ORGANIC FARMING RESEARCH FOUNDATION

P.O. Box 440
Santa Cruz, CA 95061

tel ~(831) 426-6606
fax ~ (831) 426-6670

email ~ research@ofrf.org
web ~ www.ofrf.org

Organic farming research project report submitted to the Organic Farming Research Foundation:

Project title:

Cucumber beetle mass trap development and field evaluation

FINAL PROJECT REPORT

Principal invistigator:
William Olkowski
BioIntegral Resource Center
1615 Anacapa St., Santa Barbara, CA
805-965-8869
wolkowski@earthlink.net

Farmer cooperators:
Jim and Debra Durst, Hungry Hollow Farms, Yolo County, CA

Support provided by OFRF: Total awarded $9,000; $5,000 awarded spring 1997, $4,000 awarded spring 1998

Project period: Two years, 1997-1998

Report submitted: July 1999. Report length is 9 pages.

Summary
In 1997 a series of cucumber beetle trap prototypes were evaluated in the field at Hungry Hollow Farms operated by Jim and Debra Durst in Yolo Co., north of Winters and West of Woodland, CA. Based on the 1997 tests, a modified trap was developed for testing In the 1998 season. The chief characteristics of this trap are: 1) large catch volume, 2) inexpensive, and 3) the potential for mass production by a grower with locally purchased materials. This report summarizes findings on trap operation with suggestions for further improvements. Beetle behavior as it can affect beetle management is also discussed.

This group of beetles was reported to be the most important pest problem faced by organic growers in a previously published survey conducted by OFRF. There are two types of cucumber beetles problematic in California, the western spotted cucumber beetle and the striped cucumber beetle (also called *Diabrotica* beetles, since both are in the same genus. See Attachments and the previous report for further information.

Introduction
On most farms, Diabrotica beetles are only severe in certain years, a pattern for which there is yet no analysis. Therefore, for most organic farms these beetles are tolerable in most years. However, in certain seasons some help in reducing numbers may mean the survival of many crops, particularly where beetle damage to seedlings essentially destroys the crop. Example crops are beans and early season cucumbers. Sweet corn is also such a crop, although the damage only interferes with the proportion of kernels which are fertilized.

Where destruction of the crop is likely, the extra effort given to building and operating these traps could be important. Since the larvae develop in the roots of grasses and the adults overwinter in a wide variety of places, mass trapping can be used where the standard contact insecticides are not applied. For small plots handpicking may be possible as described elsewhere (Olkowski et al, 1991) but a trap offers adult beetle reductions on a large scale.

All sticky traps currently on the market have a limited trapping capacity and are costly. These characteristics make mass trapping unlikely to be tried by growers. However, a low cost trap with a high capacity could bring mass trapping within the reach of many small growers.

<u>The BIRC Trap</u>

The design discussed here was developed by William Olkowski and Art Berlowitz, formerly employees of BIRC (the Bio-Integral Resource Center, a non-profit organization). This trap (i.e.,the BIRC trap)is inexpensive to build and operate. It also has a virtual unlimited catch capacity. Low cost means many traps can be used in a particular setting. This trap also has the possibility of being used against many other insects if the proper lure or attractant is available.

Trap Description
The trap is drawn in the Figure 1 as it was used in 1998. 12 traps were constructed but only 10 were deployed as the tape supplier only provided 20 full rolls of tape. 50 hours were used in purchase and construction, at a cost of about $240.00. The averages per trap are therefore: 4.2 hrs construction time and $20. Once some practice occurs with construction these costs can be reduced to 2 hrs or less per trap.

Two rolls of plastic yellow sticky tape are used per trap along with two empty rolls to take-up the tape when it is full of insects or when it has lost its stickiness. The yellow sticky tape is purchased in 1000-foot rolls for about $40/roll. Bulk purchases can reduce this cost considerably. Although both the western spotted and striped cucumber beetles are caught in this trap the spotted predominated in 1998 at the Durst's Farm and probably do so throughout the state.

Apparently the yellow color of the sticky tape is the attractive element. Previously, considerable effort was expended to evaluate the attractant chemical provided by Consept (Oregon) in 1997 to no avail. It seems that the Western Spotted Cucumber Beetle is not attracted by a lure that works for eastern species. Consequently trap development proceeded without a specific chemical lure or attractant. If and when such an attractant becomes available it will make this trap much more effective. See below for analysis of trap catches from the 1998 season.

