COMPARISON OF BEE POLLINATOR ABUNDANCE IN RED CLOVER SEED PRODUCTION FIELDS WITH AND WITHOUT HONEY BEE HIVES IN THE WILLAMETTE VALLEY

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Introduction

Red clover is an important forage legume that has been greatly valued as a rotation crop for increasing soil fertility due to its ability to fix nitrogen. A key region for red clover seed production in the US is the Willamette Valley due to favorable climatic conditions. The valley gets more than 40 in. of rain annually, mostly during the winter months, and remains relatively dry during bloom and harvest. Red clover can thus be grown in this region with minimal irrigation, and dried in the swath with little risk of rain damage during the summer (http://www.oregonclover.org/seedproduction.html).

Red clover is self incompatible, and hence a critical factor affecting seed production is pollination (Williams 1925). Bees are the primary pollinators of red clover, and growers in the Willamette Valley typically rent 1-2 honey bee hives per acre. However, due to diseases caused by the tracheal mite and the Varroa mite, and the recent colony collapse disorder, the availability of honey bees has decreased while the cost of renting hives has increased. This has led Willamette Valley red clover growers to consider raising red clover seed without incurring the cost of renting honey bee hives. Alternative pollinators of red clover are bumble bees which are considered to be 2.5 times as efficient as honey bees in red clover (Petersen et al., 1960). In the majority of the United States, growers can purchase commercial bumble bees for crop pollination. However, in Oregon introduction of commercial non-native bumble bees is prohibited due to speculated simultaneous inadvertent introduction of diseases in the past. Thus, Oregon farmers who raise red clover seed crops are dependent upon naturally occurring bumble bee populations.

There is considerable diversity in bumble bees in the Willamette Valley. Their abundance is also high in red clover seed production fields especially during mid-late bloom (Rao and Stephen 2009). Given the high abundance of bumble bees, it appears possible that adequate pollination of red clover seed crops can be achieved in the Willamette Valley without renting honey bee hives. However, this needs to be investigated. Hence, the objective of the current study was to compare the abundance of bumble bees and honey bees foraging on red clover bloom in fields with and without the presence of honey bee hives.

Methods

The study was conducted in 2009 in the Mid-Valley (Polk/Linn/Benton Counties) and in the North Valley (Washington County) in two fields with and two fields without honey bee hives.

In each of the 8 fields, bumble bee and honey bee foragers were estimated during 10 sets of 2 minute counts during visual observations made while walking in the field. Mid Valley fields were counted 3 times per day while North Valley fields were counted twice per day. The study was commenced during the 1st week of July and continued for 7 weeks. In the two fields in Polk County that did not have honey bee hives, data were not collected on July 30 as the fields were sprayed with an insecticide.

Results

Bumble Bee Abundance. Bumble bees foragers were present in all 8 red clover fields with and without honey bee hives in the North Valley and the Mid Valley. Across all fields, their abundance was highest towards the end of July-early August (Figure 1A,C; 2, 3). They were also more abundant in fields with no hives. The highest abundance of bumble bees was recorded during week 5 across the 4 fields with no honey bees (Figure 3).

In the North Valley, bumble bee abundance was similar in fields with and without honey bee hives during the first three weeks of the study. Subsequently, the numbers increased dramatically in fields without honey bee hives. Over the 7 weeks, the average weekly abundance of bumble bees ranged from 1.1 to 27.7 individuals per 2 min count in fields without honey bee hives and from 0.2 to 13.4 individuals per count in fields with honey bee hives.

In the Mid Valley, bumble bee abundance was slightly higher in fields without honey bee hives during the first three weeks of the study. However, in fields without honey bee hives, the numbers increased dramatically towards the end of July. It was not possible to assess the abundance of bumble bees in fields without hives during the same period as both fields were sprayed with an insecticide. Over the 7 weeks, the weekly average abundance ranged from 0.9 to 10.9 in fields without honey bee hives and from 0.6 to 25.7 in fields where honey bee hives were present.

Honey Bee Abundance. Honey bees were present in all 8 fields in the North Valley and the Mid Valley including those that did not have honey bee hives. As expected, honey bee foragers were more abundant in fields with honey bee hives (Figure 1,3,4). In contrast to bumble bees, honey bee abundance was highest during early bloom and largely absent during late bloom (Figure 1 B,D; 2,4).

