Promotion of Berry Set in Grapes by Growth Retardants

I. Comparison of the Effects of B-nine and CCC Applied as Shoot Spray and Cluster Dip on Berry Set and Shoot Growth in 'Kyoho' Grapes

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生長抑制剤によるブドウの花振い防止に関する研究

第１報　巨峰種に対するＢナイン，ＣＣＣの
葉面散布および花穂浸漬の効果

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Introduction

It has been postulated that the shoot spray with B-nine (succinic acid 2, 2-dimethylhydrazide) or CCC ((2-chloroethyl) trimethyl ammonium chloride) before anthesis depresses shoot growth and increases berry set in some seeded varieties of grapes[1)-6)]. Recently, Coombe[7)8)] has indicated that the application of CCC directly to clusters by dipping before anthesis also increases berry set and the effect is due to a correlated inhibition of shoot growth, which may reresult in the reduced competition for organic nutrients between the developing shoot and ovaries. In our preliminary experiment (unpublished data), however, berry set of 'Kyoho' grapes was improved by the application of CCC to clusters without any distinctive influences on shoot growth.

The purposes of this investigation are to compare the effects of B-nine and CCC on berry set of 'Kyoho' grapes and also to gain further understanding of the mechanism of increased berry set by the application of growth retardants especially in cluster dip.

Materials and Methods

Four vines of 4 years-old 'Kyoho' grapes (*Vitis vinifera* LINN × *Vitis Labruscana* BAILEY) having uniform size were selected at the orchard of Faculty of Agrciculture, Shimane University, Matsue. This variety bearing large and tasteful berries of blaɔk skin is widely grown in Japan, but it occasionally annoys growers by poor berry set caused by various reasons. In the spray treatments, shoots were sprayed using hand sprayer with the solution of B-nine at 2500 and 5000 ppm and of CCC at 500 and 1000 ppm, respectively. During the sprayings, clusters were covered with polyethylene film bags so as to limit the treatments to leaves and stems. In the dip treatments, clusters were treated by a momentary dip in the solution of B-nine at 500 and 1000 ppm and of CCC at 100 and 200 ppm, respectively.

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These concentrations of B-nine and CCC were decided from the data previously reported by others[2)-4), 6)]. Atlox BI was added to each solution as a wettable agent at the concentration of 0.1%.

Fifty four shoots of average vigour on the 4 vines were devided into 8 treatments as above mentioned and an untreated check, each with 6 replicates. All treatments were applied on May 28, 1970, 26 days before full bloom, when 8th leaf unfolded. Immediately prior to anthesis, all clusters except one on each shoot were removed and used as the materials for comparing nitrogen and sugar contents in florets as affected by the treatments. Accordingly, the measurements on the number of set berries per cluster and the quality of harvested fruits were conducted using the remained clusters, one on each shoot.

Results

Berry number per cluster was counted 2 weeks after full bloom when no further berries abscised and seeded berry was easily defined from seedless one in conformity with size and shape. As shown in Table 1, all spray and dip treatments with B-nine and CCC except the spray with CCC at 1000 ppm increased total number of seeded and seedless berries per cluster. Seedless berries, however, are less useful since they grow up to the size of at most one third of seeded ones. As far as seeded berries of practical importance were concerned, the dip with B-nine at 500 ppm and the spray with B-nine at 2500 ppm were most effective in promoting set where the mean numbers of seeded berries per cluster were increased by 62% and 93%, respectively. After counting the number, berries were hand-thinned to the proper population and if necessary shaped by cutting the distal part of clusters according to the routine manner in the growing of 'Kyoho' grapes. As shown in Table 2, the dip treatments with B-nine at 500 and 1000 ppm, and with CCC at 100 ppm, and also the spray with B-nine at 2500 ppm markedly increased cluster weight at maturity mainly due to increased number of seeded berries. There was no appreciable difference between treated and untreated clusters as for berry weight, seed number per berry and the contents

Table 1. Effect of B-nine and CCC applied as shoot spray and cluster dip on berry set. (July 7, 1970)

Treatment		Number of berry per cluster: Seeded	Seedless	Total
Shoot spray	B-nine 2500 ppm	25.5	15.3	40.8
	B-nine 5000	19.7	32.3	52.0
	CCC 500	15.7	20.0	35.7
	CCC 1000	17.0	10.0	27.0
Cluster dip	B-nine 500	30.3	14.4	44.7
	B-nine 1000	18.3	25.8	44.1
	CCC 100	17.3	20.9	38.2
	CCC 200	16.2	19.2	35.4
Control		15.7	11.0	26.7

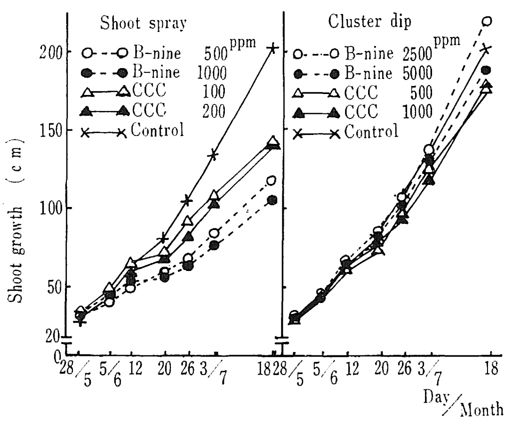

Fig. 1 Effect of B-nine and CCC applied as shoot spray and cluster dip on shoot elongation.

