Pre-emergence insecticides improve seedling emergence in the Imperial Valley

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Planting in the Imperial Valley takes place in early autumn when air and soil temperatures are above optimum and the populations of insects preying on sugarbeet seedlings such as flea beetles and armyworms are large. Growers and pest control advisors believe that control of insects on sugarbeet seedlings should commence as soon as seedlings appear and continue until after thinning. Otherwise, stand failure is considered certain. Management based on this assumption has been successful for many years, but the most commonly used materials for control (methomyl or Lannate® and chlorpyrifos or Lorsban®) are carbamate or organophosphate type compounds which are currently are under review by US EPA for possible future restriction under the provisions of the Food Quality Protection Act. Currently, there are no well-established alternatives to the use of these materials for sugarbeet seedling protection.

To evaluate alternative seedling protection strategies and document loss to insects and other causes, two trials were conducted in the Imperial Valley near Brawley in the fall of 1999 and again in 2000 (Table 1). After planting, the amount of seed remaining was weighed to get an exact weight for the seed planted. This amount was divided by the known field area to get the seed population per foot of row. We assume that planting occurred uniformly. The seeding rates used were large compared to the target root population at harvest of approximately 35,000 plants per acre, especially in the first year, but this is a rational strategy if low levels of seedling survival are anticipated.

Different pre- and/or post emergence treatments were compared (Table 2). Each treatment was replicated three times. Some similar and some different treatments were used in each year. Emerging seedlings were counted in two twenty foot long subplots in the middle three rows four or five times after the start of irrigation.. Each seedling was labeled with a small wooden stake at emergence. Using stakes allows for the identification of the majority of seedlings appearing. The stake was removed if the seedling died and the cause of mortality was evaluated visually in the field at that time. The sum of the number appearing during the counting period is *cumulative emergence*. The last count, just prior to thinning was considered to be the *final establishment*. The difference between cumulative emergence and final establishment is *cumulative mortality* (post-emergence). If the amount of seed planted is known, *pre-emergence losses* can be calculated by difference using observed cumulative emergence. Only emergence results are reported here.

Results

The percentage of seed emerging and resulting in established plants is reported in Table 3. Some important differences occurred between the years. Emergence was much lower in the second year, while armyworm pressure was observed to be much greater in the first year. Differences in seedling emergence between the two years may have been due to irrigation management. The first irrigation required three days in 1999, but eight days in 2000. In 1999, the field had been pre-irrigated before planting, while in 2000 it was not. Extended periods with

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saturated conditions delay emergence and can result in sugarbeet seed and seedling death. In 1999, most seedlings had appeared by the first observation at 10 days, while in 2000, emergence was significantly delayed emergence (Fig. 1). High quality seed was used in both years, so irrigation and related seed bed conditions appear to be the most likely cause for these large differences. The somewhat poorer performance of Gaucho® treated seeds in 2000, compared to 1999 also may have been related to saturated soil conditions. Gaucho® can be phytotoxic to seed and seedlings, and delayed emergence may have increased this effect. In 1999, Gaucho®-treated seeds emerged slightly more slowly than others, but this did not adversely affect results.

In both years, however, plant establishment was greatest when pre-emergence insecticides were used (Table 3). The greatest potential for loss was during the pre-emergence period. In both years, the number of seeds not emerging was far greater than the number of seedlings dying after emergence. Using an insecticide with the seed, either Gaucho® or Lorsban®, provided significant amounts of protection. Even in unsprayed plots (Control treatments), post-emergence losses were much smaller than pre-emergence losses, and lower than anticipated. In the Imperial Valley an insecticide applied with or to the seed appears necessary. The larger number of seedlings emerging and becoming established in treatments including a pre-emergence insecticide in this trial leads to the inference that insect damage is occurring to seeds and emerging seedlings before they appear above ground. Such damage has been reported in England and elsewhere in Europe, where Collembola *sp.* are sometimes implicated in losses (Durrant, et al., 1988) but has not been reported before in California to our knowledge. Early post-emergence seedling damage appeared to be due almost entirely to flea beetles. Armyworm larvae had not had time to develop and were not observed initially. Gaucho® is very effective against flea beetles, and substituted well for soil applied Lorsban® and the first and possibly the second or third aerial applications of Lorsban®, as well. This is a significant reduction in pesticide use. If future trials demonstrate that the lower Gaucho® rate (20 g) is as effective as the higher rate (45g), there is a potential for significant cost savings to growers, as well as imputed additional benefit to the environment.

