IDENTIFICATION OF FACTORS RESPONSIBLE
FOR FRUIT SET IN FRENCH PRUNES

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ABSTRACT

A number of different studies were conducted toward gener-
ating a better understanding of the factors associated with fruit set
in french prunes. Orchard locations in Tehama, Butte, Yolo and Merced
counties were selected. Controlled pollinations were carried out
on uniform populations of flowers (all at full bloom stage of develop-
ment). Hand pollinations made over a period of days indicated that
maximal fruit set could be obtained within a 2 day period and that
stigmatic receptivity for pollen decreased thereafter. These flowers
were enclosed in mesh bags to exclude bees. Bags were found to reduce
light intensity by approximately 40% and those bagged limbs had less
set even after each flower had been pollinated by hand. Possibly,
the lower light intensities in these bags reduced fruit set. Removal
of 23 to 48% of flowers at full bloom did not effect fruit set of
open pollinated flowers and pollen from 'Burton' or 'Imperial' prune
did not appear to improve fruit set. Prune ovules remained viable
for at least 8 days this year. Flower structure appeared to have an
effect on fruit set.

OBJECTIVE

To identify various factors associated with or which may modify
fruit set in french prunes.

PROCEDURE

Orchards were selected in Tehama, Butte, Yolo, and Merced counties
for these experiments. Soil types varied from location to location as
did the environmental conditions. We selected these orchards in
different locations in order to have a degree of variability so that
differences in fruit set would be obtained. At each site, trees with
uniform bloom density were selected at random, 1-2 m from the soil
surface, around the periphery of each tree. Flowers on each limb that
were not in full bloom were removed and a mesh bag was placed
around each limb to exclude bees. Eight limb replicates per treat-
ment were utilized at each location. The treatments were hand
pollination at full bloom, pollination 2 days later, pollination 5
days later and pollinatin 8 days later. Control limbs had no hand
pollination and had bags placed over them. Moreover, there were
open pollinated controls and open pollinated limbs which had flowers
removed like those limbs in bags to determine if removing flowers
at full bloom had an effect on fruit set. In another experiment,
pollen was collected from 'Burton', 'Imperial' and 'French' prune

and french prune flowers were hand pollinated with each pollen source
and then the limbs were bagged to determine if different sources of
pollen might modify set differently than french prune pollen.
Temperatues were monitored in each orchard location prior to, through-
out bloom, and during the fruit set period. Flower samples were
collected at full bloom and at regular intervals up to FB + 8 days
at each location. Each complete flower was fixed in a solution of
ethanol and glacial acetic acid and transported to a refrigerated
condition for later laboratory determination of ovule viability.

RESULTS

In these bloom studies, one of which was designed toward
determining the effective pollination period in prune, limbs with
similar bloom density were selected and flowers that were not in
the full bloom stage of development were removed. In a corollary
study, flowers were removed from limbs where flowers were open
pollinated and the fruit set percentage was compared against those
limbs where no flowers had been removed, to determine if flower
removal might effect fruit set. We removed from 23 to 48 percent of
the initial number of flowers present on the limb and compared the
final fruit set with that from limbs where no flowers had been
removed. We found that removal of flowers at full bloom had no
subsequent effect on the final fruit set of those flowers (Table 1).
Therefore, the remaining flowers were as likely to persist even
though there were less of them present at full bloom.
    In general, fruit set was best when flowers were pollinated at
full bloom (time 0), the receptive period apparently was short
(Table 2). Hand pollination was less effective when flowers were
pollinated full bloom + 2 days and remained low as a result of
pollination on subsequent days. For maximal fruit set, it appears
that pollen should be transferred to the stigmatic surface soon
after the petals unfold making stigmas available for pollination.
Mature pollen found on flowers more advanced in development can
be carried from those flowers by bees to the receptive stigmatic
surface.
    The bag itself appeared to reduce fruit set (Tables 2 and 4).
We measured a 40% reduction in light intensity as a result of the
bag, and observed some chlorosis on young developing leaves. The
reduction of fruit set as a result of the bag occurred before
leaves had significantly developed or matured. Reduced light
intensity within the bag may have been responsible for reducing fruit
set and the effect was unlikely to have been a result of limiting
the supply of carbohydrates. The removal and replacement of each bag
caused a minimal amount of fruit set.
    Prune flowers that had been stored in a refrigerated solution
of 3:1, ethanol:acetic acid were removed in the lab and stained with
analine blue. Ovule viability was assessed by either removing ovules
from prune flower ovaries or squashing the ovary and viewing the ovule

under fluorescence microscope using a near-UV to violet excitation filter set. Ovule fluorescence indicated inviable ovules. Ovules were viable for at least 8 days under 1987 growing conditions which comprised the duration of these experiments.
Fruit set in 1987 varied as a function of bloom date but not significantly, except in Butte county where early bloom fruit set was lowest (Table 3). At the Butte location, temperatrues got as low as 26 °F. During the same period, temperatures were as low as 28 °F in Tehama county. It may have been that the duration and extent of slightly lower temperatures experienced by flowers in Butte county helped to reduce fruit set there. Otherwise, fruit set was similar over a fairly wide range of temperature regimes as long as sky conditions were clear.