of soluble solid and free acid in juice. The effects of the treatments on shoot elongation are shown in Fig. 1. Spray with both chemicals began to inhibit shoot elongation about 10 days after treatments and the effects continued at least until the date of final measurement, 50 days after treatments. The rate of retardation was almost proportional to the concentration of each chemical. On the contrary, such the marked retardation of shoot elongation did not occur in all dip treatments. The same trend was observed on the development of the 7th leaf which unfolded at the time of treatments (Table 3). The

Table 2. Effect of B-nine and CCC applied as shoot spray and cluster dip on the quality of cluster at harvest.[a] (September 15, 1970)

Treatment		ppm	Cluster weight g	Number of berries per cluster: Seeded	Seedless	Berry weight: Seeded	Seedless	Seed number per berry	Soluble solids %	Free acid mg/100ml
Shoot spray	B-nine	2500	163	18.8	3.3	8.2	2.4	1.4	18.2	0.50
	B-nine	5000	141	16.7	6.3	8.2	2.3	1.1	18.0	0.48
	CCC	500	146	15.0	6.5	8.9	2.2	1.2	18.2	0.50
	CCC	1000	124	14.8	2.3	8.8	2.8	1.1	18.3	0.51
Cluster dip	B-nine	500	188	21.6	1.6	9.4	2.5	1.3	18.2	0.51
	B-nine	1000	162	17.4	2.5	9.6	2.4	1.2	17.9	0.50
	CCC	100	165	17.3	4.4	9.1	2.7	1.1	18.1	0.51
	CCC	200	130	14.9	2.8	8.6	2.7	1.2	18.5	0.50
Control			122	12.5	2.6	8.4	2.6	1.1	18.2	0.50

a) After measuring the berry set on July 7, berries in each cluster were hand-thinned to proper populations.

Table 3. Effect of B-nine and CCC applied as shoot spray and cluster dip on leaf development and node number per shoot.

Treatment		ppm	Size of the 7th leaf (Width) cm: May 28[a]	June 26[b]	July 18	Number of node per shoot: May 28[a]	June 26[b]	July 18
Shoot spray	R-nine	2500	3.9	15.5	16.1	8.1	17.5	28.3
	B-nine	5000	2.6	15.4	16.3	8.0	16.3	25.1
	CCC	500	3.8	17.1	17.4	8.8	18.1	27.6
	CCC	1000	2.3	16.4	16.8	7.5	17.3	28.5
Cluster dip	B-nine	500	4.3	17.4	17.8	8.8	17.3	29.4
	B-nine	1000	4.4	17.8	17.8	9.0	17.0	28.9
	CCC	100	3.5	17.1	17.5	8.9	17.1	27.1
	CCC	200	3.7	17.1	17.6	8.3	16.3	26.9
Control			2.8	17.8	18.0	8.1	16.9	28.5

a) Date of application　　b) Full bloom

number of node per shoot was not so much affected by the sprays as the shoot elongation (Table 3). Therefore, the retardation of shoot elongation was mainly connected with the reduced growth of internodes as reported by others[2)8)].

The amounts of nitrogen, reducing sugar and total sugar in florets collected immediately prior to anthesis are shown in Fig. 2. The amounts of these components were affected by some treatments, but there could not be found any consistent relationship between such the changes and increased berry set caused by the treatments.

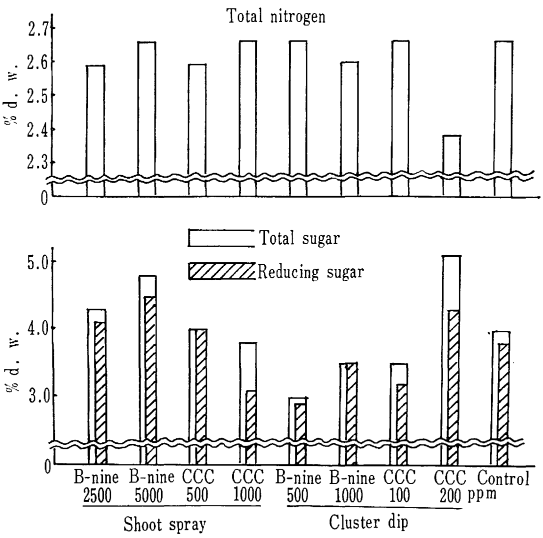

Fig. 2 Effect of B-nine and CCC applied as shoot spray and cluster dip on the amounts of nitrogen and sugar in florets just prior to anthesis. (June 13, 1970)