In fields with honey bee hives, honey bee abundance peaked in mid July and then dropped. The average weekly abundance of

honey bees ranged from 0 to 8.4 individuals per 2 min count in the North Valley and from 0 to 17.4 in the Mid Valley in fields without honey bee hives. In fields with honey bee hives, average weekly abundance across all weeks ranged from 0 to 18.3 individuals per count in the North Valley and from 0 to 25 in the Mid Valley.

Discussion

This study documented that bumble bee abundance was high in red clover fields in the North Valley and the Mid Valley. However, variation in abundance was observed across the bloom period. Lower abundance was observed during early bloom and in fields when honey bee hives were present. Data from an earlier study (Rao and Stephen 2009) and observations from the current study suggest that adequate pollination may be achieved in red clover seed production fields in the Willamette Valley by naturally occurring bumble bees.

The basis for the lower abundance of bumble bees during early bloom is not known. It is possible that during this period they forage on some other crop or that overall abundance of workers is lower during this period. Availability of pollen and nectar sources through early bloom could have led to an increase in bumble bee colony sizes resulting in the presence of higher abundance of workers towards mid to late bloom. The increase in numbers during mid to late bloom could also be due to the production of males at the end of the season. Further research is needed to determine factors leading to the variation in bumble bee abundance between early and late bloom.

Variation was also observed in honey bee abundance during red clover bloom. However, in contrast to bumble bees, honey bee abundance dropped during late bloom. Based on earlier observations with pollen traps, we speculate that this is due to honey bee preference for alternative pollen sources present in the area. Similar observations have been reported from other areas (Petersen et al 1960).

Comparison of bumble bee abundance between fields with and without honey bee hives suggest that there may be competition between the two bee species. It is possible that red clover producers may be able to attract a greater number of native bumble bees to their crop by removing costly honey bee hives from their fields. The higher abundance of bumble bees during early bloom may result in increased pollination and seed set thereby leading to more economic crop production.

Further studies are needed to evaluate potential use of flowers planted around the borders of crops and/or the use of companion planting of other early blooming seed crops to increase abundance of native bumble bees during early bloom. Currently, red clover is typically cut for hay early in the summer allowing for bloom to begin in early July. Additional studies could investigate whether crops could be cut at different times in an effort to align peak bloom with times when bumble bee abundance is at its greatest.

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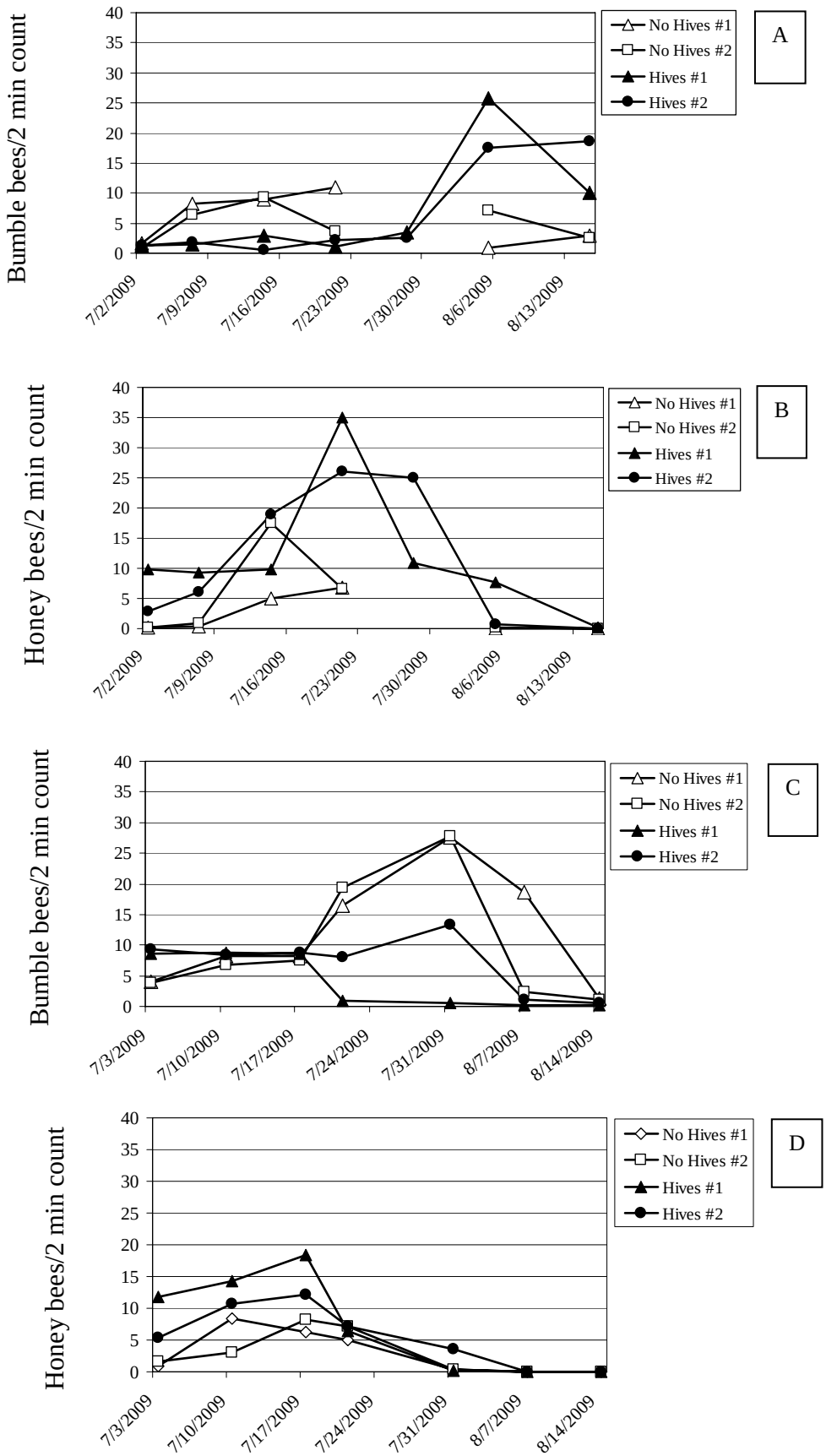

