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Studies on pruning of grape

III. Fruit bud formation in Pusa Seedless grapes (Vitis vinifera L.) under Delhi conditions

by

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Pusa Seedless, a clone similar to Sultana of Australia, Thompson Seedless and white Kishmish of Baluchistan, has been recommended for northern India from the Institute, as it ripens by the middle of June before the onset of monsoon. The training and pruning requirements of the variety have been under study at this Institute (Ghugare 1965, 1968, 1968 a). It was considered necessary to study fruit bud differentiation of this variety along with pruning experiments, as this information has been found useful in other countries (Bioletti 1907; Barnard 1932; Barnard and Thomas 1933; Snyder 1933; Colby and Tucker 1933; Winkler and Shemsettin 1937; Antcliff and Webster, 1955 and May and Antcliff 1964). For south Indian conditions, investigations have been conducted on Anab-e-Shahi variety by Rajaram (1964), Daniel (1965), Nanaya (1966) and Madhava Rao *et al.* (1966). Hence work on fruit bud differentiation and the influence of pruning and certain fertilizer treatments on this process in Pusa Seedless variety was undertaken, the results of which are reported in this paper.

Materials and Methods

The experiments reported were conducted in New Delhi between 1965 and 1967 with six year old vines of Pusa Seedless, trained on 6-arm trellises and planted 2.7 m × 3.0 m. Besides removal of dead and old wood, past season's canes were pruned back to 3, 6, 9 and 12 buds. In another set of vines, no pruning was done except removal of dead wood. The following observations were recorded.

1. Time of fruit bud initiation

Axillary buds were collected from new shoots at monthly intervals from March to June 1966 and subsequently at bimonthly intervals from the second to thirteenth nodes. The materials were fixed in Carnoy's fluid for two hours and subsequently stored in formalin-acetic alcohol. Longitudinal sections, 10 to 12 μ thick, were stained in Delafield's haematoxylin, after paraffin embedding.

To study the ontogeny of floral parts, young inflorescences were collected at four stages of development in March 1966, i. e., on the date of appearance of the inflorescence and subsequently at three days' interval, and stained with Delafield's haematoxylin and safranin.

2. Effect of pruning severity on fruit bud initiation

The effect of the 3-bud and 9-bud pruning treatments and no-pruning on the time of fruit bud initiation was observed. The difference among the basal, middle and apical buds in fruit bud initiation was also studied.

3. Forecasting fruiting potential

Ten buds from each of the nodes from 2—3 in the 3-bud treatment and from 2 to 6, 2 to 9 and 2 to 12 in the 6, 9 and 12-bud treatments respectively were selected

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at random and dissected under a binocular microscope (×30) in October 1968. The number of buds containing well developed cluster primordia was noted. The data were compared with the actual yield in 1967.

4. Difference between bearing and non-bearing shoots

To study whether the shoots which had borne fruit in the current season were capable of forming fruit buds for the subsequent season, shoots were tagged in March 1967 and the axillary buds were collected in October 1967 from the second and third nodes in the three-bud treatment and from the sixth and seventh nodes in the 9-bud treatment and from the unpruned vines at the rate of ten buds each per node. A similar set of buds was collected from shoots which had not borne any crop in the same vine. They were dissected on the following day. The number of buds with and without cluster primordia were noted.

5. Effect of fertilizers on fruit bud initiation

The effect of fertilizers on fruit bud initiation was studied. A basal dose, applied in February, consisted of 228 g N (= N_0), 114 g P_2O_5 (= P_0), and 0 g K_2O (= K_0) per plant. An additional amount of 114 g N, 114 g P_2O_5, and 228 g K_2O per plant was given in April, therefore, the fertilizers levels of N_1, P_1, and K_1 were 342 g N, 228 g P_2O_5, and 228 g K_2O per plant, respectively. Samples of axillary buds were collected 20 days after application of the additional dose, from the 9-bud pruning treatment only, at the rate of five each at the third, sixth and ninth nodes of the current season's shoots and microtome sections examined.