A single trap is made of a 10 ft long 2 x 4 with short (3 inch) pieces of 4 x 4 attached to each end (see Figures 1-2). Aluminum legs are attached to the 4 x 4 pieces with two carriage bolts. Holes (9/16 in diameter) were drilled into the 2x4 seven inches from both ends. 1/2 inch steel rods were inserted through these holes so as to leave about 1/2 the length extended from both sides.

Mounting Rods and Reels

These rods held the purchased yellow sticky tapes (Hopperfinder, from Cindy Bishop at Western Farm Service, 209-897-1200; 24730 13th Ave., Madera, CA 93637) dispenser and take-up reels. Two full reels are mounted at one end, one above the 2 x 4, the other below. The take-up reels were provided by the suppliers of the purchased reels and were the same sized reels without the sticky tape. The dispensing reel was placed over the threaded steel rod and held in place with a washer and bolt both above and below each reel.

The take-up reel was a smooth steel rod over which a piece of aluminum (1/2 in. diameter) conduit was placed. The conduit was held down with a cotter pin inserted through the steel rod. An improvement would use a threaded rod in place of this design since a threaded rod would allow for firm mounting, although it would increase the cost somewhat

Guide Rods and the Three Tape Guide Units

Three other holes (diameter 1.25 in) were drilled through the 2 x 4 to hold the tape guide unit. These units were composed of two 16 inch long steel rods (not threaded) held apart (1/ 2 in) so as to allow passage of the sticky tape. They are held apart with a piece of hard wood (0. 5 inch thick, 6 inch long by 2 Inch wide) through which two 0.5 inch holes are drilled 0.25 inches apart. The rods are pushed through the holes while mounted in a vice with the use of a hammer. The first wood piece is used to hold the two rods and then is inserted to the 2 x 4. Then the other wood piece is installed over the rods while the unit is in the 2 x 4.

Once the rods are driven half-way through one wood piece they are inserted through the 2 x 4 and the other small piece is driven down over the two rods to hold the rods to the 2 x 4. A piece of plastic or bailing wire is used to hold the two rods together while held to the wood pieces on one side close to the wood piece. This detail is important, as these guides hold the tape against the wind aver a stretch of 5 feet.

After passage of the tape these rod units were turned to hold the tape in tension so as to present a flat surface to the attracted beetles.These rod units and this system of holding the tape tense are the key to allowing a maximum distance of almost 5 feet between rod units. Without these guide units the tape would not be able to span 10 feet and the traps would need to be smaller and therefore less efficient. Longer lengths of 2 x 4 are possible. The guide units are held against the 2x4 with large one inch butterfly clips which can be purchased in any office supply store.

Design Details: Discussion
A 10 foot length of 2x4 was selected for these studies as they can fit easily into a pickup truck bed. Other lengths are possible, but the 5-foot maximum length of sticky tape should be used to position the tape guide units. Aluminum conduit was selected for the legs because it is readily available as recycled scrap and is inexpensive. Wooden legs could be substituted for the conduit (see discussion of possible trap improvements below).

Limitations and Suggested Improvements in Trap Design
Two times during the trapping period a trap was found turned over by the wind. At other times the tape was slacken so as to compromise that weeks trap catches. For comparative analysis (see below) these trap catches were dropped from further consideration even though they captured beetles. The original idea for having the trap with a movable feature was to be able to test the angle of the trapping surface vs. beetle catch.

Another feature of a turnable trap was to aid in servicing since the lower spool was difficult to pull from the clean roll and the takeup roll was similarly more difficult to access than the upper roll. The idea was to spin the trap so the lower reels were upright, more accessible for resetting a new sticky surface, and then twist the trap back to its original catching position. Although this is still an excellent arrangement some device is needed to prevent the trap from being blown over.

Two different possibilities arise to fix this problem: 1) eliminate the twisting feature by having different legs made from plywood as indicated in Figure 3, part A. The second method uses the same aluminum legs but modified with an arm attached to a downward wood piece attached to the end 4 x 4 piece (Figure 3, part B). The two new wood pieces are held together with a bolt to prevent the trap from twisting.

One of the principle problems with the 1998 trap was the difficulty in renewing the sticky surface. Part of the problem is that the sticky surfaces are not strongly attached to the reels but rely on the sticky materials to hold to the reel centers. To use the 1998 trap and renew the surface one must pull the sticky surface from the large reel by hand so that the surface with the full insect catch can be taken up on the empty reel. Latex gloves are needed to make this as tolerable as possible. When we tried to do this with just our hands they became too sticky.

