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CONTENTS

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THE INFLUENCE OF PRUNING ON THE GERMINABILITY OF POLLEN AND THE SET OF BERRIES IN VITIS VINIFERA

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In the progress of an investigation at the California Experiment Station of the effect of pruning on capacity, vigor, and bearing of Vinifera grapes,[1,2] it was observed that the type of pruning influenced the germinability of the pollen and the setting of the fruit.

So far as I have been able to find, no account of the influence of pruning on the germination of pollen has been published. This is also true with reference to the set of fruit, unless we except the many reports of larger yields resulting from the less severe or so-called "long" pruning in deciduous fruits. In this case, however, the larger yields which accrue from the development of a larger number of fruits may be the result of a larger bloom without any change in the quality of the flower parts, since the less severe pruning leaves a larger number of fruit buds on the tree.

Though there are no printed records of an increase in the set of fruits as a result of the long pruning of deciduous trees, the beneficial effect of blossom thinning on set has been indicated by Miss Bradbury.[1] She reports that during the one season of her tests, 1924, the set of fruits on sour cherry trees was increased from 24 per cent on the unthinned branches to 42 per cent on the branches on which the blossom buds of the spurs were thinned as early as practicable to one blossom to a bud.

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DEFINITION OF TYPES OF PRUNING USED

Normal Pruning.*—Pruning as nearly as possible in accord with the best accepted commercial practices of pruning each variety.[2] All bunches allowed to develop. (Fig. 1A.)

Severe Pruning.—Pruning similar to that of the normally pruned vines, but more severe, only the base buds being retained on the spurs. All bunches allowed to develop. (Fig. 1B.)

Half-long Pruning, part crop.—Pruning similar to that of the *normally pruned* vines, but less severe, six to ten buds being retained on the spurs. All bunches in excess of the number of bunches on the *normally pruned* vines, at the time of thinning, removed before blooming. (Fig. 1C.)

Cane Pruning, part crop.—Pruning similar to the commercial practice of *cane pruning* as used on Sultanina, except that more wood (four to nine canes, two to three feet long) is retained. All bunches in excess of the number on the *normally pruned* vines, at the time of thinning, removed before blooming. (Fig. 1D.)

No Pruning, part crop.—No pruning. All bunches in excess of the number on the *normally pruned* vines, at the time of thinning, removed before blooming. (Fig. 1E.)

No Pruning, all crop.—No pruning. All bunches allowed to develop. (Fig. 1E.)

THE GERMINATION OF POLLEN

Collection of Pollen.—Flower bunches under the different types of pruning were collected at as nearly the same time as possible on the same days and placed in bags. In the laboratory, the anther sacks were separated from the rest of the bunch and placed in vials. The pollen was tested for germination in no case later than 48 hours after its removal from the vine.

Germination.—In the germination tests, a small quantity of pollen was placed on a hanging drop of a sucrose medium in a Van Tieghem cell. In each test the number of germinated and ungerminated pollen grains in from ten to twenty areas over the surface of the drop was counted. Several hundred grains were counted for each variety under each type of pruning.

* Normal is used here in the sense of "usual."