In addition to having adequate numbers of seedlings, growers need healthy, vigorous plants. In 1999, treatments not receiving a pre-emergence insecticide resulted in severely damaged seedlings by the last counting date. Those seedlings surviving were reduced in size, often having damage to the apical meristem region. Even the Gaucho® treated seedlings were smaller and were beginning to suffer armyworm damage at the last counting date. These observations imply that some post-emergence worm control is necessary in the fall establishment period, when armyworm pressure is significant. Compared to the standard growers treatment, however, the amount of pesticide and the number of treatments needed could be reduced. This could spare growers a significant amount of money (Table 2).

Conclusions

1. Pre-emergence insecticide applications resulted in significantly larger numbers of seedlings than other treatments. Pre-emergence losses were the most important cause of mortality.
2. Gaucho® applied to seeds worked as well as soil applied Lorsban® in 1999, and satisfactorily in 2000. Flea beetles were the principal cause of damage at emergence and are well controlled by Gaucho®. Approximately 7 to 10 days after emergence, armyworm control can become important. At this point, an effective post-emergence insect control measure may be required in Gaucho®-treated plots. In 2000, the lower, less expensive rate of Gaucho® worked as well as

the higher rate, and very little armyworm control was required.

3. Establishing a large percentage of seeds as seedlings both saves growers money on seed costs and may make thinning unnecessary. Reducing the amount of pesticides applied has imputed environmental benefits.

4. Some post-emergence insect protection remains important in the Imperial Valley when fields are irrigated early in the fall, but the amount may be reduced by using a seed treatment insecticide like Gaucho®.

References

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Table 1
Cultural comparisons between years.

Year	Irrigation date	Planter type	Planting rate (seeds/ac)	Pre-irrigation	Days since irrigation for observations
1999-2000	Sept. 19	Monosem (vacuum type)	144,600	yes	10/16/19/25
2000-2001	Sept. 15	Milton	90,000	no	10/19/26/46

Table 2

Treatments and associated costs in 1999*

Number	Description	Pesticides used	Type of application	Cost ($/ac)
1	Standard practice in the region (Growers')	Lorsban 15G, Lorsban 4E,Diazanon4E	Soil applied with seed + 3 aerially	**73.49**
2	Seed applied systemic insecticide, (Gaucho)	Imidicloprid (45 g Gaucho)	With seed	**72.34**
3	No pre- or post-emergence treatments (Control)	none		
4	*Bacillus thuringiensis* application post-emergence (Bt)	Xentari	4 aerially	**91.28**
5	One application of standard pesticide (1X)	Lorsban 4E	Aerial	**15.84**

Treatments and costs in 2000**

Number	Description	Pesticides used	Type of application	Cost ($/ac)
1	Standard practice in the region (Growers')	Lorsban 15G,Lorsban 4E Diazanon 4E	Soil applied with seed + 3 aerial applications	**64.15**
2	Seed applied systemic insecticide (Gaucho)	Imidicloprid (Gaucho)	With seed	**43.40**
3	Seed applied systemic insecticide (Gaucho)	Imidicloprid (20 g Gaucho)	With seed	**19.30**
4	No pre- or post-emergence treatments (Control)	none		
5	Seed applied systemic insecticide (Gaucho) One application of standard pesticide (1X)	Imidicloprid (Gaucho, 45 g), Lorsban 4E	With seed and aerially	**60.55**

* In 1999, seed was planted at 144,600 seeds per acre. ** in 2000, seed was planted at the rate of 90,000 per acre.

Table 3
Seedling emergence and establishment at thinning.

Treatment	Cumulative emergence (% of seed)	Cumulative post-emergence mortality (% of seed)	Cumulative post-emergence mortality (% of seedlings)	Established (% of seed)	Pre-emergence mortality (% of seed)
			1999		
1. Grower's	82.2	2.7	3.5	79.3	17.8
2. Imidicloprid@45g	79.4	5.1	6.9	74.1	20.6
3. Control	56.3	8.1	15.6	47.5	43.7
4. Bt	55.6	5.5	7.1	49.7	44.4
5. Control + Lorsban (1x)	58.2	6.2	11.5	51.6	41.2
			2000		
1. Grower's	49.2	6.6	13.4	42.6	50.8
2. Imidicloprid@45g	38.7	—*	—*	29.0	61.3
3. Imidicloprid@20 g	38.9	5.6	14.6	33.2	61.1
4. Control	32.9	9.4	28.6	23.5	67.1
5. Imidicloprid@45g + Lorsban (1x)	38.3	7.4	19.2	31.5	67.1