Flowers that were pollinated by 'Burton' or 'Imperial' pollen did not set more fruit than those flowers pollinated by 'French' pollen (Table 4). However, the bags which covered the limbs of these controlled pollinations reduced set when compared to open pollinated controls.

In another study, 2 orchards were selected in Merced county that had histories of consistently producing a good crop and the adjacent orchard a poor crop. One orchard was planted a year earlier than the other and there was some question as to whether the source originated from the same nursery material. Our investigation substantiated the observation that the orchard with a good cropping history set more fruit while the orchard with poor cropping history produced a lower fruit set (Table 5). Upon analysis of flower structure, we observed that flowers in the good crop orchard had a higher percentage of stigmas that were equal in length with anthers. In the poor crop orchard, a higher percentage of stigmas were elevated above the anthers. This data would suggest that the stigma/anther relationship within each flower may effect fruit set. An observation made by Polish researchers indicated that different prune rootstocks created situations were stigmas were higher than anthers, which resulted in less fruit set.

CONCLUSIONS

-Fruit set in 1987 was high.
-Fruit set was best when pollination occurred at full bloom and decreased shortly thereafter, presumably as a result of decreasing stigma receptivity. This result generally was true from location to location.
-Placing flowering limbs in bags reduced fruit set. The bag reduced light intensity by 40%, but the period of time in which the bag was most influential in reducing set was not determined.
-Ovules were viable for at least 8 days.
-Fruit set was similar as a function of bloom date across several orchard locations, however, fruit set was reduced during early bloom in 1 location possibly as a function of colder temperatures.
-Removal of 23 to 48% of the flowers at full bloom did not effect fruit set of the remaining flowers.

-'Imperial' or 'Burton' pollen did not improve fruit set over
'French' pollen in these 1987 studies.
-An orchard with a poor cropping history was found to have a signifi-
cant percentage of stigmas positioned higher than anthers within the
same flowers, which may have contributed to a reduced orchard set.

More work is needed to substantiate and expand upon these preliminary
conclusions.

Table 1. Effect of removing flowers at full bloom on fruit set of
open pollinated flowers.[z]

Orchard Location	Flowers removed (% of total)	Fruit set (% of total)	
		Removed	Not removed
Tehama	31.3[y]	31.4	40.3
SD	±14.5	12.4	16.3
Butte	23.0	31.6	22.7
SD	± 9.6	8.9	9.9
Yolo	27.7	36.6	37.8
SD	± 9.5	10.9	9.9
Merced	48.0	8.2	8.3
SD	±11.8	6.9	4.4
TOTAL OF LOCATIONS	32.5	26.95	27.26 NS

[z]Data values represent means from 8 replicate samples collected at
each of the above orchard locations.

[y]Values represent means ± standard deviations.

Table 2. Average percentage fruit set at each orchard location as a
          function of pollination time.

Orchard Location	Fruit Set (%)				
	Pollination time (days after full bloom)				
	0	2	5	8	open pollination
Tehama	23.0^z	11.1	6.6	8.6	40.2
SD	± 5.2	5.4	5.5	4.0	16.3
Butte	8.8	3.3	5.2	4.5	22.7
SD	± 3.7	3.2	1.9	1.5	9.9
Yolo	15.7	5.7	5.5	4.5	37.9
SD	5.4	2.7	3.8	2.6	9.9
Merced	3.1	4.5	1.2	2.6	8.3
SD	2.0	2.8	1.2	2.6	4.4

^{z}Values represent means from 8 replicates ± standard deviations.

Table 3. Effect of bloom date and temperature at various orchard locations on fruit set (%) in French prune.

Temperature categoreis at each orchard location	Bloom Date[z]					
	Early		Mid		Late	
	Fruit set (%)	°F (mean)	Fruit set (%)	°F (mean)	Fruit set (%)	°F (mean)
Tehama						
Max		49.5		62.0		69.0
Min	37	33.5	47	33.5	37	38.0
Ave		41.5		47.7		53.5
Butte						
Max		49.5		63.7		70.3
Min	13	31.2	44	30.2	34	33.7
Ave		40.5		47.5		52.3
Yolo						
Max		57.5		68.0		75.3
Min	45	36.5	39	42.3	26	44.7
Ave		47.2		55.5		60.1

[z]Bloom dates at Tehama (3/20-3/31); at Butte (3/18-3/31); at Yolo (3/20-3/31). Early, mid and late bloom dates were grouped into 4 day periods and means calculated for each.

Table 4. Effect of pollen source on
          percentage fruit set in French
          prune.

Pollen Source	Fruit Set (%)
Open pollination	38.8[z]
SD	± 9.9
French	15.7
(limbs bagged) SD	± 5.4
Burton	24.0
(limbs bagged) SD	± 4.6
Imperial	18.7
(limbs bagged) SD	± 5.6

[z]Values represent means from 8 replicates
± standard deviations.

Table 5. Evaluation of differential stigma heights in adjacent orchards. One orchard had a good fruit set history, the other poor.

Orchard cropping history	Fruit set (%)	Stigma/anther relationship (%)		
		Above	Equal	Below
Good	44.8a[z]	25.6a	71.2a	0.2
Poor	23.8b	69.4b	26.8b	0.0NS

[z]Values represent means from 5 replicate samples and were separated within columns by Duncan's multiple range test, 5% level.