Issue 2, September, 2005

Organic Research Matters

A publication of the USDA-ARS Organic Research Program in Salinas, California.

From Eric's Desk

Greetings! This is the second issue of this relatively new newsletter that communicates research results and updates readers on developments at the USDA-ARS Organic Research Program in Salinas. *Organic Research Matters* is now available on line at the USDA ARS web site at www.ars.usda.gov/Research/docs.htm?docid=6607.

This past year was busy with year round trials. We completed the 2nd and final year of several winter cover crop trials including (1) a seeding rate and planting arrangement trial at three locations, (2) a trial with several common and novel winter cover crop mixtures at two locations, and (3) a trial on weed control in cover crops with the rotary hoe. The first year results from the seeding rate and rotary hoe trials were summarized in the first issue of *Organic Research Matters*. We are in the process of analyzing the data from these trials and preparing papers for publication.

In addition to the short-term (i.e. 2 year) trials mentioned above, we also completed the second year of our long-term systems study. This multidisciplinary trial was featured during the annual Cover Crop Field Day in February 2005, and focuses on the impact of cover crop variety and seeding rate on weeds, soil quality, winter water usage, and profitability of organic vegetable production. I encourage you to attend the Cover Crop Field Day in February 2006 to learn about the latest results from this trial. The date of the Cover Crop Field day will be announced in an upcoming issue of Monterey County Crop Notes.

Eric with romaine lettuce from the systems trial in May, 2005. The head on the right is from a plot where a legume-rye winter cover crop was grown, and the head on left is from a plot that was fallow over the winter. Both plots received 5 tons/acre of yard waste compost and 65 lbs/acre of nitrogen from an organic pre-plant fertilizer (4-4-2) prior to transplanting the lettuce.

Much of the research described here would not have been possible without the dedication and efforts of Dr. Nathan Boyd, a Canadian post doctoral researcher in my program. For the past two years I have had the pleasure of working with Nathan. He has made numerous contributions to the organic research program, and will began a permanent position at the Nova Scotia Agricultural College in Canada in November. He will be working on weed management in wild blueberries, and vegetables. Nathan and I have worked side by side on all aspects of the research program from mixing cover crop seeds and counting thousands of weeds, to spraying clove oil herbicides and trapping gophers. We have had some frustrating moments like when we burned out the electrical wiring on our fancy grain drill and had to rewire it before the rain began. We have also had lots of fun and laughs like the time Nathan was covered in liquid organic fertilizer from a loose injection hose. We have many good memories and Nathan will be missed but I am extremely pleased that he has found meaningful position at a time when the job market for agricultural scientists is tough.

Nathan and Eric in hair nets during our 2005 lettuce harvest.

Thanks for supporting change in agricultural research by supporting organic farmers. Please don't hesitate to contact me to give input on the organic research program or this newsletter.

Sincerely,
Eric B. Brennan, Ph.D. (Research Horticulturist)

Stale Seedbed Techniques for Organic Vegetable Production

Nathan. S. Boyd, Eric. B. Brennan, and Steven A. Fennimore

Weed management in organic vegetable production is challenging and can be expensive. Weeds emerging with crops planted at high densities (i.e. baby spinach and spring mix) are generally removed by hand. Creating stale seedbeds may minimize the number of weeds that emerge in the crop and could reduce hand weeding costs. A stale seedbed is formed when weed seeds in the top few inches of soil are ger-minated with pre-irrigation and killed prior to crop planting. Three inches of irrigation water is typically added to ger-minate weeds in California. The weeds are then killed with a variety of techniques including shallow cultivation and pro-pane flaming.

The most effective techniques used to form a stale seedbed minimize soil disturbance and the movement of weed seeds from deep in the soil profile into the shallow zone where they can germinate. Herbicides and flamers do not disturb the soil and should minimize the number of weeds that emerge with the crop following stale seedbed formation. Many shallow tillage implements may also be used to form stale seedbeds and may, in some instances, be more effective than zero disturbance techniques. We recently completed a trial comparing the effectiveness and cost of creating stale seedbeds with various implements and techniques that ranged from zero to high soil disturbance. We expected less weed emergence with the crop when stale seedbeds were formed without disturbing the soil.