6. Effect of fertilizers on fruit bud formation

The overall effect of the fertilizers on the total number of fruit buds formed was also studied after full development of the primordia at the rate of five buds each at the sixth and seventh nodes of the nine-bud treatment, after fixing in formalin-acetic alcohol in October 1967 and dissecting them under a binocular microscope (×30).

Results

Time of fruit bud initiation

March collection: The buds collected in March had four or five leaf rudiments (Fig. 1 a) and a microscopic axillary bud rudiment, and showed no indication of initiation of the flower primordium.

April collection: The first indication of the initiation of the inflorescence primordium, viz, the unequal division of the growing point and a blunt out-growth opposite a leaf primordium was observed in the second node of spur pruned vine in April (Fig. 1 b). In the eighth node the development of the inflorescence primordium was seen with the characteristic growth on one side of the growing point opposite a leaf. From pruning to fruit bud initiation, the time taken was 66 to 74 days and from bud burst to initiation 45 to 53 days.

At the time of fruit bud initiation, the main shoots were on an average 65 cm long, some of which were carrying inflorescences in 'full bloom'. Thus both the development of the current season's crop and of the inflorescence initials for the next year were found to progress simultaneously.

May collection: The buds showed an advanced stage of development of the cluster primordium, dividing into more than three branches, each subtended by a bract. The initiation of a second cluster was also seen in the eighth node of a three-bud treatment.

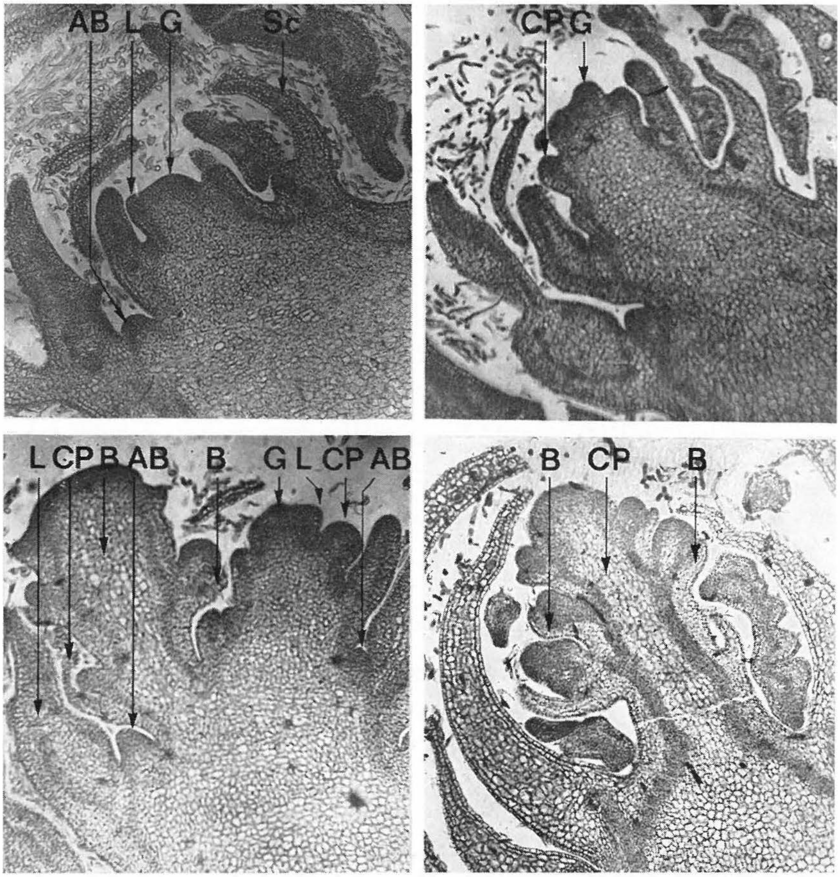

Fig. 1 a—d: Inflorescence and flower bud development in Pusa Seedless.
Stage of inflorescence development in March (a: upper left), April (b: upper right), June (c: below left), October (d: below right).
AB = axillary bud, B = bracts, CP = cluster primordium, Ca = calyx, Co = corolla, G = growing point, I = integument, L = leaf primordium, P = pollen, Sc = scales, Sta = stamen, Sti = stigma, TP = tendril primordium, UP = undifferentiated primordium.