Discussion

It has been known that the shoot spray with B-nine about 20 to 30 days before anthesis is very effective in promoting the set of seeded berries of 'Kyoho' grapes[2)3)6)]. The results of this experiment indicated that the cluster dip with the compound also effective even at lower concentrations. The applications of CCC either by shoot spray at 500 and 1000 ppm or by cluster dip at 100 and 200 ppm were found to be less promotive for berry set as compared to the correspondent applications of B-nine. Hirata et al[9)] showed that the shoot spray with CCC at 1000 to 2000 ppm 16 or 26 days before anthesis increased berry set of 'Kyoho' grapes almost as well as that with B-nine at 5000 ppm. Coombe[7)8)] reported, however, that CCC applied either as a spray or directly to clusters at the lower concentrations (100−300 ppm) significantly increased berry set of 'Muscat of Alexandria' and some grape varieties. Thus, it is likely that the effective concentration of CCC is dissimilar depending on grape varieties.

As for the mechanism of the promotive effect of the growth retardants on berry set of grapes, the following interpretation is generally supported : the retard shoot growth caused by the application reduces the competition for organic nutrients between the growing shoot and clusters just as in the case of pinching. From the nutritional observations on the effects of shoot pinching and boron spray before anthesis, Okamoto and Kobayashi[10)] concluded that the translocation of nutritional components into clusters and the metabolic actvity in floret tissue during anthesis might be the important factors controlling the set of grapes. As a interpretation of the increased berry set caused by the shoot spray with growth retardants, the 'Competition theory' seems quite acceptable since the number of set berries is almost proportional to the reduced shoot growth in this and other investigations[2)−4), 6)8)9)]. In the case of cluster dip, however, no obvious retardation of shoot growth and leaf development was observed even though the treatments were as effective for berry set as the shoot sprays. This fact is difficult to be explained by means of the 'Competition theory' and contradicts to the Coombe's recent findings[8)] that the CCC treatment, even if it is applied directly to the cluster, increases berry set indirectly by retarding shoot growth. According to his implication, CCC, or a product with similar properties, may be translocated readily from its point of application throughout the shoot and at the apex it may retard shoot growth. Further studies are now going on to acertain whether or not the application of CCC or B-nine directly to clusters affects the shoot growth since this seems to be a key point to implicate the action of these chemicals in berry set.

It is interesting that any consistent relationship was not found between the increased berry set by the treatments and the amounts of nitrogen and sugar in florets just prior to anthesis. This indicates that some unknown factors other than these components in florets are probably connected with the increased berry set. Though fertilization is known to play a decisive role in berry set, it seems to be not affected by the application of growth retardants[4)8)]. Skene[11)] found that when the roots of grape vines were treated with CCC, the bleeding sap of vines contained up to 20 times the cytokinin concentration of untreated plants, and from the fact he suggested that the CCC effect on berry set might be due to increased cytokinin production in plant tissues. Therefore, it may be possible that the behavior of endogenous growth regurators such as cytokinin and gibberellin in florets relates to the increased berry set caused by the application of growth retardants. This should be investigated hereafter together with the effects of the cluster dip with growth retardants on shoot elongation as mentioned above.

Summary

The applications of B-nine and CCC by either shoot spray or cluster dip 26 days before anthesis increased the berry set of 'Kyoho' grapes. In shoot spray treatments, the highest number of seeded berries per cluster was obtained by B-nine application at 2500 ppm. In cluster dip treatments, B-nine application at 500 ppm was most effective for the set of seeded berries followed by B-nine at 1000 ppm and CCC at 100 ppm.

Sprays with both chemicals depressed the shoot elongation and the leaf development in almost proportional to the concentrations but such the retardation of shoot growth was not detected in all dip treatments. No consistent relationship was not found between the amounts of nitrogen and sugar in florets collected just prior to anthesis and the increased berry set caused by the treatments.

The mechanism of these promotive effects of the growth retardants on berry set was discussed in relation to shoot growth during the set period.

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摘　　要

ブドウ巨峰種について，生長抑制剤BナインおよびCCCの花振い防止効果を葉面散布，花穂浸漬の両処理法で比較するとともに，作用機作に関連があると思われる事項について調査した．処理は満開前26日，8葉期に行なった．

葉面散布ではBナインの 2500ppm で有核果の着果がもっとも促進され，ついでBナイン 5000 ppm，CCC 1000ppm であった．花穂浸漬ではBナイン 500ppm が 2500ppm 葉面散布に勝る効果を示し，Bナイン 1000ppm，CCC 100ppm がこれについだ．収穫果の房重はこれらの処理により増加したが品質にはとくに影響がなかった．Bナイン，CCCともに葉面散布では新梢の伸長，新葉の発育を抑制し，その程度は濃度にほぼ比例的であった．しかし花穂浸漬ではその様な抑制作用は認められなかった．開花直前の花蕾中の全窒素および還元糖，全糖含量と処理による着粒増加との間に関連性は認められなかった．これらの結果より，生長抑制剤の花振い防止作用が従来の新梢と果粒間の養分競合の減少という観点からのみでは説明出来ないことが指摘された．