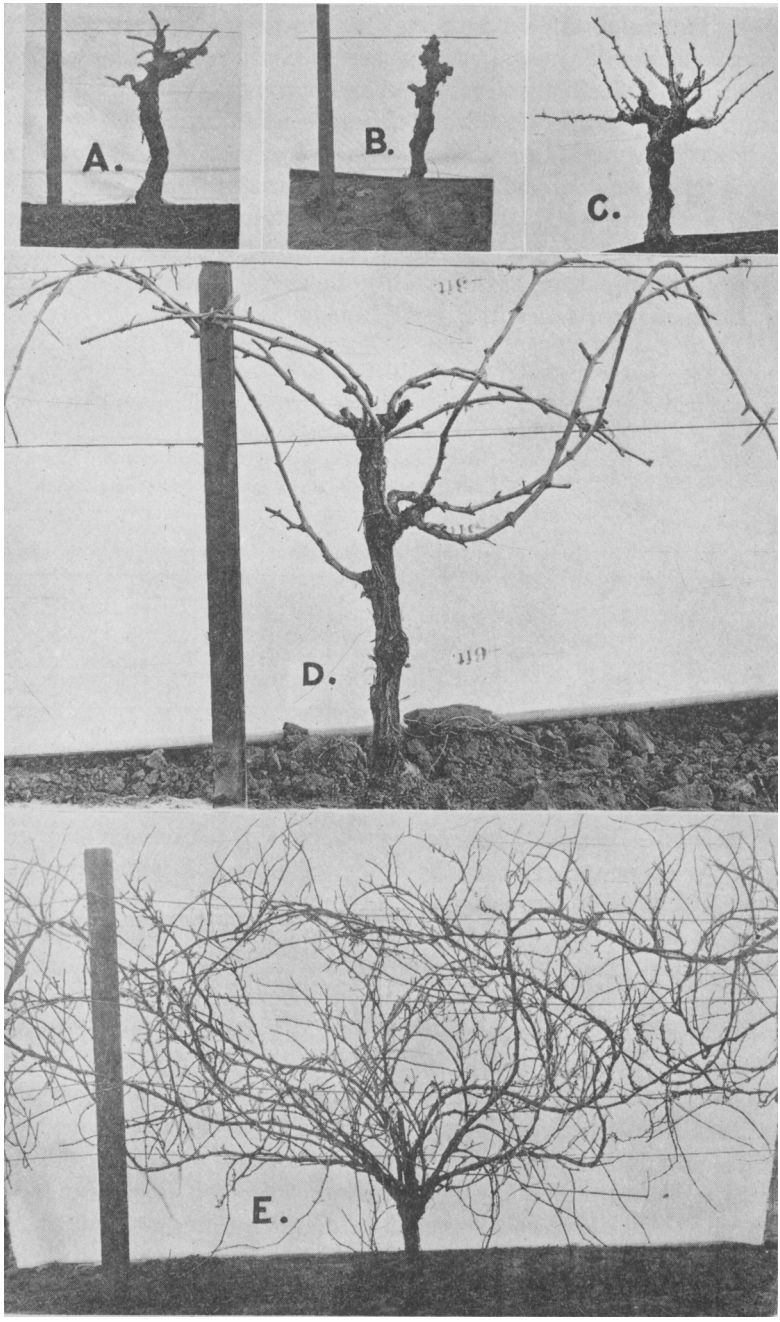

Fig. 1. Muscat of Alexandria vines showing the types of pruning used. A. *Normal (or usual) pruning.* B. *Severe pruning.* C. *Half-long pruning.* D. *Cane pruning.* E. *No pruning.*

The figures of table 1 indicate that grape pollen germinates well over a considerable range of temperature. Its sensitiveness to concentration of media, however, is more marked. Not a single grain germinated in water. In 15 and 20 per cent sucrose the germination was best, differing little in these two concentrations. Beyond these limits there was a rapid falling off in the germination.

In view of the data of table 1, all germination tests were made in both 15 and 20 per cent sucrose at 27°–30° C. In the table showing figures on germination, however, only the average per cent of germination for these two concentrations of media is given.

TABLE 1

THE INFLUENCE OF TEMPERATURE AND CONCENTRATION OF SUCROSE MEDIA ON THE GERMINATION OF GRAPE POLLEN

Temperature	Concentration of Sucrose Media—and per cent of germination						
	0 (Water)	5 per cent	10 per cent	15 per cent	20 per cent	25 per cent	30 per cent
18–21° C.	0	9	17	23	26	13	6
24–26° C.	0	9	17	27	33	17	9
30° C.	0	6	13	21	35	22	16
35° C.	0	4	7	20	27	24	17
Average	0	7	13.2	22.7	30.2	19	12

The samples of pollen of the Muscat of Alexandria, Black Monukka, and Alicante Bouschet were collected from the twelve vines under each type of pruning. For the other varieties the pollen was taken from five vines under each type of pruning. The pollen from all the vines of a variety under the same types of pruning was massed together, and after thorough mixing, was used as a single sample in the germination tests. The percentage of germination of the pollen of the several varieties under the different types of pruning is shown in table 2.

The data in table 2 indicate that the influence of pruning on the germinability of pollen is very marked. If we take the percentage of the germination of the pollen from the *normally pruned* vines as a standard, the germinability of the pollen of the *half-long pruned, part crop* vines was increased from 38 to 277 per cent; that of the *cane pruned, part crop* vines from 44 to 606 per cent; that of the *non-pruned, part crop* vines from 219 to 606 per cent; and that of the *non-pruned, all crop* vines from 117 to 576 per cent, when all of the varieties are treated as a whole.

The greatest increase was in Muscat of Alexandria and Alicante Bouschet, where the percentage of germination of the pollen from the *normally pruned* vines was very low. For the Muscat of Alexandria, for which the data for three years of the *non-pruned* vines are available, the average increase in germinability of pollen has been 277 per cent for the *half-long pruned, part crop;* 342 per cent for the *cane pruned, part crop;* 414 per cent for the *non-pruned, part crop;* and 296 per cent for the *non-pruned, all crop* vines.

TABLE 2

THE INFLUENCE OF PRUNING ON THE GERMINABILITY OF POLLEN

Variety	Year	Types of pruning—with per cent of germination					
		Severe	Normal	Half-long, part crop	Cane pruned, part crop	Non-pruned, part crop	Non-pruned, all crop
Muscat of Alexandria	1924	5.4	6.9	26	.....	26	15
Muscat of Alexandria	1925	7.8	8.0	.....	41	54	42
Muscat of Alexandria	1926	11.0	10.7	.....	41	52	45
Black Monukka	1925	17.3	17.6	46	.....	58	48
Black Monukka	1926	17.0	16.0	37	.....	51	40
Alicante Bouschet	1926	6.7	6.8	.....	48	48	56
Muscat gigas	1925	7.4	8.7	11	17	.....	.....
Muscat gigas	1926	5.0	12.0	17	19	.....	.....
Dizmar	1925	15.0	18.0	27	31	.....	.....
Dizmar	1926	15.0	15.0	.....	32	.....	.....
Molinera	1926	9	16	28	43	.....	.....
Henab	1925	33	37	58	57	.....	.....
Henab	1926	21	25	49	67	.....	.....
Malaga	1925	31	28	54	56	.....	.....
Malaga	1926	28	30	41	53	.....	.....
Emperor	1925	23	25	42	40	.....	.....
Emperor	1926	25	25	.....	36	.....	.....

In the case of such varieties as Malaga, Henab, and Emperor, where the pollen of the *normally pruned* vines gives a relatively high percentage of germination, the increase in germinability as a result of less severe pruning was not so great. It was, however, sufficient to be significant. The average increase in germinability of the Malaga pollen—which is typical of these varieties—was 65 per cent for the *half-long pruned, part crop* and 105 per cent for the *cane pruned, part crop* vines.

As might be expected, since the difference in the severity of pruning is relatively small, there has been no great difference between the germinability of the pollen of the *severely* and *normally pruned* vines.

The *severe pruning,* however, in twelve instances out of seventeen, decreased the germinability of pollen. This decrease varied from zero to 58 per cent. In two instances the percentage of germination was the same, and in three instances there was a very slight increase (2.5, 5.8 and 10.7 per cent).

