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An Experiment to Determine the Effective Time of Fertilizer Application for 'Kyoho' Grapes

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Summary

The experiment was carried out with three years old 'Kyoho' grapevines planted on gravelled beds. Applications of aqueous fertilizer were started at different times from autumn to spring. Effectiveness of each application was determined by measuring vine growth and fruit productivity and also by analysing the nutrient contents in root, cane and leaf at several times.

Applying fertilizer in autumn increased the N content of root and cane even during winter and resulted in earlier and more dud bursting and better development of flower cluster. Application from March or April caused a rapid increase in N content of root and cane at bud bursting. The greatest shoot length and the largest ovary size were measured at blooming, and a better crop with larger sized berries and good qualities was yielded on the vines fertilized in spring.

Introduction

Most grape varieties require less fertilizer than many other tree fruits [5]. However, greater amounts of fertilizer are needed during early shoot growth and throughout the period of blooming to berry setting [5]. After the crop sets, nitrogen supply should be only enough to provide for the adequate but diminishing shoot growth and a healthy leaves [5].

In Japan, fertilizer application for grapevine has been recommended in autumn when the vines become dormant [1]. 'Kyoho' (*Vitis laburascana B.* × *V. vinifera L.*) is a rather recently spreading Japanese variety. It is one of tetraploided varieties with a very vigorous shoot growth. The nutritional condition of vines or schoots should be controlled appropriately, because excessively vigorous growth of shoots tends to cause severe flower shattering [4] and poor coloration of berries.

In this experiment, using gravel culture technique, we assayed the effect of fertilizer application on the vine nutrition, vine growth and fruit productivity, and discussed the best time to apply fertilizer for 'Kyoho' vines.

Materials and Methods

The experiment was carried out using own rooted 'Kyoho' vines of three years old as plant materials, and started in October 1982. Thirty six vines were transplanted from soil media in pots to six gravelled beds set in a plastic house. They were pruned to have a single cane of 10 nodes for each. Each bed received different fertilizing treatment as follows :

F-10 ; Fertilizer was applied continuously from October 15 throughout the experiment duration.

F-10/12 ; Fertilizer was applied from October 15 to December 31, then stopped until bud bursting in April.

F-1 ; Fertilizer was applied from January 1 throughout the experiment duration.

F-3 ; Fertilizer was applied from March 1.

F-4 ; Fertilizer was applied from April 8 (bud bursting).

N-F ; No fertilizer was applied until May 20 (berry setting).

Fertilizer solution or only water was circulated automatically three times a day for each 30 minutes. The solution was made up by mixing the 10 kinds of chemicals shown as below, and renewed every week. The pH value was adjusted to 6.0 with HCl in every treatment solution.

KNO_3	27.0 g/100 l
$Ca(NO_3)_2 \cdot 4H_2O$	31.7
$MgSO_4 \cdot 7H_2O$	16.7
$NH_4H_2PO_4$	5.0
EDTA-Fe	1.5
H_3BO_3	0.3
$MnSO_4 \cdot 5H_2O$	0.2
$ZnSO_4 \cdot 7H_2O$	0.022
$CuSO_4 \cdot 5H_2O$	0.005
$Na_2MoO_4 \cdot 2H_2O$	0.002

After bud bursting, the number of buds bursted, shoot length, the number of leaves unfolded and cluster length were recorded weekly. Disbudding was done in middle April so as to have only one shoot growing best for each vine. The number of florets was calculated before cluster trimming conducted in early May. After berry setting, width of five berries of each cluster was measured weekly from June 6 to August 15.

Harvest was done on August 18. The size of cluster and berry, the number of seeds per berry and soluble solids (Brix°) were determined immediately. Berry samples were stored in deep frozen condition until acid and anthocyanin determinations. Acidity was determined by titrating 5 ml of sample juice with 0.1N NaOH and the results were expressed as percentage of tartaric acid. Anthocyanin was extracted from 40 skin discs equivalent to 26 cm^2 with 100 ml of methanol containning 1% of HCl, and color spectrum was obtained by a spectrophotometer.

Sample collection for nutritional analysis

Cane sample was obtained from the tip of each cane by cutting off a short piece having one node at its middle. Root sample consisted of small roots less than 3 mm in diameter. They were collected at several important times like the start of each treatment up to bud bursting. Leaf sample was collected from the 4th—6th leaves from the base at the time of blooming, berry setting, veraison and harvest. Plant samples were dried at 95°C immediately and stored in a desiccator.

Chemical analysis

For total N, 250 mg of dried and powdered sample was decomposed in boiling H_2SO_4 and the content of NH_4 was determined by semi-micro Kjeldahl method.

For other mineral determination, 500 mg of the sample was dry-ashed at 550°C and resolved into 25 ml of 1N HCl. P was determined photometrically according to vanado-molybdate method. K, Ca and Mg were determined by an atomic absorption spectrophotometer.