Collection of June, August, October and December: The primordia divided further into second and third order axes, each subtended by a pair of bracts. Most advanced stage was seen in December with numerous branches. Although the development of the branches was rapid, the apical meristem of each branch continued to be an undifferentiated mass. The primordium as a whole resembled a bunch of grapes, each representing a growing point (Figs. 1 c and d, 2 a).

Fig. 2 b shows a typical tendril primordium opposite a leaf, and the rudiments of an undifferentiated inflorescence primordium in the next node. The growing point also shows division suggestive of initiation of a tissue other than a leaf. The latter two tissues may be considered as transition forms which, due to their delayed emergence, may turn out to be tendrils or unproductive tissues. As in the case of cluster primordia, tendril primordia were also situated in a leaf opposed position and never below a cluster.

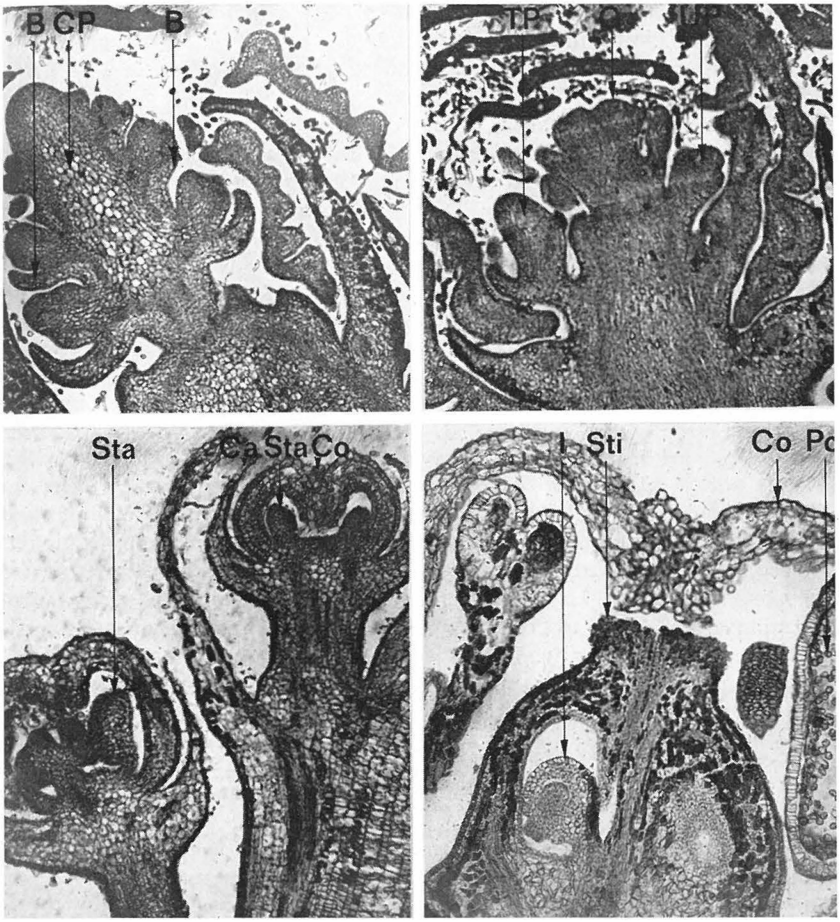

Fig. 2 a—d: Inflorescence and flower bud development in Pusa Seedless.
a (upper left): Stage of inflorescence development in December; b (upper right): section showing a typical tendril primordium and undifferentiated tissue; c (below left): flower primordia; d (below right): advanced stage of flower primordium. — Further data as Fig. 1.

The differentiation of floral parts

Samples collected on the day of their appearance, showed that the development of the floral parts was regular in the order of calyx, corolla, stamen and carpels. Contrary to observations of Barnard and Thomas (1933), that all the flowers in different parts of an inflorescence reach the same stage of development at one time, different stages of development were noticed in the same inflorescence (Fig. 2 c and d). All the essential organs of the flower were formed within 10 days of the appearance of the inflorescence.