Near the end of the season we experimented with a device much like a handle attached to both reels so it would be possible to unwind the reel enough so that the second- or take up- reel could be easily turned and the loose tape can be taken up on the empty reel in the easiest manner. This improvement is sketched out in Figure 3, part C. With handles on both the take-up and dispensing reels it is possible to let out some tape from the new clean sticky reel and then take u p the old tape on the empty reel. Two people can do this most easily, but one person can do it with some additional effort. If a method can be developed to attach the old tape to the empty reel so it remains connected to the inner sections only, an empty reel with a handle would be needed.

Trap Catches of Beetles in 1998

Unfortunately, the 1998 season in the Yolo County area where the field tests were conducted was not a heavy year for cucumber beetles. Although the traps performed well in catching beetles the amount of damage to squash blossoms was not serious enough to give an indication that mass trapping was still worth pursuing as a concept. Bonnie Hoffman counted and serviced all traps except for setting up on 7/9/99 and one date (8/ 17/ 99) when William Olkowski did so.

The catches on the traps are summarized in Table 1. The trap locations in relation to the different crops are indicated in Figure 4. The most important findings from the 1998 trapping season are: (1) The trap worked to capture a large number of beetles and provided some important observations on the biology of the beetles, 2) certain design features need to be changed to improve serviceability, and 3) trap location is critical for improving trap catches. Trap redesign has been discussed previously while the other two subjects are discussed below.

Interpreting Beetle Captures

As Table 1 indicates, almost 7, 000 beetles were captured during the flight season of the beetles, the major portion of which started about the first week in July and ended by the second week in September. The orange shaded figures are catches corrected for the times when the particular trap had fallen over or the sticky surface had been blown by the wind and had been folded which reduced its catching surface. Such times are indicated by the zeros. The design changes to prevent these occurrences are discussed in the other section of this report.

To correct for the times when the catch was compromised the total catch for the date or the trap was divided by the number of active traps. For example, for August 27 there were 10 traps operating so the total of 1669 was divided by 10 to give 166.9. Similarly on Sept. 9 the total per active trap was 79.9. To provide a comparison to other traps and other years these totals should be divided by the total trapping surface. Thus the total of one surface of sticky tape 6 inches high and 10 feet long ss 5 sq. ft. and since both surfaces are sticky the total effective surface is 10 sq. ft. A capture of 512 beetles on Aug. 27 means 51.2 beetles were caught per sq. ft. The highest catch in the previous year when different traps were compared was 11.2 beetles/sq. ft. Thus trap efficiency was improved 5 fold.

Trap Height and Beetle Flight

In 1998 the trap was designed to test flight height and direction of beetle flight on trap catch. For the first two trapping periods the lower spool of sticky tape was operated. Afterwards this was discontinued because it was too difficult to change the roll due to its inaccessibility. This problem was reconsidered in the redesign changes discussed previously.

Nevertheless, the greatest proportion of the beetles in this field were being captured by the upper roll, the height of which started at about 20 inches above the soil surface (19 inch high legs and 2 inch thick 2 x 4). The sticky surface therefore arose from 20 to 26 inches above the soil. The melon crop during this period only grew up to a maximum of 6 inches. Thus the trapping surface was about two feet above the crop. The lower reel had its sticky surface at 3 to 9 inches above the soil. An example describes the pattern of observations. On 7/30 trap number 3 captured 129 CBs on the West Upper reel but only 8 on the lower West side. This pattern was repeated for all traps on 7/23 and 7/30 and was the principal reason for discontinuing use of the lower reels.

Table 1. Cucumber Beetle Catches at Durst Farm, Yolo Co., CA 1998.