THE SET OF BERRIES

It is the observation of growers wherever the Muscat of Alexandria and Hunisa are grown that these varieties are very subject to *Coulure* (shelling) and *millerandage*—the production of small seedless (shot) berries. The Muscat gigas is similarly defective with regard to *coulure.* These defects in the Muscat of Alexandria presented one of the first problems of the California grape growers to receive the attention of the Experiment Station. Efforts to overcome these varietal defects in California as well as in the other countries where these varieties are grown have been almost fruitless. In the other varieties listed in tables 3 and 4, these defects are rarely sufficiently serious to be of commercial importance. It is questionable, however, if there is a single variety of grape that under certain conditions of soil and climate is not subject to the setting of seedless berries or to shelling, and with many these defects are common.

In following up the influence of the different types of pruning on the set of berries, counts of the number of normal berries to a bunch were made. All of the berries on all of the bunches of six vines of Muscat of Alexandria, of four vines of Muscat gigas and of Molinera and of two vines each of Hunisa, Henab, Malaga, Emperor, and Ohanez under each type of pruning were counted. The numbers of normal berries to a bunch under the different types of pruning are given in table 3.

If the number of normal berries to a bunch on the *normally pruned* vines is taken as a standard, the data indicate an increase in Muscat of Alexandria of 221 and 312 per cent, respectively, for the years 1924 and 1925 in the number of normal berries to a bunch on the *non-pruned, part crop* vines. This increase in the case of the *non-pruned, all crop* vines was 57 and 68 per cent, respectively. In case of the *half-long pruned, part crop* and the *cane pruned, part crop* vines, the increase during 1925 was 114 and 238 per cent, respectively (fig. 2A and B).

In Hunisa, which of all the varieties of Vinifera grapes is one of the most prone to produce small seedless berries, the increase in the

number of normal berries was greatest. Here the increase was 407 per cent for the *half-long pruned, part crop* and 728 per cent for the *cane pruned, part crop* vines. In this variety the number of normal berries to a bunch was reduced almost to zero by *severe pruning.*

TABLE 3

THE INFLUENCE OF PRUNING ON THE NUMBER OF NORMAL BERRIES TO A BUNCH

Variety	Year	Types of pruning—and the number of normal berries to a bunch					
		Severe	Normal	Half-long, part crop	Cane pruned, part crop	Non-pruned, part crop	Non-pruned, all crop
Muscat of Alexandria	1924	32±1.6	37±1.1	77±1.9	.....	119±2.1	58±1.9
Muscat of Alexandria	1925	42±1.8	34±1.4	.....	115±3.6	140±2.4	57±2.9
Hunisa	1925	2±.31	14±1.8	71±5.0	102±9.1	.....	.....
Muscat gigas	1925	18±1.5	20±1.8	64±3.8	84±4.0	.....	.....
Molinera	1925	56±3.2	62±3.5	132±3.4	121±4.0	.....	.....
Henab	1925	80±4.2	80±5.0	109±7.1	123±6.1	.....	.....
Malaga	1925	103±13.2	132±14.0	183±7.0	166±11.0	.....	.....
Emperor	1925	100±7.3	138±6.8	164±8.7	165±8.9	.....	.....
Ohanez	1925	44±4.1	74±6.7	113±6.1	159±7.6	.....	.....

In Muscat gigas the increase in the number of normal berries to a bunch was 220 per cent for the *half-long pruned, part crop* and 320 per cent for the *cane pruned, part crop* vines. There was no significant difference in the number of normal berries to a bunch on *severely* and *normally pruned* vines.

In the other varieties—Molinera, Henab, Malaga, Emperor, and Ohanez—which are generally little affected by *coulure* and which usually set a very high percentage of normal berries, the number of normal berries to a bunch has not been so much influenced by the type of pruning. The increase as a result of the less severe pruning has, nevertheless, been considerable. The increase in the number of normal berries to a bunch has ranged from 19 to 112 per cent for the *half-long pruned, part crop* and from 20 to 115 per cent for the *cane pruned, part crop* vines. In these varieties the decrease in the number of normal berries to a bunch on the *severely pruned* vines also was small. The decrease ranged from zero in Henab to 40 per cent in Ohanez.

Of only slightly less importance than the number is the percentage of normal berries to a bunch. An increase in the number of normal berries to a bunch would not improve the quality of a grape or increase

its salability if it were accompanied by a corresponding increase of small seedless (shot) berries. That is, a large bunch of equally poor quality is little or no more desirable than a small bunch.