Organic baby spinach growing after stale seedbed formation

Methods. The experiment included three trials at the USDA-ARS certified or transitional organic research land in Salinas during the summer and fall of 2004. The results from two of these trials are described here. The fields were cover cropped the previous winter (October to February), mowed and cultivated to incorporate the cover crops in the spring, and the field left fallow until the beginning of the experiment. A roto-tiller/bed shaper combination[1] implement was used to form flat, smooth, 80" wide beds at the beginning of the experiment. Three inches of sprinkler irrigation was applied at site 1 in July and site 2 in September to germinate the weeds.

Six implements were tested for their weed control potential on the pre-irrigated beds including: (1) a flamer using 21 lbs/acre of propane, (2) an application of 10% clove oil[2] at 30 gallons/acre (site 1) or 15% clove oil at 50 gallons/acre (site 2), (3) a sled with top knives, (4) a rolling cultivator[3], (5) a rotary hoe[4], and (6) the roto-tiller/bed shaper combination. A single pass was used for all techniques except the rotary hoe, where two consecutive passes in opposite directions were used. Weed control operations occurred 15 to 19 days after the initial irrigation, when weeds were at the 2 to 4 leaf stage (site 1) and the cotyledon to 1 leaf stage (site 2). Thirty rows of baby spinach were planted on the bed 1 to 2 days after the weed control treatments. Weeds were counted and identified 1 day before applying the weed control treatments, 1 to 2 days later, and at least 15 days after spinach planting.

Results and Discussion. The dominant weeds were broadleaf species such as hairy nightshade, shepherd's purse, and chickweed. Although the bed shaper was the most effective implement, it may not be the most appropriate tool to form stale seedbeds because (1) it is more expensive to operate and maintain than the rotary hoe, rolling cultivator, or top knives, and (2) it causes high levels of soil disturbance that may degrade soil physical properties and increase organic matter losses. The rotary cultivator, rotary hoe, and top knives removed 95 to 99% of all weeds when they were small (cotyledon to 1 leaf stage) but were less effective on weeds at the 2 to 4 leaf stage (Figure 1). The rotary hoe is especially sensitive to weed size and is most effective on seedlings just before, or after emergence. All implements, except the bed shaper, controlled broadleaf weeds better than they controlled volunteer rye. Implement effectiveness also varied with broadleaf species (Table 1).