Trap #		23-Jul	30-Jul	6-Aug	17-Aug	27-Aug	9-Sep	16-Sep	Totals by trap	Catch/ period
		DATES								
1	E	14	36	28	55	64	93	5	295	42.1
	W	47	49	32	62	55	61	7	313	44.7
	Total	61	85	60	117	119	154	12	608	
2	E	1	11	13	13	23	58	14	133	19.0
	W	10	15	12	22	72	20	19	170	24.3
	Total	11	26	25	35	95	78	33	303	
3	E	101	129	85	0	294	58	1	668	95.4
	W	160	129	95	0	218	69	7	678	96.9
	Total	261	258	180	0	512	127	8	1346	
4	E	38	59	0	58	58	42	33	288	41.1
	W	69	73	0	85	57	92	46	422	60.3
	Total	107	132	0	143	115	134	79	710	
5	E	43	105	26	0	77	63	0	314	44.9
	W	56	232	21	0	87	52	0	448	64.0
	Total	99	337	47	0	164	115	0	762	
6	E	16	50	25	60	62	6	16	235	33.6
	W	32	91	26	54	123	25	11	362	51.7
	Total	48	141	51	114	185	31	27	597	
7	E	35	101	14	44	48	11	0	253	36.1
	W	76	165	10	32	68	15	0	366	52.3
	Total	111	266	24	76	116	26	0	619	
8	E	21	52	41	54	39	8	9	224	32.0
	W	31	92	31	27	61	2	7	251	35.9
	Total	52	144	72	81	100	10	16	475	
9	E	0	49	37	139	84	0	0	309	44.1
	W	0	129	41	45	108	0	0	323	46.1
	Total	0	178	78	184	192	0	0	632	
10	E	84	35	36	79	37	18	0	289	41.3
	W	123	74	42	92	34	26	0	391	55.9
	Total	207	109	78	171	71	44	0	680	
Total East		353	627	305	502	786	357	78	3008	
East/Trap		39.2	62.7	33.9	62.8	87.3	39.7	13.0	334.2	
Total West		604	1049	310	419	883	362	97	3724	
West/Trap		67.1	104.9	34.4	52.4	98.1	40.2	16.2	413.8	
Active Traps		9	10	9	8	10	9	6		
Grand Total		957	1676	615	921	1669	719	175	6732	
Total /Trap										

See trap redesign for further discussion of trap height. The data from the lower reels was not included in the table since it only serves to complicate the presentation and the main, more important observations.

Beetle Flight Direction

The direction of beetle movement toward the trapping surface tells an important story about trap location and source of beetles. From Table 1 one can see that there are two peaks in catches per active rap.. July 30 and August 27. The August 27 peak is associated with the cutting of the large alfalfa field to the West of the main line of traps, i.e, 1-8 (see Figure 4).

Overall the traps closely adjacent to the alfalfa field (#3, 5, and 7) caught the most beetles, except for #9 and 10 which were located too far away to affect these numbers. Traps 3, 5 and 7 caught 224, 127, and 103 beetles, respectively. Leaving out #1 since it is essentially within melons on both sides the trap catches for 2, 6 and 8 are: 43, 85 and 68, respectively. The West surfaces of the other traps, which faced the alfalfa field generally had higher catches. Trap #8 had a 15 foot tall line of trees between it and the alfalfa field.

In the 1996 season, during testing of the first prototype trap the migration from alfalfa into cucumber and squash fields was most pronounced during periods of cutting the alfalfa. The significance of alfalfa and beetle control is discussed below in the conclusion section.

Traps number 9 and 10 were located to test the idea that the beetle adults were coming primarily from the field corn across the road from the melons to the East. Although adults could be found in the corn we did not run emergence traps to determine if the adults were arising from the soil as is commonly believed. Trap#9 was second in numbers of beetles caught whjle #10 was 4th in overall catch (per active trap). Corn is another source of adult beetles. It is difficult to compare alfalfa and corn as sources with these observations. However, it is likely that both operate as sources, corn being a source from which the beetles migrate out primarily and alfalfa a source where beetles migrate in until it is cut, then they migrate out.

Peaks of Beetle Captures

There were two peaks in abundance. The second peak during 8/17 and 8/27 is associated with the cutting of the large alfalfa field to the east of the trap line (see Figure 4). The earlier peak may have been associated with another cut but not at the same exact time when the trap was being counted and refreshed. Alfalfa is cut about every 4-6 weeks so the peaks could be related to alfalfa cutting or generation times and emergence of adults. This possibly indicates the existence of two generations. These captures alone cannot distinguish amongst these possibilities.

Natural Enemy Captures

The downside in the use of this trap is that the yellow sticky surface catches natural enemies as well as herbivores. The most common natural enemiees captured are the lady beetle, especially *Hippodamia convergens*, the Convergent Ladybeetle. Green Lacewings, *Chrysoperla carnea,* are the next most captured species. Others observed include brown lacewings, various Tachinids, Ichneumonids and Braconids, among the more obvious of those captured.