*plots damaged by cultivation before counting

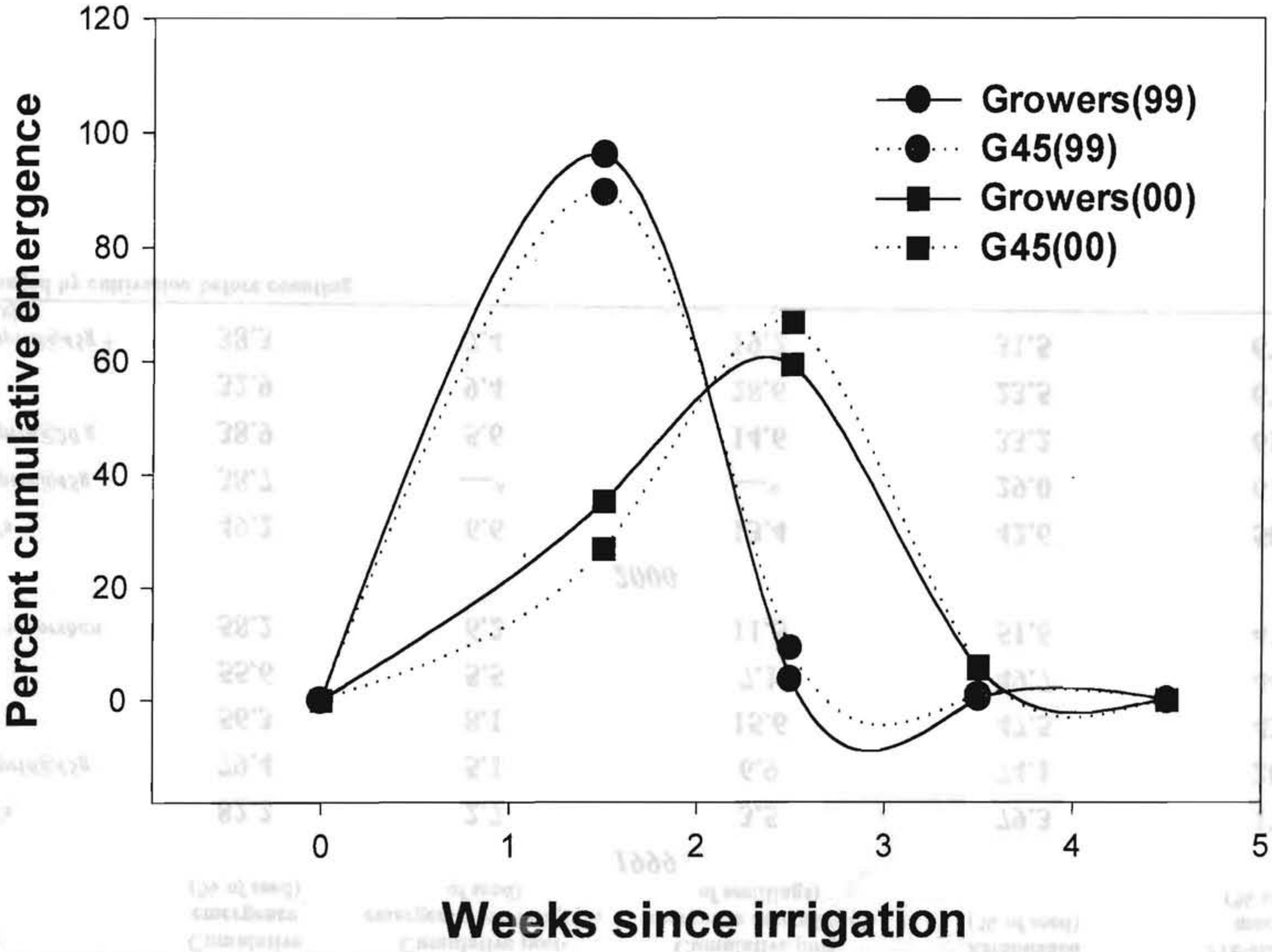

Fig. 1. Comparisons between the rate of emergence in 1999 and 2000. G45 is Gaucho applied at 45 g per unit