CALIFORNIA LEAFY GREENS RESEARCH PROGRAM

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CONTROL OF SOIL PESTS WITH BAND STEAM FOR LEAFY GREENS

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ABSTRACT

The project seeks to develop a band steam applicator to inject steam in a 4-inch band aligned with the seedline prior to lettuce planting. Steam was applied alone and in combination with quicklime, a compound that reacts with moisture in the soil to release heat in combination with heat from steam. Steam was applied in August 2017, and then Romaine and iceberg lettuce were transplanted into the plant line. Data gathered were weed density counts and percentage of lettuce plants infected with lettuce drop. The weed control in the steamed band was excellent. Lettuce drop control in the steamed band was not different from the no steam control. Efforts are underway to redesign the steam applicator to provide better control of lettuce drop and new work will be conducted in 2018 with funding from a USDA competitive grant.

OBJECTIVE

Development of a band-applied steam applicator system to minimize lettuce drop incidence and weed emergence in the lettuce seedline.

Band Steam Treatment of Soil. Use of steam to raise soil temperatures to 158°F for 20 minutes has long been known to kill soil pests (Baker and Roistacher 1957). Steam treatment of the entire field may cost more than $5,000 per acre, but application of steam in bands to targeted areas may greatly reduce this cost. Our objective is to developing a practical steam applicator for lettuce. The approach is: (1) design an applicator for optimized steam treatment of soil strips of a defined area (e.g. 4 in wide x 2 in deep), and (2) build and test the prototype applicator (Fig. 1).

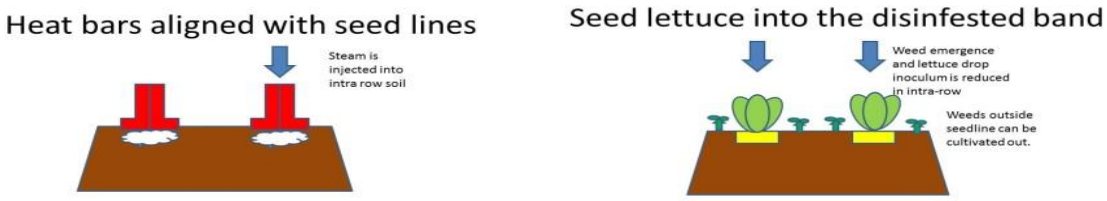

Fig. 1. Treatment sequence: steam is injected into intra-row space (left), and lettuce is seeded into the disinfested band (right).

PROCEDURES

Field Assessment of Thermal Soil Disinfestation System. Prior to treatment evaluation the field site was artificially infested with the lettuce drop pathogen May 2, 2017 to ensure that the disease pressure would be sufficient to evaluate the performance of the device. Lettuce was seeded May 4 and allowed to become infected with lettuce drop to build up inoculum.

We fabricated a simple channel iron design that applied steam to a 4-inch band (Fig. 2). Steam was applied with and without quicklime to the intra-row band on raised beds as shown in Fig. 2 below on August 28 and 30, 2017 raising the soil temperature to 158°F. Then lettuce was transplanted into the treated band on August 31, 2017. Steam was generated using a Sioux 20 HP steam generator (Sioux Corp. Beresford, SD). Treatments tested were steam alone, steam plus quicklime 3600 lbs. per treated acre, and the control. Quicklime was applied with a Gandy applicator just in front of the steam injector bar so that the exothermic heat was released with the steam heat. Previous results have shown that the exothermic reaction between quicklime (calcium oxide) and water is complimentary to steam disinfestation of soil (Luvisi et al. 2008). Onset Hobo data loggers were used to measure soil temperatures at one inch depth for 24 hours after application.

Treatments were replicated five times and arranged in a randomized complete block design. Data was subjected to ANOVA and mean separation was assessed using Fisher's protected LSD. Assessments were weekly counts of lettuce drop infected plants, stand counts, crop yield, and weed densities by species.

Fig. 2. Steam application wide view (left), close up (right).

RESULTS AND DISCUSSION

The steam and steam plus quicklime treatments increased soil temperatures above 140°F for 13.5 and 9.5 minutes, respectively (Table 1). This temperature was a bit low as the target with steam for soil disinfestation is >158°F for 20 minutes. The weed control, consisting mostly of common purslane, was excellent in the 4 inch steamed band on the seedline.

Table 1. Weed densities, weed control and minutes above 140°F immediately following steam injection.

Treatment	Time above 140°F	Weed densities Sept. 26, 2017	Weed control Sept. 26, 2017
	Minutes	Number/ ft.^{2}	% control
Steam	13.5 A	2.6 B	93
Steam + quicklime	9.5 A	1.6 B	96
Non-treated	0.0 B	37.2 A	0
Treatment P	<0.0001	<0.0001	--

Percentage lettuce drop infected plants was not different between plants grown in the steamed band vs. the non-treated control (Table 2). On October 4, the results looked promising with a 6.7% non-significant difference between steam and the non-treated control. However, possible benefits from band steaming disappeared as the lettuce grew. There was no obvious benefit from the co-application of steam with quicklime.

Table 2. Percentage of plants infested with lettuce drop following steam and steam plus quicklime applications during October 2017.

Treatment	Oct. 4, 2017	Oct. 12, 2017	Oct. 19, 2017	Oct. 25, 2017
	---------- % infected plants ----------			
Steam	1.5	5.0	10.1	22.2
Steam + quicklime	2.9	2.9	16.0	30.1
Non-treated	8.2	8.1	14.9	31.1
Treatment P	0.1395	0.4261	0.4295	0.1508

Summary

This was an initial design of a steam applicator and it worked with limited success on weeds, but less so for control of lettuce drop. Funding has been secured from the USDA Crop Protection and Pest Management program and a new design for a steam applicator is being built and tested to improve upon the results of this work.

References

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