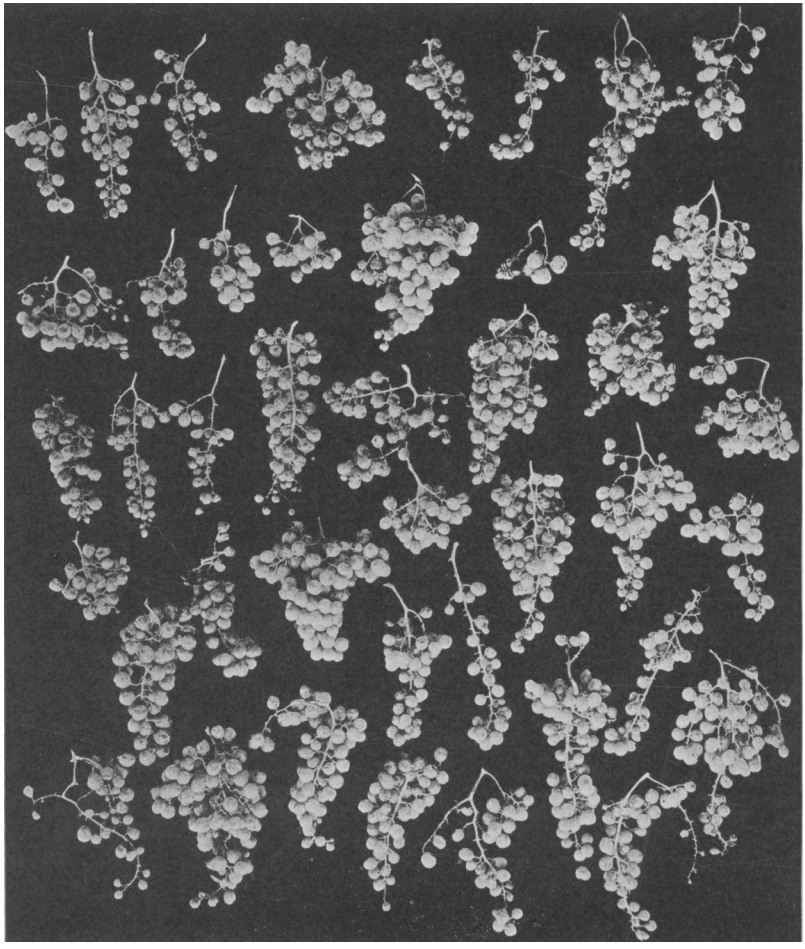

Fig. 2A. The influence of the type of pruning on the number of normal berries set to a bunch on Muscat of Alexandria. *Normal pruning* (34 normal berries to a bunch). (Entire crop from one average vine.)

At the time of the count of normal berries the total number of berries on each bunch was determined. The average percentage of normal berries to a bunch was then calculated from these counts. The percentage of normal berries to a bunch under the different types of pruning are given in table 4.

Again, if we take the percentage of normal berries to a bunch on the *normally pruned* vines as a standard, the average increase of normal berries to a bunch in Muscat of Alexandria has been 25 per cent for the *non-pruned, all crop;* 40 per cent for the *non-pruned,*

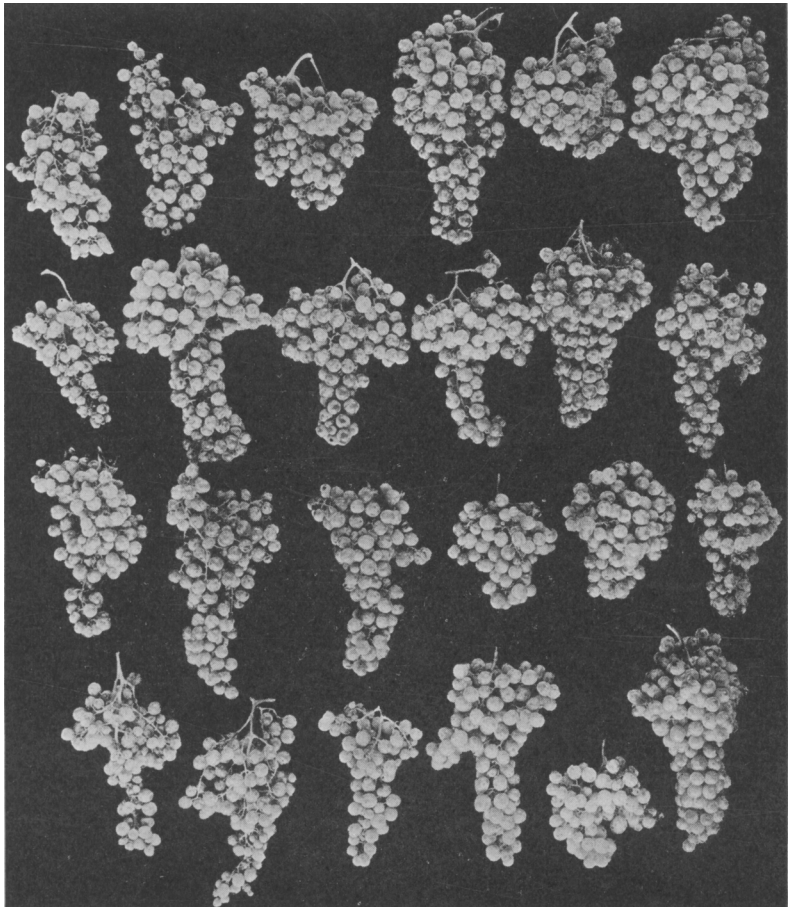

Fig. 2B. The influence of the type of pruning on the number of normal berries set to a bunch on Muscat of Alexandria. *Cane pruning, part crop* (115 normal berries to a bunch). (Entire crop from one average vine.)

part crop; and 36 per cent for the *half-long* and *cane pruned, part crop* vines. For Hunisa the increase has been very marked, being 230 per cent for *half-long pruned, part crop* and 590 per cent for the *cane pruned, part crop vines.* (Fig. 3A and B.)

The *severe pruning* in the case of these varieties also reduced the percentage of normal berries considerably. With the Muscat of Alexandria, the reduction was 18 per cent and with Hunisa, 75 per cent.