Effect of pruning severity

Fruit bud initiation was pronounced in the 3-bud treatment, while none of the buds of the unpruned treatment showed any such indication. Between the 3 and 9-bud treatments, the differences were not appreciable. In the batch of buds examined in May, however, the distinction between the pruned and unpruned vines had apparently narrowed down considerably; buds from both the treatments having shown clear indication of fruit bud initiation. The samples of June showed that initial differences almost disappeared, since the primordial development of the 3-bud, 9-bud and unpruned treatments had progressed to more or less the same stage.

No definite evidence could be obtained to show the more advanced stage of development of the basal buds compared with the apical ones as reported by BARNARD *et al.* (1938). On the contrary, buds from the 8th and 9th nodes revealed a more advanced stage of development in April than the basal buds. Primordia of more or less the same size were found in the basal as well as in apical buds.

Forecasting fruiting potential

The percentage of fruitfulness at every node was compared through dissection in October, 1966 with the actual yield of fruits recorded in June, 1967. The data showed that the difference between the mean predicted values and the actual yield was 11 to 19 per cent.

Fruit bud initiation in bearing and non-bearing shoots

The data showed that the shoots which had borne fruits in one year have the potential for being fruitful in the next year as well. There are also instances of the fruitfulness being reduced to 0 to 10 per cent. Again, a barren shoot did not necessarily become fruitful in the following year. It could continue to be barren for a second year in succession. In both the pruning treatments (3 and 9 buds), none of the buds examined was found to be fruitful, while in the unpruned vines 41.7 per cent of non-bearing shoots were fruitful. Even in the unpruned vines, fruitfulness of a shoot that had borne a crop was more than that of the non-bearing one.

Effect of fertilizer treatments on fruit bud initiation

The effect of eight fertilizer treatments, seven of which were given as additional dose in April (at the time of fruit bud initiation), on fruit bud formation is presented in Table 1.

The results indicate that three treatments 6, 7 and 8 showed significantly higher fruitfulness than level 1. The difference among the other treatments was not appreciable. Indications of earlier fruit bud initiation were also obtained in the treatment 8. These results need confirmation.

Table 1
Effect of fertilizers on fruit bud initiation

Fertilizer level	N		P		K		Fruitfulness %
	February	April	February	April	February	April	
	g	g	g	g	g	g	
1	228	0	114	0	0	0	23.5
2	228	0	114	0	0	228	29.0
3	228	0	114	114	0	0	39.1
4	228	0	114	114	0	228	28.5
5	228	114	114	0	0	0	39.4
6	228	114	114	0	0	228	47.3
7	228	114	114	114	0	0	47.7
8	228	114	114	114	0	228	52.2
L.S.D. ($P < 5\%$)							19.01

Discussion

Under north Indian conditions, there is no report so far of the time of fruit bud initiation for any variety of grapes. The results of researches carried out in other countries in the Seedless group of varieties do not tally with the observations on Pusa Seedless variety under Delhi conditions, because fruit bud initiation has been reported to occur in the previous summer, viz., middle of June (PEROLD, 1927), mid-summer (KARTRIDGE 1929), early June (SNYDER 1933) in the U. S. A., November in Australia and South Africa (BARNARD 1932; and BARNARD and THOMAS 1933). In the present study, it has been found to occur in the first or second week of April, which obviously is related to the earlier bud burst in February.

While cluster initiation started in April, inflorescence primordia reached an advanced stage of development in May and June. By December, the cluster primordia had developed to the fullest extent, but the terminal points were still undifferentiated. Further differentiation into floral parts did not occur until after bud burst in February, when it was so rapid that all the essential organs were formed within 15 days. In October, more than two months before pruning the canes, the cluster primordia in the axillary buds could be easily seen on dissection under a binocular microscope.