Figure 1. Average number of bumble bees and honey bees observed foraging on red clover bloom in summer 2009 in seed crops in fields with and without honey bee hives. Gaps represent periods when no observations were made as fields were sprayed with an insecticide. A, B = Fields in Polk/Linn/Benton Counties. C, D = Fields in Washington County.

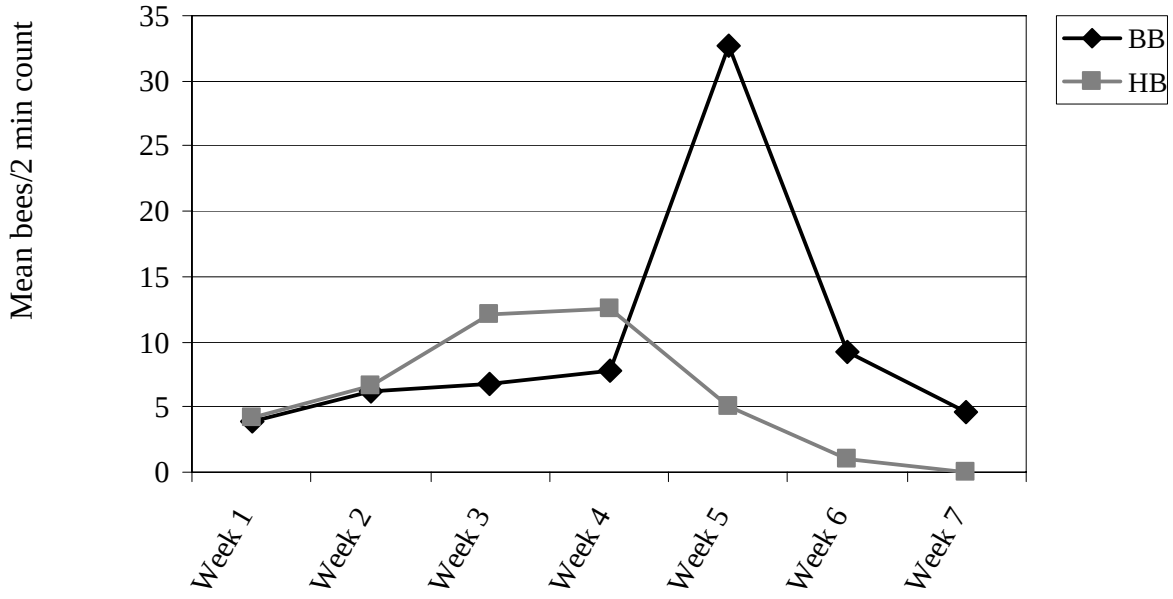

Figure 2. Mean number of bumble bees (BB) and honey bees (HB) observed during 2 minute visual observations made during bloom in 8 red clover fields in the Mid Valley and North Valley except for week 5 when counts were not made in 2 Mid Valley fields due to insecticide sprays.