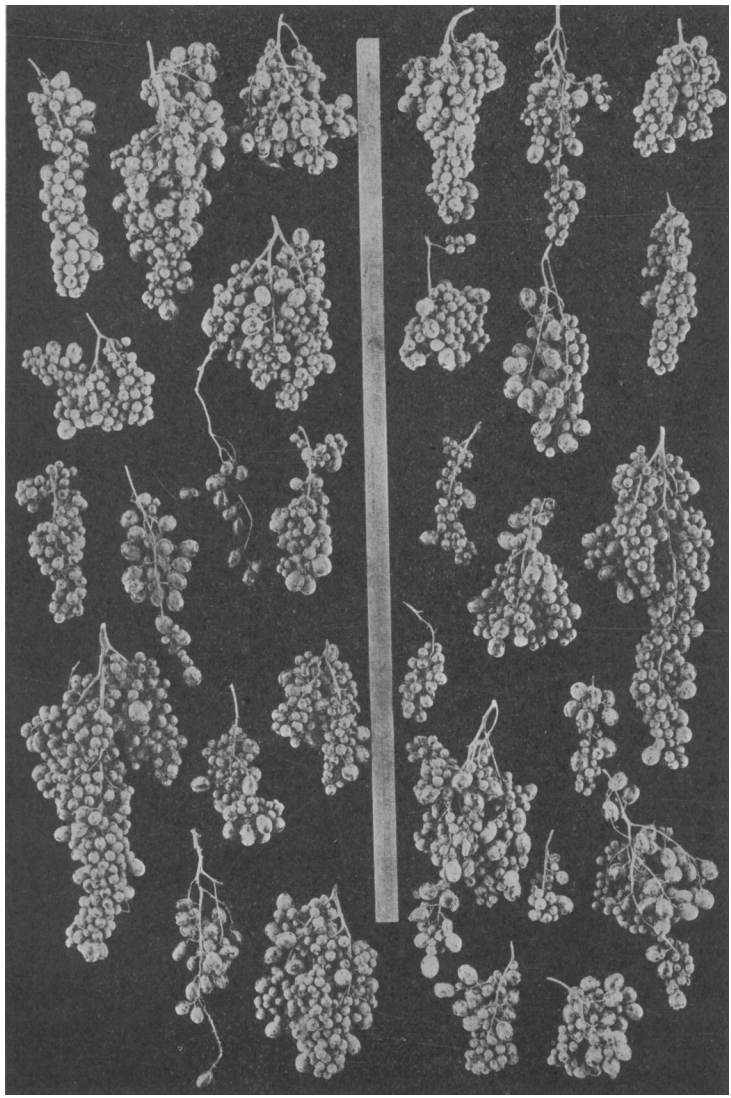

Fig. 3A. The influence of the type of pruning on the set of normal berries on Hunisa. *Normal pruning* (10 per cent of berries normal). (Entire crop from one average vine.)

In the other varieties which set very few small seedless (shot) berries, the increase in the percentage of normal berries has been relatively small. It has ranged from 3.4 to 17 per cent for the *half-*

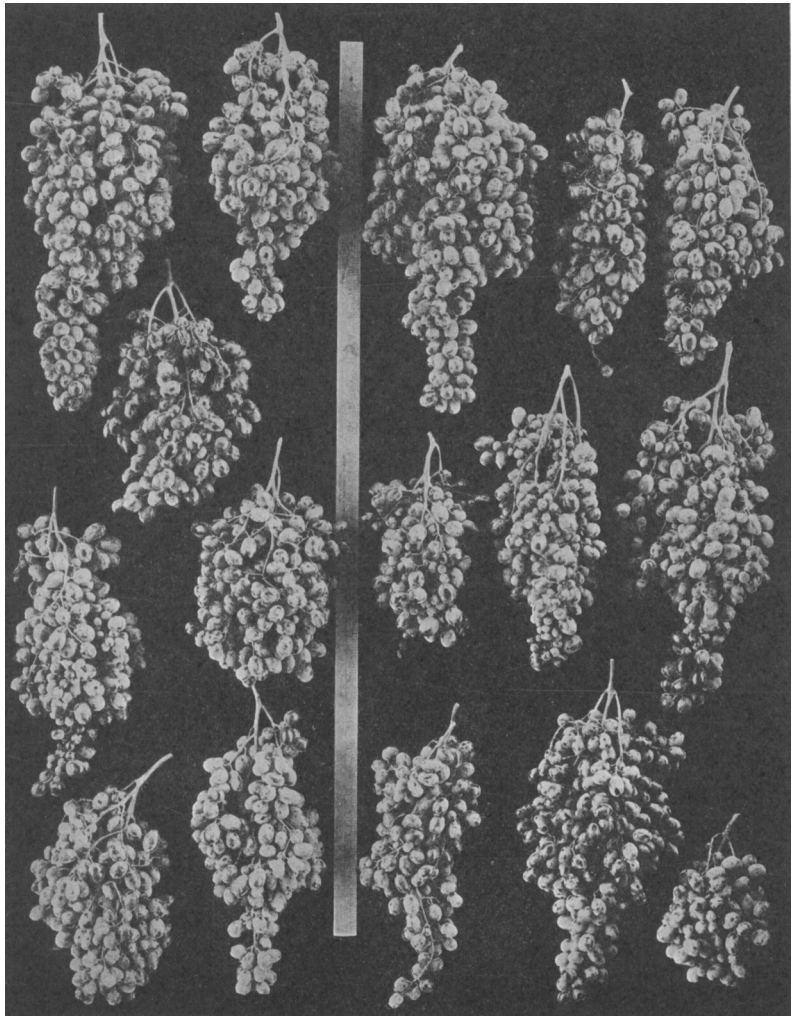

Fig. 3B. The influence of the type of pruning on the set of normal berries on Hunisa. *Cane pruning, part crop* (82 per cent of berries normal). (Entire crop from one average vine.)

long and *cane pruned, part crop* vines. In these varieties the more *severe pruning* also had little influence on the percentages of normal berries.

TABLE 4

THE INFLUENCE OF PRUNING ON THE PERCENTAGE OF NORMAL BERRIES TO A BUNCH

Variety	Year	Types of pruning—and percentage of normal berries to a bunch					
		Severe	Normal	Half-long, part crop	Cane, part crop	Non-pruned, part crop	Non-pruned, all crop
Muscat of Alexandria	1924	47	68	93	.....	95	78
Muscat of Alexandria	1925	65	69	.....	94	96	93
Hunisa	1925	2.5	10	33	59	.....	.....
Muscat gigas	1925	81	83	97	95	.....	.....
Henab	1925	96	93	97	97	.....	.....
Molinera	1925	77	85	91	92	.....	.....
Malaga	1925	86	86	89	92	.....	.....
Emperor	1925	83	85	91	93	.....	.....
Ohanez	1925	75	88	91	91	.....	.....

