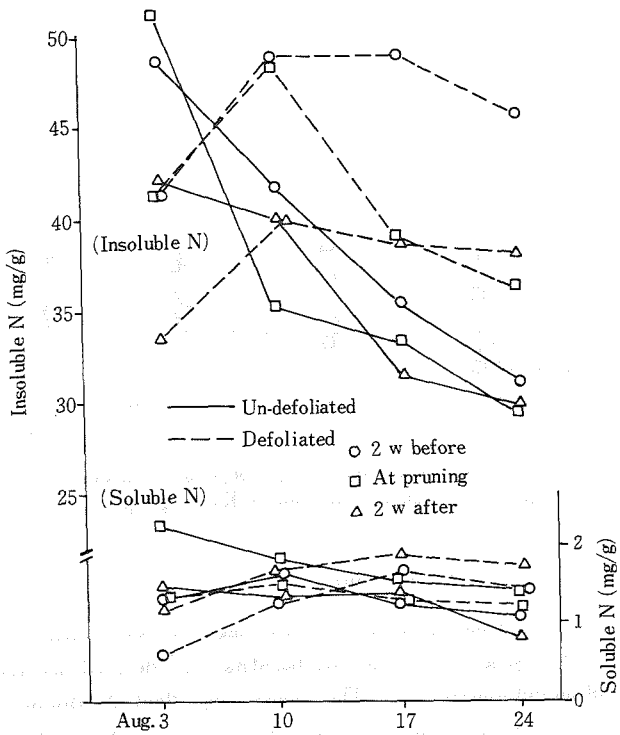

Fig. 4 Effect of defoliation and fertilizing time on N content of new leaves developed after summer pruning in Kyoho grapes.

N level also decreased slowly. In the vines of defoliated, on the other hand, the levels of both insoluble and soluble N increased from Aug. 3rd until Aug. 10th, then decreased gradually.

The latest application of fertilizers caused the lowest content of insoluble N on the first sampling day both in the vines of defoliated and un-defoliated. Fertilizing on pruning day to un-defoliated vines caused the highest contents of both soluble and insoluble N at the first sampling, though their levels decreased rapidly thereafter.

The starch content of new leaves increased as they matured in un-defoliated vines, while that in defoliated vines did not show such a distinct accumulation. For sugar content, on the contrary, a marked increase was detected only in defoliated vines (Fig. 5).

