# YEAR TO YEAR VARIATION IN BUMBLE BEE ACTIVITY IN RED CLOVER SEED PRODUCTION FIELDS IN THE WILLAMETTE VALLEY

*W.P. Stephen and S. Rao*

**Introduction**

Red clover (*Trifolium pratense* L.) is self-sterile and hence a critical factor for seed production is pollination. The florets on each seed head open over six to eight days but due to rapid decrease in fertility, the florets must be pollinated within two to four days after opening (Free 1965). Hollowell and Tysdal (1948) indicated that 875 million florets are present in a hectare of red clover. This highlights the need for an abundance of pollinators during bloom for achieving high yield in red clover seed crops.

In the Willamette Valley, red clover typically blooms over six weeks in the months of July and August. Producers rent 1-2 honey bee hives per acre for pollination. While honey bees are capable of pollinating red clover under cage conditions (Rao and Stephen 2009), their performance in this crop is known to be affected by the presence of competing foraging resources in the vicinity (Peterson et al. 1960). Alternative pollinators in Oregon include the social bumble bees and a diversity of solitary bees. Bumble bees, in particular, are considered to be excellent pollinators of red clover. A diversity of bumble bee species exists in western Oregon (Stephen 1957), of which several species are believed to contribute considerably to the high red clover seed yield recorded in the Willamette Valley compared to other regions in the US (Rao and Stephen 2009; 2010). However, climatic conditions, which vary from year to year, affect bumble bee colony development and forging behavior, both of which could in turn affect red clover pollination and seed yield. Hence, the objective of this study was to determine the variation in bumble bee abundance during red clover bloom over a five year period to determine if tactics need to be developed for ensuring adequate abundance of bumble bees to enable producers to continue to achieve high seed yields.

**Methods**

The study was conducted in red clover seed production fields in Polk county in western Oregon between 2006 and 2010. Bumble bees were sampled using blue vane traps used in earlier studies (Stephen and Rao 2005; Rao et al. 2008). Each year, traps were set up in 5-6 fields, from late June to mid-September. Four traps were set up in each field every 7-10 days during bloom. Bumble bees were collected after 48 hours, preserved by freezing, and subsequently identified.

**Results and Discussion**

Over the five years, bumble bees trapped during red clover bloom included *Bombus appositus*, *B. caliginosus*, *B. californicus*, *B. griseocollis*, *B. melanopygus*, *B. mixtus*, *B. nevadensis*, *B. sitkensis* and *B. vosnesenskii*. However, *B. griseocollis*, *B. nevadensis* and *B. vosnesenskii* were the most dominant. Amongst these three species, *B. vosnesenskii* was by far the most common comprising 50 - 75% of all *Bombus* observed each year.

Bumble bee activity recorded during red clover bloom over the five years of the study is presented in Figure 1. Each year, the numbers increased during early bloom though there was variation in the rate of increase in abundance within the first three weeks. Peak activity also varied considerably, and appeared to have gradually shifted towards late-bloom in recent years (Figure 1). In 2006 and 2007, peak activity was recorded in late July-early August while in 2009 it shifted to mid-late August, and in 2010 it shifted further to late August and early September. The shift in peak activity is likely to have affected red clover seed yield in the Willamette Valley.

Both high and low temperatures during bloom impact foraging activity by bumble bees in red clover. In addition, cultural practices affect synchrony between crop bloom and foraging behavior by bumble bees. If spring cutting of the crop for hay is delayed, bloom will be available from late July onwards when native bumble bees and other native bees are more abundant. In addition, delay of the last irrigation will facilitate bloom continuing in mid-late August. Either of the options may require modifications in harvest procedures to avoid potentials problems with early rains.

In addition, many producers are not aware that the abundance of native bumble bees in red clover seed production fields in any year is dependent on their abundance in red clover fields the previous year, and also the abundance of queens in a spring blooming crop in the landscape. In the Willamette Valley, bumble bee queens emerge from hibernation in spring, forage on spring blooming crops prior to initiating nests. Workers forage in late spring and summer, and colonies increase in size. As a result, an abundance of workers is typically available for pollination in red clover seed crops in late summer-early fall. Late blooming red clover also benefits by the presence of males which are produced in late summer-early fall along with new queens. Male bumble bees have been considered to be inconsequential as pollinators, but in cage tests we have shown that they are as effective as females. At the end of the year, all workers and males die; only mated queens are alive, and they find an appropriate site for hibernation. Thus, for availability of bumble bees for pollination the following year, the red clover crops must provide sufficient foraging resources late enough in the season to ensure that late flying queens and males are well nourished prior to hibernation by queens. In addition, a spring bee-pollinated crop must be present to provide adequate resources for queens to initiate nests.