DISCUSSION

The great differences in the germinability of pollen and in the set and in the percentage of normal berries as a result of the less severe pruning indicates that the quality of one or both of the flower parts is improved. For the male part of the flower, the improvement is rather conclusively shown by the increase in the percentage of germination of the pollen. The increase in the number and the percentage of normal berries to a bunch indicates that the female part of the flower also is improved. In the Muscat of Alexandria, Muscat gigas, and Molinera, where the pollen germination on the normally pruned vines was 8, 7, and 16 per cent, respectively, an influence on the female part of the flower may be questioned, since the poor quality of pollen alone may have been sufficient to limit the set of normal berries very considerably. The increase in the set of normal berries under the less severe pruning might then, for these varieties, be entirely a result of the great increase in the germinability of pollen. This could hardly be the case, however, in such varieties as Henab, Malaga, and Emperor where the pollen from the *normally pruned* vines gave a germination of 25 per cent or more.

The improvement in the female part of the flowers is further indicated by the results of pollination tests on the *normally pruned* Muscat of Alexandria vines. In these tests twenty bunches on the *normally pruned* vines were dusted each day with pollen of the

non-pruned, part crop vines until all of the calyptera were off. The influence of the pollen of greater germinability on the set of normal berries on the pollinated as compared to the non-pollinated bunches on the *normally pruned* vines and to the non-pollinated bunches on the *cane* and *nonpruned, part crop* vines is shown in table 5.

TABLE 5

THE INFLUENCE OF POLLINATION WITH POLLEN OF THE NON-PRUNED, PART CROP VINES ON THE SET OF NORMAL BERRIES UNDER NORMAL PRUNING AS COMPARED TO THE SET OF NORMAL BERRIES ON THE CANE AND NON-PRUNED PART CROP VINES

Normal berries	Types of pruning and the pollination treatments			
	Normally pruned		Cane pruned, part crop, not pollinated	Non-pruned, part crop, not pollinated
	Not pollinated	Pollinated		
Number to a bunch	34±1.4	68±6.1	115±3.5	140±2.4
Per cent of total berries	69	76	94	96
Increase in number as a result of—				
1. Pollination		100		
2. Less severe pruning			238	312
Increase in percentage as a result of—				
1. Pollination		10		
2. Less severe pruning			36	39

These data show an increase in both the number and percentage of normal berries to a bunch on the pollinated when compared to the non-pollinated bunches on the *normally pruned* vines. This increase as a result of pollination, however, has not been so great as that following less severe pruning.

The question now arises—How do less severe pruning and non-pruning improve the germination of the pollen and the set of berries? Or, on the other hand—Why do *normal* and *severe* pruning tend to reduce the germination of pollen and the set of normal berries? The answer to these questions is, no doubt, bound up with the nutrition of the flower buds from the time of their differentiation until or even after blooming. Hilgard[6] believed that the failure of Muscat of Alexandria to set normal berries was due to a lack of proper soil fertility. The fertilizers which he recommended for the amelioration of the trouble, however, were ineffective. Müller-Thurgau[8] (1883) and Merjanian[7] (1919) state that the poor nourishment of the flowers

is the chief cause of *coulure* and of the setting of shot berries. Müller observed that in cold cloudy weather, which favors the tendency to *coulure,* the elaboration in the leaves and the transport of organic substances to the flowers was limited. This limiting of the food supply to the flowers was especially noticeable when there were a considerable number of rapidly growing shoots on the vine. Both of these workers succeeded in moderating the tendency to *coulure* and *Millerandage* by pinching and ringing. Pinching, according to Bioletti,[3] however, is weakening to such an extent that after one or two years of its practice, production falls off. Sartorius[9] states that the stage of development of the embryonic flowers in the fruit bud at the time growth begins in spring greatly influences their bloom, set, and later development. He[10] has shown also that the poor development of pollen in cold weather may play a considerable role in the dropping of flowers. In deciduous trees it has been stated by Dorsey[4] that the vigorous spurs set in greater number than weak ones, probably because of their larger supply of stored food and because of their greater ability to compete for water and other food substances.

The data of table 6 and figure 4 seem to indicate that the number of leaves on a vine, especially during the early part of the season, as influenced by pruning, may be responsible for the difference in the germinability of its pollen and the set of its berries. For the five varieties these figures show an average increase in the number of leaves to a vine over that for the *normally pruned* vines of 75 per cent for the *half-long pruned, part crop,* and 139 per cent for the *cane pruned, part crop* vines. Then, too, as illustrated by the graphs of figure 4, the *non-pruned* vines had produced more leaves at the time of the first count, on May 15th, two weeks before blossoming, than the *normally* or *severely pruned* vines produced during the entire growing season. The rate of increase in the number of leaves for the remainder of the season was also greater for the *non-pruned* than for the *Normally* or *severely pruned* vines. The graphs of figure 4 show also that the slight decrease in the weight of the individual leaves produced by the *non-pruned* vines was of little importance compared to the great increase in the number of leaves.

The influence of the number of leaves at or near the time of blooming on the germination of pollen and the set of normal berries is further indicated by the ratios shown in table 7.