Results

More buds bursted on the vines of F-10 and F-10/12 treatments than in others and they developed faster until middle April (Fig. 1). However, shoot elongation in F-10/12 became inactive thereafter, while the shoots of F-3 and F-4 vines grew more vigorously until blooming. Bud bursting and shoot growth in N-F were very weak.

Flower development and berry setting are shown in Table 1. The number of well developed clusters was greater in F-10, F-10/12 and F-3, and smaller in F-1 and N-F. Florets per cluster were more in autumn application treatments and fewer in unfertilized treatment. The size of ovary, on the other hand, was larger in F-3 and F-4, and smaller in F-1 and N-F. Berry setting was not so different among the fertilizer treatments,and the lowest percentage was shown in N-F treatment.

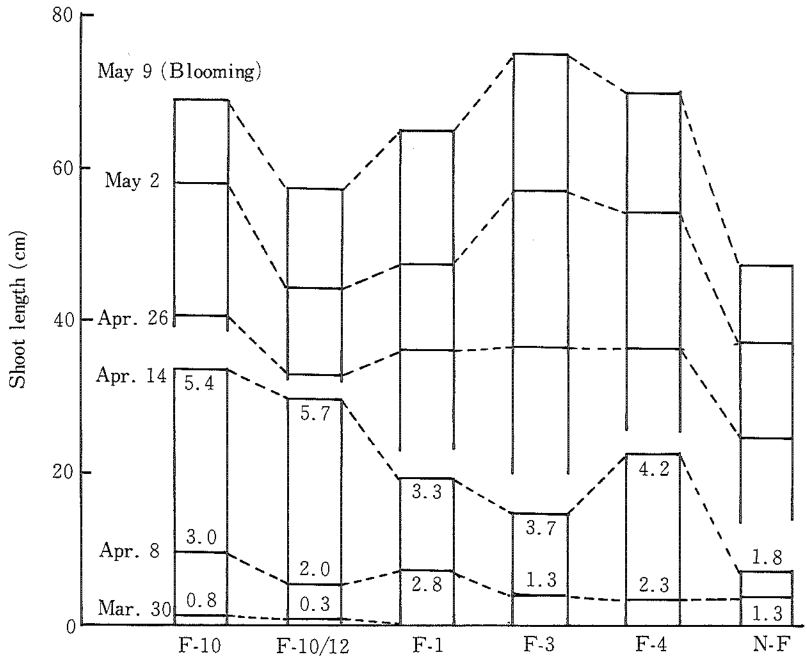

Fig. 1. Bud bursting and early shoot growth. Figures in columns represent the number of buds bursted per vine. Disbudding was practised to leave one shoot per vine after the measurement on Apr. 14.

Table 1. Flower development and berry setting

Treat-ment	No. of clusters per vine	Cluster length* (cm)	No of florets per cluster*	Ovary size** Width (mm)	Ovary size** Length (mm)	No of set berries	Set %
F-10	2.0	12.6	216.2	1.63	1.75	48.2	38.5
F-10/12	1.8	13.5	292.0	1.50	1.68	50.3	43.2
F-1	1.0	12.0	167.0	1.47	1.55	60.5	46.0
F-3	1.7	12.5	171.8	1.80	1.75	55.5	45.4
F-4	1.3	12.5	177.4	1.75	1.75	46.3	33.2
N-F	1.2	17.5	156.8	1.42	1.67	30.8	24.1

* Determined May 2, 1 week before blooming. Flower clusters were trimmed thereafter to have 120−140 florets for each cluster.
** Average values of 20 ovaries of just blooming.

From berry setting to veraison stage, berries of any fertilized treatments developed at about the same pace (Fig. 2). After veraison, however, the rate of berry enlargement in F-10 and F-10/12 slowed down compared to that in F-1, F-3 and F-4. Berry growth in N-F was very poor before and after veraison.