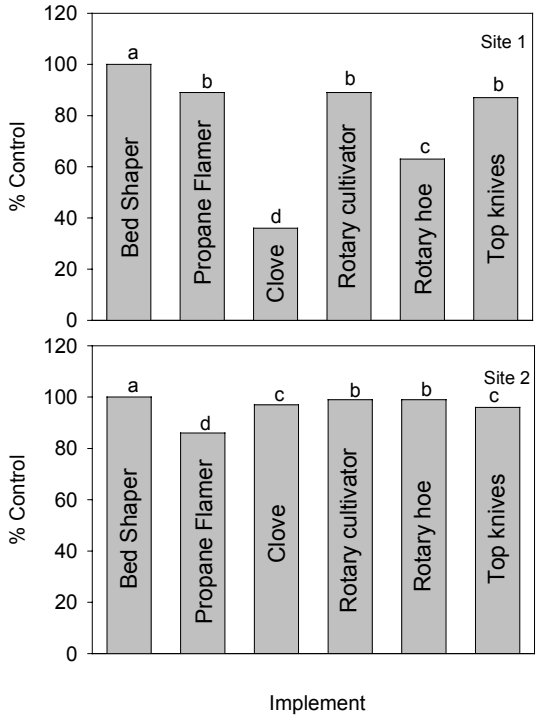

Figure 1. *Control of broadleaf weeds by various implements.*

The effectiveness of implements that do not disturb the soil surface varied. Clove oil was most effective at concentrations of 15% in 50 gallons of solution/acre (Figure 1). The propane flamer killed 86 to 89% of the weeds over a range of sizes. The scientific literature suggests that 9 to 36 lbs/acre of propane will kill 95% of weeds at the cotyledon to 4 leaf stage. It takes more heat to kill larger weeds (4 to 12 leaves) and requires between 36 to 134 lbs/acre of propane to achieve 95% removal depending on species. Neither the clove oil nor the propane effectively controlled rye. Volunteer rye can be a problem when rye cover crops set seed.

Fewer weeds emerged with the spinach crop after stale seedbed creation with the clove oil and the propane flamer than in stale seedbeds created with the shallow tillage implements (Table 2). The total number of weeds in the crop, including weeds germinating in the crop and those that survived during stale seed bed formation, was significantly lower with the flamer and clove oil treatments (Table 2).

[1] Plantivator, Johnson Farm Machinery Co. Inc., Woodland, CA.
[2] Matran 2, EcoSmart Technologies, Franklin TN.
[3] Lilliston, Bigham Brothers Inc., Lubbock Texas.
[4] Yetter farm equipment, Colchester, Illinois.

Table 1. *Percent control of individual weed species by various implements.*

Implement	Burning nettle	chickweed	Hairy night-shade	Little mallow	purslane	Shepherd's purse
Bed shaper	100 a[1]	100 a	100 a	100 a	100 a	100 a
Flamer	65 b	100 a	91 b	67 d	82 b	55 b
Clove oil	100 a	94 b	99 a	86 c	96 a	100 a
Rotary cultivator	99 a	100 a	99 a	76 cd	100 a	100 a
Rotary hoe	100 a	99 a	99 a	97 ab	100 a	100 a
Top knives	97 a	98 a	94 ab	72 d	98 a	97 a

[1]Mean within columns followed by different letters are significantly different at $P<0.05$.

Therefore, although fewer weeds were killed with clove oil or the propane flamer, fewer weeds would need to be removed by hand weeding in these treatments than where the shallow tillage implements were used. We are uncertain if the in-crop weed differences among the various stale seedbed treatments would result in significant differences in hand weeding cost between the treatments.

The rotary cultivator, rotary hoe, and top knives were the fastest implements with the lowest labor costs, whereas, the bed shaper was the slowest technique with the greatest labor costs. The herbicide and the flamer were the most expensive techniques at $1389 and $204/acre, respectively. The rotary cultivator, rotary hoe, and top knives were the least expensive techniques ranging from $174 to $178/acre. The propane flamer cost $26 to $30/acre more than the least expensive implements but also created stale seedbeds with fewer weeds in the crop (Table 2). The current cost of the clove oil herbicide make its use prohibitive for broadcast applications.

A variety of organic compliant techniques may be used effectively to form stale seedbeds. The appropriate implement may vary between growers and should be selected based on operating cost, on-farm availability, and efficacy.

Table 2. *The number of weeds killed with various implements during stale seedbed formation, the number of weeds in the crop, and the cost of stale seedbed formation.*

Implement	Weeds removed	Weeds[1] in-crop	Cost[2]
	----------Weeds/ft^2----------		--$/acre--
Bed shaper	25	12 a	191
Flamer	22	7 b	204
Clove oil	25	4 c	1389
Rotary cult.	25	11 a	178
Rotary hoe	25	12 a	177
Top knives	24	10 a	174

[1]Includes weeds that survived control measures with the various implements and weeds that emerged after crop planting.
[2]Includes cost of operating implement and tractor, current cost of propane ($1.63/gallon) and herbicide mix (Matran II at $72.35/gallon mixed with Integrate at $19.50/gallon), labor (assuming a salary of $13.84 per hour) and cost of applying 3 inches of irrigation water.