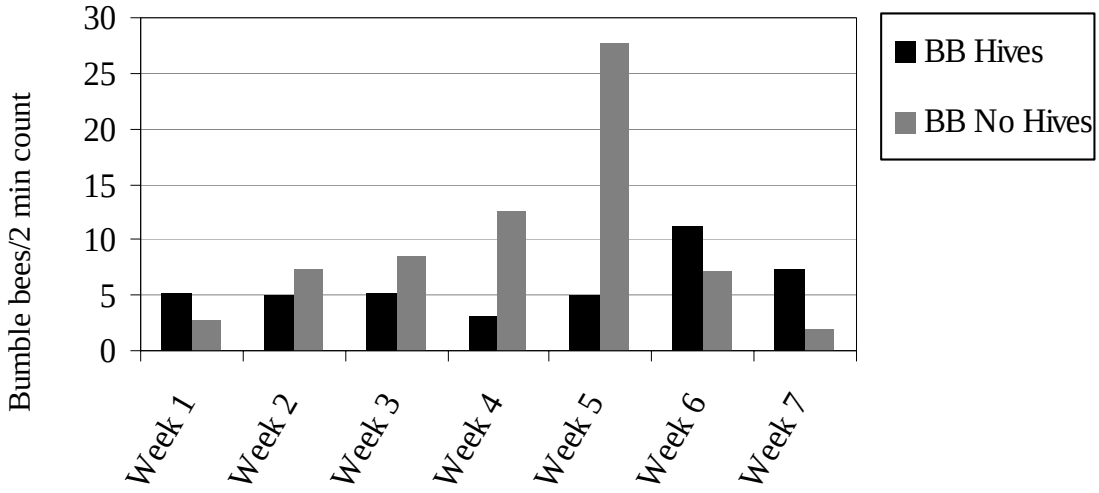

Figure 3. Mean number of bumble bees (BB) observed during 2 minute visual observations made during bloom in 4 fields with hives and 4 fields without hives in the Mid Valley and North Valley except for week 5 when counts were not made in 2 Mid Valley fields due to insecticide sprays.

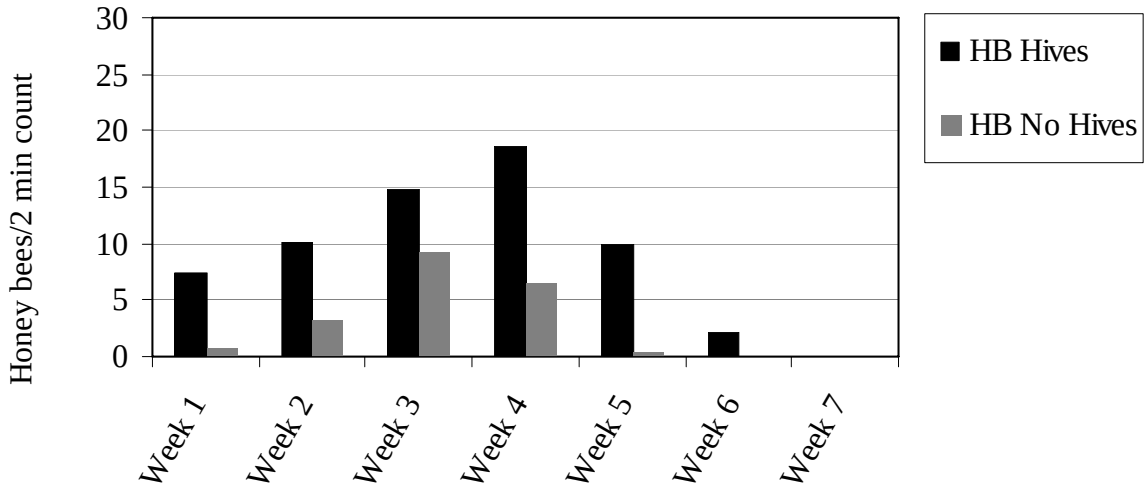

Figure 4. Mean number of honey bees (HB) observed during 2 minute visual observations made during bloom in 4 fields with hives and 4 fields without hives in the Mid Valley and North Valley except for week 5 when counts were not made in 2 Mid Valley fields due to insecticide sprays.