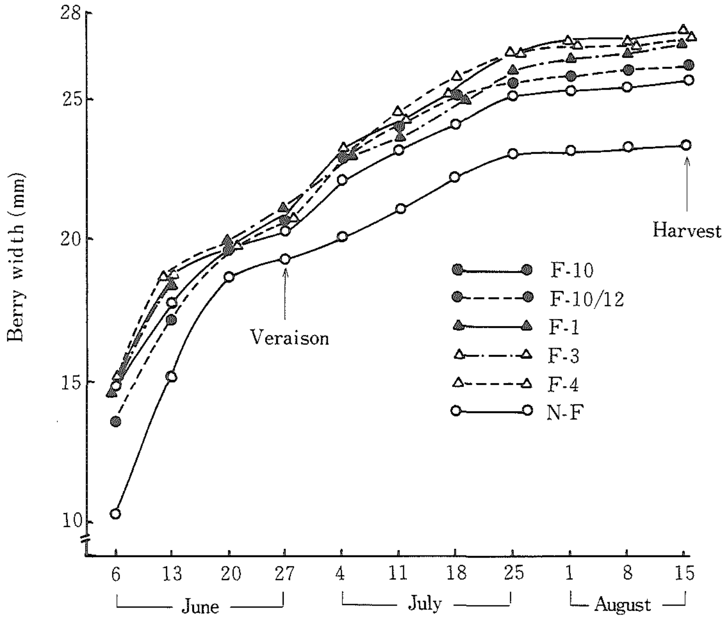

Fig. 2. Increase in berry width after berry thinning.

Table 2. Size and qualities of crops after harvest

Treat-ment	Cluster weight* (g)	Berry weight (g)	No of seeds per berry	Total soluble solids (%)	Titra-table acidity (%)	Skin coloration** Index	O. D.
F-10	270.7	10.1	2.0	15.8	0.30	6.3	0.72
F-10/12	323.0	10.2	2.2	14.4	0.37	2.2	0.17
F-1	326.7	11.9	2.2	14.1	0.32	1.9	0.18
F-3	323.3	11.8	2.4	16.8	0.30	3.9	0.43
F-4	293.3	11.3	2.0	14.7	0.32	5.0	0.61
N-F	213.3	8.8	1.9	14.2	0.42	3.5	0.17

* Number of clusters was restricted to only one per vine at veraison.

** Index by visible score, 1 ; uncolored, 12 ; most darkly colored. O. D. at 540 nm of methanolic extracts from 26 cm^2 of skin with 100 ml of methanol containing 1% HCl.

Size and qualities of the crop determined after harvest are shown in Table 2. Vines of F-1 and F-3 yielded bigger clusters with large berries. Clusters of F-10 and F-10/12 had a little smaller berries, but much bigger than that of N-F. Berries of F-3 contained the most soluble solids and the least acid, while N-F berries contained less soluble solids and the most acid. Skin coloration was better in F-10 and F-4, and poor in F-1 and F-10/12.

Changes in N content of cane and root are given in Fig. 3. After the start of fertilizer application, a gradual increase of N content was observed for both cane and root of F-10 and F-10/12 vines. However, no increase was found in F-1 until March, and N content of only root increased thereafter. On the contrary, N content of root and cane increased sharply in F-3 after the start

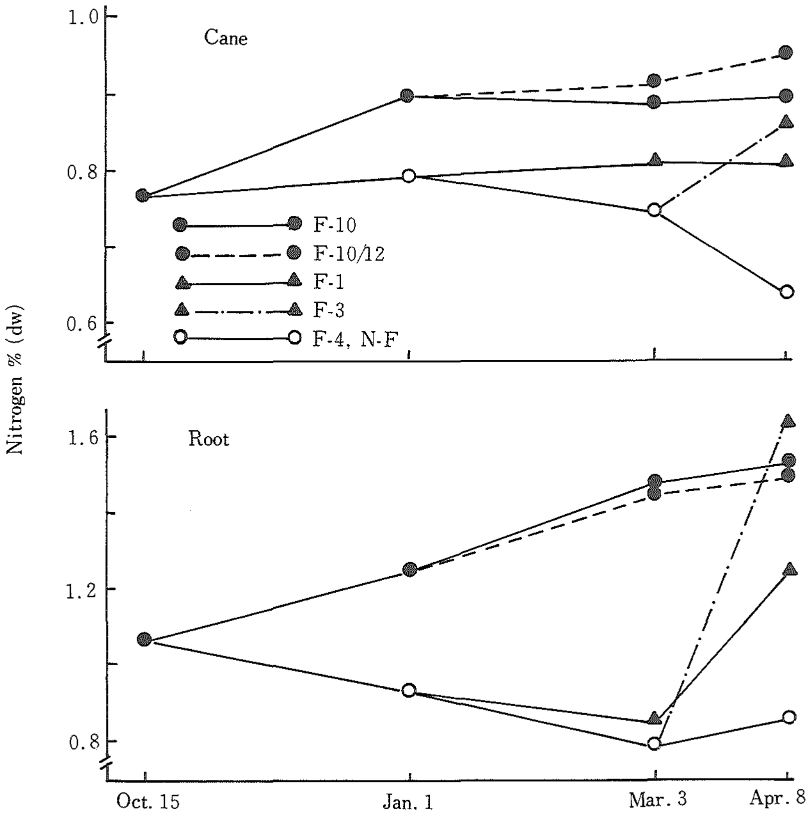

Fig. 3. Changes in N contents of cane and root after the beginning of fertilizing treatments until bud bursting.