In view of the data it appears probable that the increase in the number of leaves as a result of less severe or no pruning has resulted in a better nutrition of the flower buds. This better nourishment has

TABLE 6

THE NUMBER OF LEAVES TO A VINE AT OR NEAR THE TIME OF BLOOM UNDER THE DIFFERENT TYPES OF PRUNING

Variety	Beginning of bloom	Full bloom	Time of leaf counts	Types of pruning—and number of leaves			
				Severe	Normal	Half-long, part crop	Cane, part crop
Muscat of Alexandria	May 17	May 25–28	May 5	34	89	.....	470
			June 24	545	773	.....	1724
Muscat gigas	May 13	May 19–23	May 5	101	147	277	489
			June 23	315	436	703	971
Hunisa	May 18	May 25–28	May 7	147	179	517	651
			June 20	891	1134	1437	1897
Ohanez	May 12	May 20–24	May 14	467	476	864	1057
Dizmar	May 13	May 21–25	May 15	258	353	756	1125

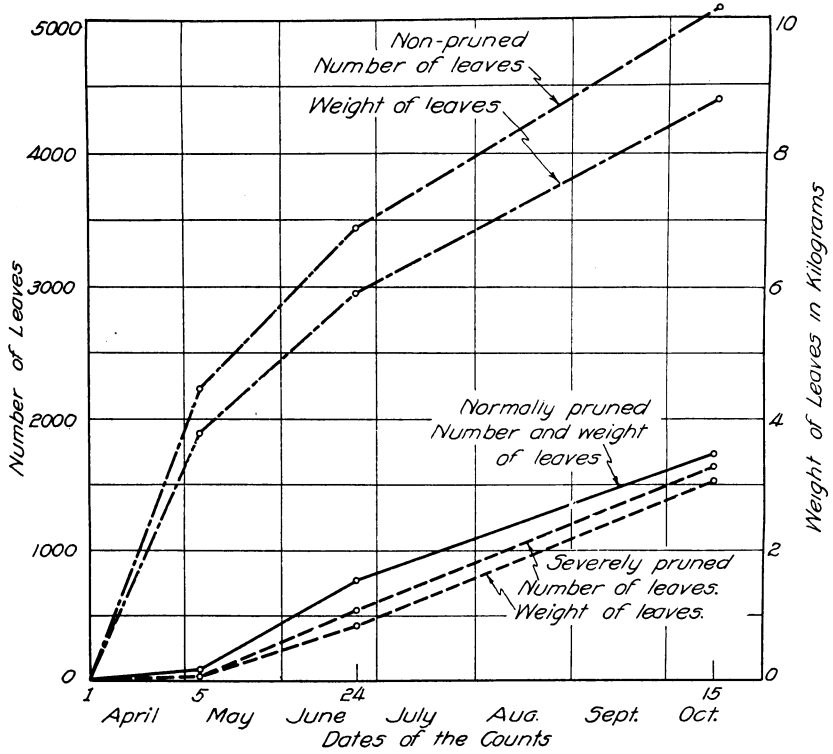

Fig. 4. The number and weight of leaves on a vine at several dates during the season under *severe, normal,* and *no pruning.*

given rise to stronger flower parts which, in turn, has resulted in the production of pollen of greater germinability and an increase in the set of normal berries. This relation of the number of leaves to the improvement in set of berries is further substantiated by the fact that the second crop, the bloom for which develops in mid-season when the vine is in full leaf, usually sets normal berries, however prone the variety may be to set shot berries in the primary crop.

TABLE 7

THE RATIOS OF INCREASE IN THE NUMBER OF LEAVES TO THE INCREASE IN THE GERMINATION OF POLLEN AND TO THE INCREASE IN THE SET OF NORMAL BERRIES FOR THE NORMAL, HALF-LONG, AND CANE PRUNED OVER THE SEVERELY PRUNED VINES

Ratios	Normally pruned	Half long-pruned, part crop	Cane pruned, part crop
Leaves/berries	6.5	6.7	7.2
Leaves/germination of pollen	42.8	44.7	42.6

The results of other investigators indicate also that the number of leaves at or near the time of blooming influences the set of fruits. Müller-Thurgau[8] and Sartorius[10] were able to induce *coulure* by the removal of the large leaves. Then, too, if they pinched the tip of the shoot, thus stopping elongation and reducing the keenness of the competition of the flowers for food substances, the tendency to *coulure* was moderated. Sorauer[11] states that "if the wood is thinned too much, i.e., too many leaf branches are cut away in order to furnish light for the blossoms and young fruit, the buds, blossoms and young fruit may be dropped." In work with apples Haller and Magness[5] have found that the number of fruits dropping decreased with an increase in the leaf area per fruit until a certain leaf area was attained.

SUMMARY

Less severe pruning increases germinability of pollen:

When the pollen of the *normally pruned* vines is taken as a standard, the germinability of the pollen of the *half-long pruned, part crop* vines was increased from 38 to 277 per cent, that of the *cane pruned, part crop* vines, from 44 to 606 per cent; that of the *non-pruned, part crop vines,* 219 to 606 per cent; and that of the *non-pruned, all crop* vines, 117 to 576 per cent.

Severe pruning resulted in decreased germinability of the pollen in most of the tests.

Less severe pruning increases set of normal berries:

In Muscat of Alexandria, Muscat gigas, and Hunisa which are very subject to *coulure,* the increase in the set of normal berries to a bunch over that of the *normally pruned* vines was 114, 220, and 407 per cent for the *half-long pruned, part crop* and 238, 320, and 728 for the *cane pruned, part crop* vines, respectively. The increase in Muscat of Alexandria for the *non-pruned, part crop* vines was 266 per cent and for the *non-pruned, all crop* vines was 62 per cent.

In the other varieties—Molinera, Henab, Emperor, Malaga and Ohanez—which are little affected by *coulure,* the increase in the set of normal berries to a bunch ranged from 19 to 112 per cent for the *half-long pruned, part crop* and from 20 to 115 per cent for the *cane pruned, part crop* vines.

The set of normal berries on the *severely pruned* has been less than that on the *normally pruned* vines in six of the eight varieties tested.

Less severe pruning increases percentage of normal berries to a bunch:

In Muscat of Alexandria and Hunisa varieties, which are very subject to *millerandage,* the percentage of normal berries to a bunch was increased 36 and 230 per cent, respectively, on the *half-long pruned, part crop* vines, and 36 and 590 per cent, respectively, on the *cane pruned, part crop* vines. Similar increases were obtained under the types of no pruning with the Muscat of Alexandria.

