

# Seed development in Californian poppy (*Eschscholzia californica* Cham.)

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## Abstract

Interest in Californian poppy (*Eschscholzia californica* Cham.) is increasing because of its ornamental attractiveness and its medicinal properties (e.g., benzophenanthridine alkaloids). However, little is known about seed production characteristics of this species. Studies on seed development in Californian poppy were conducted at Lincoln, Canterbury, New Zealand. One hundred flowers were tagged at pollination and pods were harvested at 3-4 day intervals commencing 12 days after pollination (DAP). Harvesting the pods earlier than 30 DAP produced light seeds with high moisture content and poor viability. Maximum viability and thousand seed weight were obtained at 42-54 DAP. After 54 DAP the pods started dropping off the plant. Data are discussed in relationship to optimum time of harvest. Results from this trial will assist seed growers of Californian poppy achieve maximum yields of viable seed.

*Additional key words:* Seed moisture, seed weight.

## Introduction

The Californian poppy (*Eschscholzia californica* Cham.) is a common native wildflower of the North American west coast (Munz, 1974). It has a tap-root system and rosette growth habit forming an elongated floral stalk bearing pale yellow to orange terminal flowers under long-day inductive conditions (Lewis and Went, 1945; Munz, 1974; Sharma and Nanda, 1976; Lyons and Booze-Danials, 1986). The plant grows to a height of 40-50 cm and bears fruits which are elongated pods, 40-60 mm in length. At maturity each pod carries 20-30 seeds. The plant is known to contain benzophenanthridine alkaloids which are of medicinal importance because of their analgesic, spasmolytic, antimicrobial and anti-tumour activity (Cordell, 1981; Tanahasha and Zenk, 1990; Dittrich and Kutchan, 1991). The American Indians used the slightly narcotic juice as a remedy for tooth-ache (Duke, 1989). It is also cultivated as a herbaceous ornamental (Lyons and Booze-Danials, 1986) and herbal (Urzua and Mendoza, 1986) plant. In New Zealand it is most commonly seen growing in dry, stony sites, especially on roadsides, riverbeds and hillsides, providing brilliant displays when flowering. Californian poppy is a new species in agricultural research as an ingredient in wildflower mixtures and as a possible alternative species in pasture systems.

Californian poppy has an indeterminate flowering characteristic which greatly extends the date of maturity

of individual flowers along the inflorescence and thus compounds the difficulty of collecting the seed. Concentrated flowering and maturity are essential for mechanical harvesting since multiple harvesting may not be an economically viable option.

There are no data in the literature on growing Californian poppy for seed. This paper reports studies on seed development and optimum harvest time for Californian poppy in New Zealand.

## Materials and Methods

The experiment was conducted at Lincoln, Canterbury in 1994. Seeds of cultivar Planet Junior were sown on 11 April in rows 60 cm apart and a plant spacing of 50 cm within rows. In February, from a population of 400 plants, one hundred flowers on different plants were tagged at the start of pollination. At the time of tagging there were 8-12 flowers per plant. Pod formation and further development were monitored thereafter.

Five pods were harvested at random starting 12 DAP and continuing at 3 to 4 day intervals until all remaining tagged pods dropped off the plant. All samples were dissected and fresh weight of seeds recorded.

The samples were air-dried at room temperature for three weeks prior to recording seed weight and calculating moisture at harvest. Seeds were germinated at 15°C with 0.2% potassium nitrate solution according to the International Seed Testing Association rules

(ISTA, 1993) but only 10-15% germination resulted. The same seeds were then pre-chilled at 5°C for 7 days and germinated at 15°C using 0.2% potassium nitrate solution. Germination counts were made at 7 and 14 days.

Pod and seed colour were also monitored throughout the harvesting period and were indexed according to the

colour. Pods were grouped in three categories as green (1), green with brown stripes (2) and brown (3). Similarly, seeds were grouped into three categories as green (1), black (2) and grey (3).

Meteorological data were recorded from pollination to final harvest of pods.

**Table 1. Weather variables from pollination to final harvest of Californian poppy. Pollination was on 16 February and pod drop was on 11 April.**