We believe that, in the Willamette Valley, the spring crop that provides foraging resources for bumble bee queens is blueberry (*Vaccinium* spp.). Thus, red clover crops have a mutualistic interaction with blueberry crops through their mutual need of the same pollinator resource, bumble bees. Spring queens depend upon a plentiful pollen and nectar source in blueberries while workers, males and new queens are dependent on red clover for food resources in summer and early fall. Both crops are critical for maintenance of bumble bee colonies and each crop is dependent on the other for ensuring colony survival so that adequate numbers of individuals are available for pollination.

For sustaining the high yields recorded in red clover seed and other bee-pollinated crops in the Willamette Valley, the relationship between bumble bee pollinators and bee-pollinated crops should be reinforced, possibly through the introduction of other cash crops with staggered blooming cycles. Currently, research is in progress for rearing bumble bees that are native to Oregon; when these are available commercially, growers can purchase them for placement in their fields in years when bumble bee abundance is not synchronized with bloom. Meanwhile, if bumble bee queens are estimated during blueberry bloom, predictions can be made on when their populations may peak later in the year, and red clover seed growers can assess whether they should consider manipulating their crop production practices to synchronize peak bloom with peak bumble bee activity.

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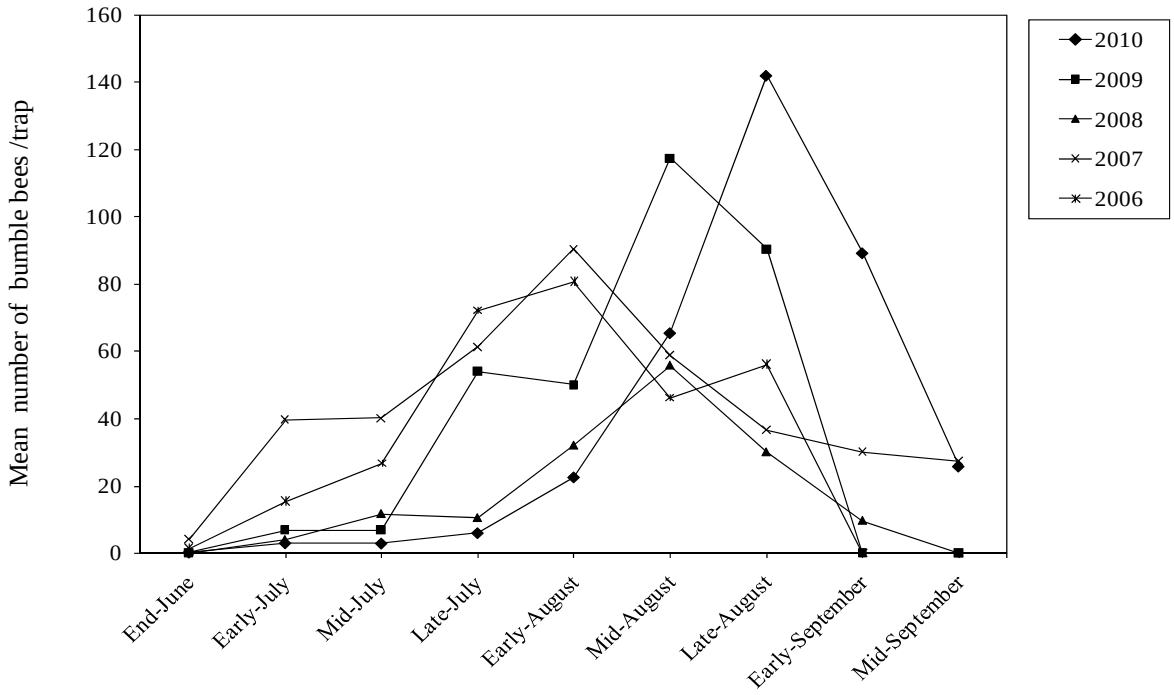


Figure 1. Mean number of bumble bees captured in traps placed around red clover seed production fields during bloom in the Willamette Valley.