In the other varieties, which usually set very few small seedless berries, the increase in the percentage of normal berries to a bunch ranged from 3.4 to 17 per cent for the *half-long* and *cane pruned, part crop* vines over that of the *normally pruned* vines.

Severe pruning has reduced the percentage of normal berries below that of the *normally pruned* vines in six of the eight varieties tested.

Flower parts are probably improved under less severe types of pruning:

The increased germinability of pollen, the set of normal berries, and the percentage of normal berries to a bunch, together with the pollination tests, indicate that both the male and female parts of the flowers are improved by the less severe pruning.

The improvement in the flower parts appears to follow as a result of an earlier development of the foliage and an increase in its area with less severe pruning.

LITERATURE CITED

[1] BRADBURY, D.
1925. Notes on the dropping of immature sour cherry fruits. Proc. Amer. Soc. Hort. Sci. **22**: 105–110.

[2] BIOLETTI, F. T. AND H. E. JACOB
1924. Head, cane and cordon pruning of vines. California Agr. Exp. Sta. Cir. **277**: 1–32.

[3] BIOLETTI, F. T. AND F. C. H. FLOSSFEDER
1918. Topping and pinching vines. California Agr. Exp. Sta. Bul. **296**: 371–384.

[4] DORSEY, M. J., AND H. E. KNOWLTON
1925. The relation of growth to fruitfulness in some varieties of apple. Proc. Amer. Soc. Hort. Sci. **22**: 161–172.

[5] HALLER, J. H., AND J. R. MAGNESS
1925. The relation of leaf area to the growth and composition of apples. Proc. Amer. Soc. Hort. Sci. **22**: 189–196.

[6] HILGARD, E. W.
1884. The Muscat on the southern mesas. California Agr. Exp. Sta. Bul. **17**: 1.

[7] MERJANIAN, A. S.
1919. De la coulure et du millerandage (Russian with French summary). Bul. Sta. Oenolog., Odessa, **1**: 1–55.

[8] MÜLLER–THURGAU, H.
1883. Über das abfallen der Rebenblüten und die entstehung kernloser Traubenbeeren. Der Weinbau no. 22.

[9] SARTORIUS, OTTO
1926. Zur Entwicklung und Physiologie der Rebblüte. Angew. Botanik **8**: 29–62.

[10] SARTORIUS, OTTO
1926. Zur Entwicklung und Physiologie der Rebblüte. Angew. Botanik **8**: 65–89.

[11] SCRAUER, PAUL
1924. Handbuch der Pflanzenkrankheiten. 5th Ed. **1**: 396–398.

[12] WINKLER, A. J.
1926. Some responses of Vitis vinifera to pruning. Hilgardia **1**: 526–543.

The titles of the Technical Papers of the California Agricultural Experiment Station, Nos. 1 to 20, which HILGARDIA replaces, and copies of which may be had on application to the Publication Secretary, Agricultural Experiment Station, Berkeley, are as follows:

1. The Removal of Sodium Carbonate from Soils, by Walter P. Kelley and Edward E. Thomas. January, 1923.
3. The Formation of Sodium Carbonate in Soils, by Arthur B. Cummins and Walter P. Kelley. March, 1923.
4. Effect of Sodium Chlorid and Calcium Chlorid upon the Growth and Composition of Young Orange Trees, by H. S. Reed and A. R. C. Haas. April, 1923.
5. Citrus Blast and Black Pit, by H. S. Fawcett, W. T. Horne, and A. F. Camp. May, 1923.
6. A Study of Deciduous Fruit Tree Rootstocks with Special Reference to Their Identification, by Myer J. Heppner. June, 1923.
7. A Study of the Darkening of Apple Tissue, by E. L. Overholser and W. V. Cruess. June, 1923.
8. Effect of Salts on the Intake of Inorganic Elements and on the Buffer System of the Plant, by D. R. Hoagland and J. C. Martin. July, 1923.
9. Experiments on the Reclamation of Alkali Soils by Leaching with Water and Gypsum, by P. L. Hibbard. August, 1923.
10. The Seasonal Variation of the Soil Moisture in a Walnut Grove in Relation to Hygroscopic Coefficient, by L. D. Batchelor and H. S. Reed. September, 1923.
11. Studies on the Effects of Sodium, Potassium, and Calcium on Young Orange Trees, by H. S. Reed and A. R. C. Haas. October, 1923.
12. The Effect of the Plant on the Reaction of the Culture Solution, by D. R. Hoagland. November, 1923.
13. Some Mutual Effects on Soil and Plant Induced by Added Solutes, by John S. Burd and J. C. Martin. December, 1923.
14. The Respiration of Potato Tubers in Relation to the Occurrence of Blackheart, by J. P. Bennett and E. T. Bartholomew. January, 1924.
15. Replaceable Bases in Soils, by Walter P. Kelley and S. Melvin Brown. February, 1924.
16. The Moisture Equivalent as Influenced by the Amount of Soil Used in its Determination, by F. J. Veihmeyer, O. W. Israelson and J. P. Conrad. September, 1924.
17. Nutrient and Toxic Effects of Certain Ions on Citrus and Walnut Trees with Especial Reference to the Concentration and Ph of the Medium, by H. S. Reed and A. R. C. Haas. October, 1924.
18. Factors Influencing the Rate of Germination of Seed of Asparagus officinalis, by H. A. Borthwick. March, 1925.
19. The Relation of the Subcutaneous Administration of Living Bacterium abortum to the Immunity and Carrier Problem of Bovine Infectious Abortion, by George H. Hart and Jacob Traum. April, 1925.
20. A Study of the Conductive Tissues in Shoots of the Bartlett Pear and the Relationship of Food Movement to Dominance of the Apical Buds, by Frank E. Gardner. April, 1925.