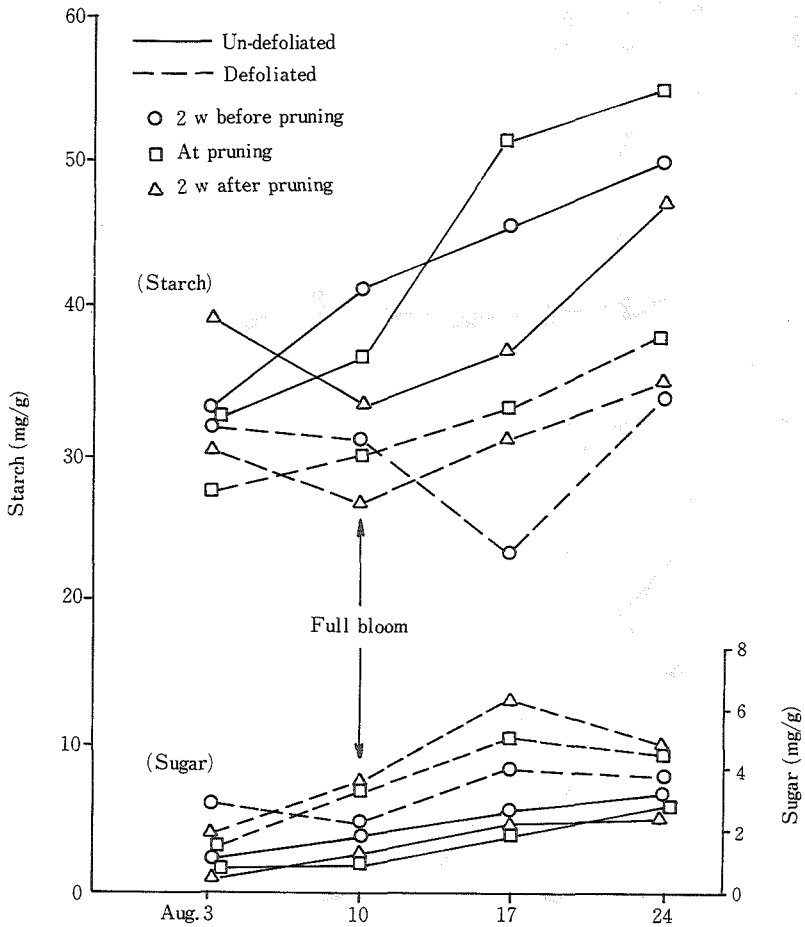

Fig. 5 Effect of defoliation and fertilizing time on carbohydrate content in new leaves developed after summer pruning in Kyoho grapes.

Discussion

Defoliation of mature leaves at summer pruning gave the negative effect either on the shoot growth or on the flowering of Kyoho grapes. The bud bursting was delayed and the length of shoot was shorter than that of un-defoliated vines. The suppressing effect of defoliation on flower development was remarkable. The same result was found by COOMBE[1] who studied the berry setting of Corinth and Sultanina grapes, in which no berry setting was resulted on topped and girdled shoots without leaves.

Defoliation caused the shortage of carbohydrate in the vine as shown in the lower starch level in new leaves (Fig. 5).

In addition to that, defoliation also lowered the levels of both insoluble and soluble N in new leaves at the early stage of new shoot growing (Fig. 4). This may be an indication that defoliation of mature leaves suppresses the mineral absorption by root. In fact, high levels of insoluble N was accumulated in old leaves after pruning in un-defoliated vines (Fig. 3).

Besides the organic nutrient factors, natural growth substances like auxin, gibberellin and cytokinin play important roles in flower development and berry setting[1,2,6,12,20,21]. As we know, flowering is the results of the functional activities of three main organs — leaf, stem and root — as sources of the growth substances. The removal of leaves from the vine might disturb the flow of these substances, and the flower primordia that had been formed in axillary bud became abnormal.

In tropical countries, removing old leaves at pruning is needed to assure good bud bursting for some fruit trees[14,19]. NAKANO *et al*[15] have reported that the mature leaves of Delawere grapes contained a high level of abscisic acid in autumn, which is known to controll dormancy of axillary buds. In this experiment, however, the presence of mature leaves did not exert any negative effect for bud bursting or shoot growth. It may be the reason that we conducted summer pruning in middle July, when axillary buds had not been induced into dormancy[7].

The effect of fertilizing time on the shoot growth and flowering was not so distinct as compared with that of defoliation. Application on the same day with pruning, however, gave the best results for bud bursting and flower development and good berry setting (Table 1, 2, Fig. 1).

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ブドウ‘巨峰’に対する摘葉と施肥時期が夏季せん定後の新梢の生長と果実生産に及ぼす影響

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熱帯地方ではブドウは常緑であり，せん定も枝梢が旺盛に生育している際中に行われる．このような夏季せん定では，発芽を促すために，成葉の摘除や施肥などが推奨されている．

本実験では，‘巨峰’を供試して，摘葉と施肥時期が夏季せん定後に発育する新梢の生長と果実の生産性に及ぼす影響を観察し，樹体内栄養との関連性を検討した．

1．夏季せん定時に本梢上のすべての葉を摘除すると，無摘葉樹にくらべて発芽が遅れ，新梢の生長，花穂の発育も著しく劣り，ほとんど着果しなかった．

2．新梢の葉を栄養分析すると，摘葉樹ではデンプン含量が著しく少なく，窒素含量も新梢の生育初期には無摘葉樹より低かった．

無摘葉樹では，新梢の生長に伴なって葉内窒素含量が急減したが，摘葉樹では開花期にかけて増加した．また，糖含量も摘葉樹のほうが高かった．これらのことは，摘葉樹では新梢の先端部や花穂への栄養の転流が不活発であることを示すものと考えられる．

3．新梢の生長は，せん定の2週間前に施肥した無摘葉樹でもっとも旺盛であったが，花穂の発育はせん定と同じ日に施肥した区でもっともすぐれ，結実率は2週間後の施肥区でもっとも高かった．

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