Table 3. Mineral contents of cane* and root** at bud bursting

Treat-ment	P	K	Ca	Mg
	(% dw)			
		Cane		
F-10	0.18	1.46	0.25	0.67
F-10/12	0.12	1.46	0.24	0.72
F-1	0.10	1.13	0.22	0.65
F-3	0.18	1.33	0.23	0.65
F-4, N-F	0.13	1.59	0.25	0.69
		Root		
F-10	0.20	1.32	0.13	0.52
F-10/12	0.16	1.63	0.13	0.47
F-1	0.11	0.95	0.12	0.41
F-3	0.08	1.54	0.17	0.36
F-4, N-F	0.08	0.93	0.20	0.34

* At the position of 6th to 10th node from the base.
** Small root less than 3 mm in diameter.

of fertilizing to attain the highest level in root at bud bursting. In vines not applied fertilizer until bud bursting (F-4 and N-F), N content of both cane and root decreased gradually during winter.

P, K, Ca and Mg contents of cane and root at bud bursting are shown in Table 3. No distinguishable differences or consistent tendencies were found among the treatments except that F-10 and F-10/12 vines contained more P in root.

Results of leaf analysis are shown in Table 4. N, P and K contents were highest in F-3 at blooming. F-10 had the highest Ca and Mg, while F-4 had the lowest K and Mg. At veraison, F-3 had the highest N and K, while N-F contained the highest Ca and Mg.

Table 4. Mineral contents of leaf* at blooming and veraison

Treatment	N	P	K (% dw)	Ca	Mg
		Blooming (May 5)			
F-10	3.28	0.18	3.32	0.51	1.23
F-10/12	3.15	0.18	3.03	0.46	1.06
F-1	3.41	0.14	3.09	0.40	1.01
F-3	3.64	0.18	3.43	0.46	1.01
F-4	3.27	0.18	2.68	0.40	0.87
N-F	2.41	0.18	2.65	0.38	0.86
		Veraison (June 28)			
F-10	2.22	0.13	2.46	0.50	1.12
F-10/12	2.23	0.13	2.54	0.53	1.09
F-1	2.47	0.10	2.70	0.54	0.97
F-3	2.49	0.12	2.99	0.59	1.11
F-4	2.49	0.13	2.39	0.65	1.01
N-F	1.85	0.13	2.30	0.83	1.52

* At the position of 4th to 6th node from the base of cane.

Discussion

Vines fertilized from autumn, as represented by the treatment such as F-10 and F-10/12, showed the earlier and more bud bursting and a better development of flower cluster. Higher N content in cane and root during winter seems to be a desirable condition for early shoot growth and cluster development. However, the shorter shoot length of F-10/12 vines indicates that the requirement for fertilizer application in early spring cannot be neglected.

KOBAYASHI and ITO[3] reported that 'Delawere' grapevines fertilized in January contained more abundant total N and amino acids in their root at bud bursting than those fertilized in March and April, and developed more clusters and florets. Results of our chemical analysis indicate the fact that the peak period for nutrient requirement of Kyoho vines is near to bud bursting or at the start of rapid growth in spring. The nutrients supplied in these periods are absorbed readily and moved into the buds to accelerate their growth. HIROYASU[2] demonstrated that the shoot growth of 'Black Qeen' grapevines was not so suppressed when N supply started at bud bursting, though it was much inhibited on vines started after blooming.

Applying fertilizer from January could not raise the N content of root and cane until March. It may be caused not only by low temperature in midwinter but also by some physiological inactivity. The reason why the activity of nutrient absorption of F-1 vines was lower in March than that of F-3 is not clear, but this inactivity might have caused the weak development of shoot and flower and poor berry setting.

Applying fertilizer from March resulted in the best shoot growth towards blooming, larger ovaries and higher percentage of berry set. Apart from poor coloration, F-3 treatment seems to be a more economical fertilizing method.

Fertilizing throughout the experimental season resulted in the earlier ripening and better coloration, but with smaller sized berries. This may be due to the fact that too many big clusters were born on each vine, and the cluster thinning practiced at veraison was too late to restore the active berry enlargement.

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ブドウ‘巨峰’に対する施肥時期に関する研究

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礫耕栽培の3年生巨峰樹に対する液肥の施用開始期を秋から春までの数時期に分けて行い，樹体の生長と果実生産性に及ぼす効果を比較した．また，根，母枝，葉の栄養分析も行った．

秋季に施肥すると，冬の間から根及び母枝中の窒素含量が高まり，発芽が早まるとともに1樹あたりの発芽数も増加し，花房の発達もすぐれた．3月または4月から施肥を始めると，発芽期に根及び母枝中の窒素含量が急増し，開花期までの新梢及び子房の発達がすぐれ，果粒の大きい，良品質の果実が収穫された．