The observations on the structure of the bud and the primordia were similar to those of other workers (BARNARD *et al.* 1933), except that different stages of development of floral parts were noticed in the bud during the first three days of its appearance. The period of fruit bud initiation synchronised with the 'full bloom' stage of the current season's shoots. Thus, the shoot carries the current season's crop and simultaneously forms the flower primordia in its axils for the next season. Along with the bunch and berry development, the flower primordia development makes simultaneous progress, which has a bearing on cropping in grapes. Failure to appreciate this process may lead to biennial or irregular bearing tendency in grapes. MANEY and MAGNESS cited by GARDNER *et al.* (1952) demonstrated this effect by inducing over-bearing by underpruning, which resulted in less fruit bud initiation for the next crop.

This leads to the question of augmenting the nutritional needs of the vine at this stage, when the additional doses of fertilizers were given, among which treatment 8 gave indications of promoting fruit bud initiation. A thinning treatment was not envisaged in this experiment. A combined fertilizer cum thinning experiment is expected to demonstrate the effects more clearly.

The position of the pruning cut did not appear to influence flower bud initiation. The slight differences noticed in the beginning were absent as the season advanced, as reported also by DANIEL (1965) in the variety Anab-e-Shahi and by MAY and ANTCLIFF (1964) in Sultana.

It was also observed that the basal buds are not barren but relatively less fruitful than those beyond the fifth or sixth bud. The position of the pruning cut determines the fruitfulness of a node to a greater degree than other factors. The apical bud, regardless of the position of the pruning cut was found to be the most fruitful.

The present study has led to determination of the time of fruit bud initiation of Pusa Seedless, which will help to forecast the fruiting potential for the next year through examination of bud fertility in advance. The utility of such forecasts has been well realised in Australia, where pruning of Sultana vines is done after the receipt of news bulletins on bud fertility. A similar technique is reported to be in vogue in Yugoslavia (BRIZA and MILOSAVLJEVIĆ 1954).

The present study indicates that the bearing shoots are capable of initiating buds for the subsequent season also and that a barren shoot does not necessarily become fruitful in the succeeding season. The fruitful or barren condition of a shoot does not seem to have any predictable relation to its condition in the previous season. As far as the nutrient status of such shoots is concerned, studies of Gallo and De Oliveira (1961) have shown that fruiting and non-fruiting shoots differed very little in their composition of N, P and K. This suggests that the causes for the differences may have to be sought in endogenous growth regulators.

The results of the fertilizer trial indicate the utility of a combination of nitrogen and phosphate fertilizers for promoting fruit bud initiation and the desirability of a split dose of fertilizers at monthly intervals from the time of pruning. This aspect deserves further study.

Summary

Experiments conducted in 1965 and 1967 on the effect of pruning severity and certain fertilizer treatments on fruit bud initiation in Pusa Seedless under Delhi conditions showed that:

1. Fruit bud initiation commenced between the first and second week of April, and the time taken from pruning was 66 to 74 days, and from bud burst it was 45 to 53 days. At the time of fruit bud initiation, the shoots were carrying fully developed inflorescences, many of which were in full bloom. Thus both the development of the current season's crop as well as the inflorescence primordia for the next year occur simultaneously. The primordia showed full development by October though the differentiation of floral parts did not occur until after bud burst.
2. The severity of pruning past season's canes to 3 or 9 buds or 'no pruning' did not exert any influence on the time of fruit bud initiation. No difference was noticed between the basal and apical buds in the rate of development of primordia.
3. Dissection of buds prior to pruning and forecasting the fruiting potential was found to agree closely with the actual yields, the difference between the predicted and actual values being 11—19 percent.
4. Fruiting shoots of the current season were found capable of initiating fruit buds for the succeeding season also to the extent of 10 to 100 per cent. There were also instances of the fruitfulness in such shoots being reduced from zero to 10 percent. Non-bearing shoots of the current season were not necessarily fruitful in the following season.
5. Among 8 fertilizer treatments with two levels each of N, P and K, three combinations, viz., $N_1P_0K_1$ $N_1P_1K_0$ and $N_1P_1K_1$ showed significantly higher fruitfulness than $N_0P_0K_0$. Indications of earlier fruitfulness were also obtained in the treatment $N_1P_1K_1$.

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