Day	Rainfall (mm)			Maximum Air Temperature (°C)			Evapotranspiration (Penman; mm)		
	February	March	April	February	March	April	February	March	April
1	-	3.7	0.0	-	24.4	7.7	-	2.8	2.4
2	-	3.7	0.0	-	15.4	23.8	-	2.3	3.4
3	-	1.3	2.2	-	17.5	16.1	-	2.3	1.2
4	-	0.0	0.0	-	22.3	21.5	-	3.8	2.6
5	-	0.0	0.0	-	19.8	23.1	-	4.7	2.9
6	-	0.0	0.0	-	26.9	21.8	-	6.3	2.9
7	-	4.4	0.0	-	14.8	20.6	-	2.4	2.9
8	-	0.3	0.0	-	19.2	23.7	-	4.0	4.0
9	-	0.0	0.0	-	15.1	13.9	-	3.1	1.3
10	-	0.0	0.0	-	14.2	14.5	-	1.6	0.9
11	-	0.0	0.0	-	16.8	18.2	-	3.2	2.0
12	-	0.0	-	-	18.6	-	-	3.6	-
13	-	0.2	-	-	21.7	-	-	2.9	-
14	-	2.0	-	-	19.9	-	-	1.9	-
15	-	0.0	-	-	24.2	-	-	3.3	-
16	0.0	0.0	-	22.5	24.0	-	3.7	2.5	-
17	0.0	0.0	-	23.2	18.0	-	4.0	1.4	-
18	0.0	15.0	-	23.1	17.7	-	3.0	1.2	-
19	10.2	30.0	-	21.9	14.3	-	3.1	0.5	-
20	1.2	5.9	-	23.2	12.8	-	3.4	2.0	-
21	0.0	0.0	-	22.9	14.8	-	3.1	1.8	-
22	0.8	0.0	-	24.8	16.5	-	3.3	2.3	-
23	0.0	5.4	-	22.7	17.0	-	4.4	2.1	-
24	0.5	2.9	-	20.6	12.0	-	4.5	2.0	-
25	0.0	3.4	-	23.4	14.7	-	5.1	2.0	-
26	0.0	0.7	-	20.2	15.5	-	2.0	1.3	-
27	0.0	0.0	-	21.6	24.8	-	4.1	2.9	-
28	0.0	1.0	-	23.2	17.7	-	5.1	1.4	-
29	-	0.0	-	-	16.4	-	-	2.4	-
30	-	0.2	-	-	18.4	-	-	2.8	-
31	-	0.0	-	-	16.2	-	-	2.3	-
Monthly means/totals	37.8	81.0	17.5	21.7	18.1	18.5	108.5	79.1	68.4
Long term means	51.3	58.9	51.8	21.7	20.1	17.5	117.6	96.2	62.6
Mean relative humidity	79.9%	59.9%	71.3%						

## Results and Discussion:

Meteorological data are presented in Table 1.

### Seed development

In Californian poppy three main phases of seed development were identified in relation to moisture content, dry seed weight and development of viable seeds from time of pollination to seed maturity. The first phase of seed development lasted for 30 DAP. This phase was characterised by rapid increase in seed dry weight and decline in seed moisture. Seeds harvested during this phase were low in germination (Figure 1).

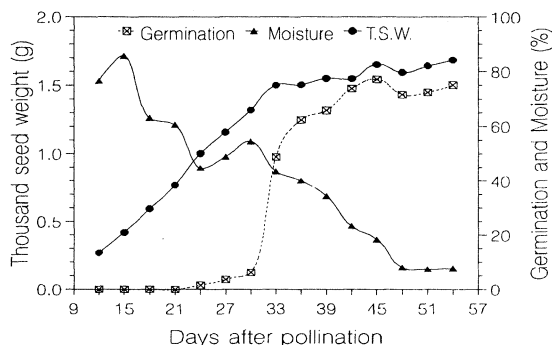
The second phase lasted for another 12 days (30-42 DAP) during which the seed weight gain was small and relatively constant indicating that physiological maturity had been achieved. However the pods did not drop until seed moisture was below 7 %.

The third phase lasted for another 12 days (42-54 DAP). During this phase seed weight and viability were relatively constant whereas the seed moisture declined.

Identifying the stage of maturity has been a guide in other plant species to determine the optimum time of harvest. Most of these studies (Hyde *et al.*, 1959; Anslow, 1964; Hill and Watkin, 1975; Lutz and Murant, 1983; Hare and Lucas, 1984; Hare, 1986; Reddy *et al.*, 1993; Rowarth *et al.*, 1993) were based on seed weight, moisture, viability and seed shattering so that seeds of high quality could be obtained in quantity. In Californian poppy, harvesting at any time between 42 and 54 DAP produced optimum germination and seed weight in the 1994 season. Delaying harvest beyond 54 DAP increased the risk of loss of pods that carried mature seed as the pods detached from the plant after full maturity.

### Pod and seed colour

All pods harvested before 30 DAP were green with immature green seeds. Pods harvested between 30 and 42 DAP were green with some brown stripes. At this stage (30-42 DAP) seeds changed from green to dark green and brown coinciding with physiological maturity. Brown stripes on the pod started becoming thick and distinctive after 42 days whereas pods harvested after 51 DAP were all brown. Both colours of pods (green with thick brown stripes and brown) carried black or grey seeds which had low moisture and maximum seed weight and germination. Pods harvested at this stage (green pods with thick brown stripes and brown pods) produced seeds of high quality. Thus pod and seed colour are good indicators for determining the optimum time for harvesting Californian poppy.



**Figure 1. Changes in seed moisture, seed weight and germination after pollination in Californian poppy.**

## Conclusion

Pod and seed colour could be used to identify the optimum time for harvesting Californian poppy for maximum seed yield. Green pods with thick brown stripes and brown pods carried black or grey seeds. These seeds were obtained after day 42 and produced maximum seed weight and germination. All pods harvested after this period (42 DAP) produced seeds of high quality. Harvesting after 54 days increased the risk of losing pods that carried mature seed because the pods detached from the plant after full maturity. Therefore the optimum time to hand harvest Californian poppy would be when the pods are either green with thick brown stripes or brown, and the seeds are black or grey in colour.

Close observations of changes in pod and seed colour of Californian poppy will give farmers a reliable indicator of the optimum time to hand harvest the crop. As Californian poppy has an indeterminate growth habit and flowering and pod formation occurs over a long period, the next stage would be to identify peak flowering and investigate methods for concentrating flowering so that the crop could be machine harvested.

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