New Rye Variety for Cover Cropping

Eric B. Brennan and Nathan S. Boyd

Several cereals (rye, oats, and barley) that are used for cover crops were included in demonstration plots in the cover crop field day in February, 2003. This included 'Merced' rye, a well known cover crop in this area, and several breeding lines from Dr. Ron Barnett of the University of Florida. Richard Smith and Steve Koike of UCCE Cooperative Extension helped evaluate the resistance of the cereals to rust in the 2003. The rye lines from the University of Florida had excellent resistance to rust relative to 'Merced' rye (Monterey County Crop Notes, September 2003). We evaluated biomass production, rust resistance, and lateness to flower on a larger scale at the USDA-ARS over the winter of 2003 to 2004. One of the breeding rye lines has since been released by the University of Florida and is called 'AGS104'. In our trials, 'AGS104' flowered late, produced as much biomass as 'Merced', and was much more resistant to rust. 'AGS104' is now available from the L.A. Hearne Company in King City. We will conduct a preliminary evaluation of 'AGS104' rye versus 'Merced' rye, in the legume/rye mixed cover crop on our research land this winter.

Nathan with a 6 ft tall 'AGS104' rye cover crop at the USDA-ARS research station on Spence Road in Salinas in April 2004.

Abstract of a Recent Publication

Eric B. Brennan and Richard F. Smith. **Winter Cover Crop Growth and Weed Suppression on the Central Coast of California.** *Weed Technology* (In Press)

Winter cover crops are increasingly common on organic and conventional vegetable farms on the central coast of California between periods of intensive vegetable pro-duction. A 2-yr study was conducted in Salinas, Califor-nia, to quantify (1) cover crop and weed biomass produc-tion during cover cropping, (2) early-season canopy development of cover crops, (3) weed seed production by burning nettle during cover cropping, and (4) weed emer-gence following cover crop incorporation. The cover crops included oats, a mustard mix, and a legume/oats mix that were planted in October and soil-incorporated in Feb-ruary. Weed and cover crop densities, early-season cover crop canopy development, above ground weed and cover crop biomass production, seed production by the burning nettle, and post-incorporation weed emergence was evalu-ated. Mustard produced more early-season biomass than oats and the legume/oats mix. There were no differences in above ground biomass production by the cover crops at the end of their growth period. Suppression of weed bio-mass and seed production of burning nettle was greatest in mustard, and least in oats and the legume/oats mix. The weed suppressive ability of each cover crop was affected by early-season canopy development and was highly cor-related with cover crop plant density. Weed emergence following cover crop incorporation was in order of legume/oats mix > oats > mustard in yr 1, but was not different in yr 2. This study provides initial information on cover crop effects on weed management in irrigated and tilled vegetable production systems in the central coast of California. The results suggest that the legume/oats mix could exacerbate weed problems in subsequent vegetable crops.

(Copies of the complete article are available upon request)

Follow up note on the above study. Our on-going research is revealing that the legume/cereal mixes can compete well with weeds when they are planted at higher seeding rates. The rotary hoe also helps control winter weeds in less competitive cover crops (see Issue 1 of *Organic Research Matters*).

Recommended Reading

The evolution of the organic farming movement is complex and fascinating for both scientific and socio-economic reasons. If you are looking for a thought provoking book about organic farming, I highly recommend the recently published *Agrarian Dreams: The Paradox of Organic Farming in California* (University of California Press, 2004) by Dr. Julie Guthman of the University of California, Santa Cruz. I found this book to be a comprehensive, insightful, and valid critique of organic farming……that I believe will inspire and energize new and ongoing efforts to develop and imple-ment more ecologically sound agricultural systems. I would be very interested to hear what you think about *Agrarian Dreams*. EBB

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All issues of *Organic Research Matters* are now available on the web at www.ars.usda.gov/Research/docs.htm?docid=6607.

Mention of trade or company names is not an endorsement.