In general the loss of natural enemies should not be tolerated nor recommended. Methods to enhance natural enemies should be a priority. However, in speciftc cases and with careful use, the loss of trapped natural enemies may be tolerable compared to insecticide use, which would kill many more natural enemies. In our studies the ratio of pests trapped to natural enemies was low and maybe an acceptable tradeoff. For example, in Table 1 the trap catches listed for August 27 when the highest number of Cucumber beetles

(CBs) was 1669 or 185/trap. On the same date 43 ladybeetles were captured, mostly *H. convergens*. The ratio is 39:1. For every 39 CBs captured one ladybeetle is killed.

On this particular ranch there is no problem with aphids, the principle prey of *H. convergens.* Besides CBs and squash bugs, this farm has no other important pest problems. Minor pests include flea beetles on eggplant and *Blapstinus* beetles which attack seeds and small seedlings in the larval and adult stages. All the surrounding farms are treated with conventional materials. Alfaffa is the principle source of most of the natural enemies on this farm. The total alfalfa acreage is 100 to 200 acres each year. So, the loss of a very small number of ladybeetles and a smaller number yet of other natural enemies is tolerable.

Conclusions
The trap design is effective in catching large numbers of beetles up to 50/sq. ft. Higher numbers and greater efficiency in beetle capture may be possible in years when beetle numbers are much higher. 1998 was not a high beetle year judging by farmer observations and our own field work in Yolo Co. from 1994 to 1998.

Design changes could make the BIRC Trap more effective. The trap is useful in study of beetle flights and sources and possibly in adult beetle population reduction. Further study is needed to determine if mass trapping could be useful in various settings. The most important finding of this work is the influence of alfalfa on beetle concentrations. Alfalfa harbors large numbers of CBs. Alfalfa is not known to be a source of developing CB populations (i.e., place of larval development) but is a food source for adults. The feeding damage to alfalfa leaves by adult beetles is evident but just how much loss is uncompensated by alfalfa plants is unknown.

Work done by Everett Dietrick on a farm in Santa Barbara county, NatureFarm, with strips of alfalfa between strips of various commercial vegetable crops shows that alfalfa could be used as a source of biological controls and a trap crop for CBs (Dietrick et al. 1995). The significance of our observations derived from work with this trap, and the observations by Dietrick et al, 1995, need to be further elaborated into an overall control program for adult beetles. Alfalfa strips and vacuuming can both offer control of adult beetles and a source of natural enemies for overall biological control on the farm.

When alfalfa is cut, and the cucumber beetles migrate out into surrounding crops, use of BIRC traps offers an opportunity to catch these pests. This would be most valuable when adjacent susceptible crops are in the most sensitive periods of growth, ie., seedlings and blossoming.

References Cited

Dietrick, E., J., J.M. Phillips, and J. Grossman. 1995. Biological control of insect pests using pest break strips, a new dimension to Integrated Pest Management California Energy Commission and the Nature Farming Research and DevelopmerA Foundation, Lom@ Ca. 39pfx

Olkowski, W., S. Daar, and H. Olkowski. 1991. Common Sense Pest Control. Taunton Press, Newtown, CT. 715 pp.

Fig. 1. The BIRC sticky trap, 1998.

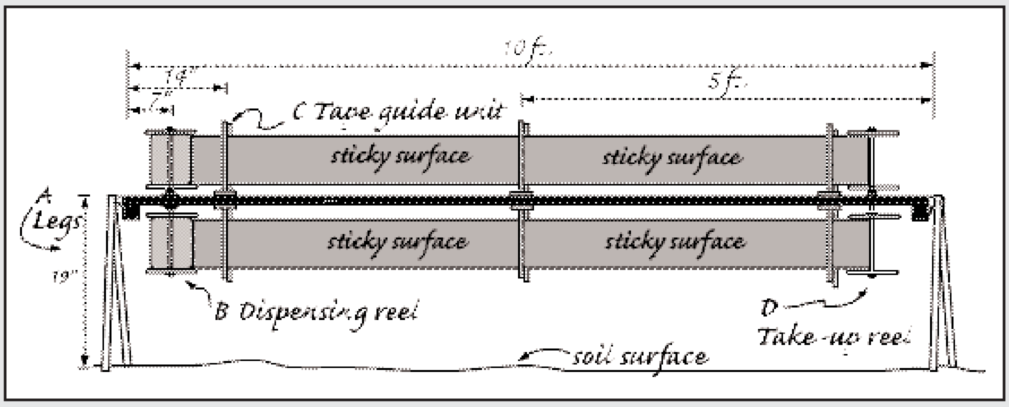


Fig. 2. Design details.

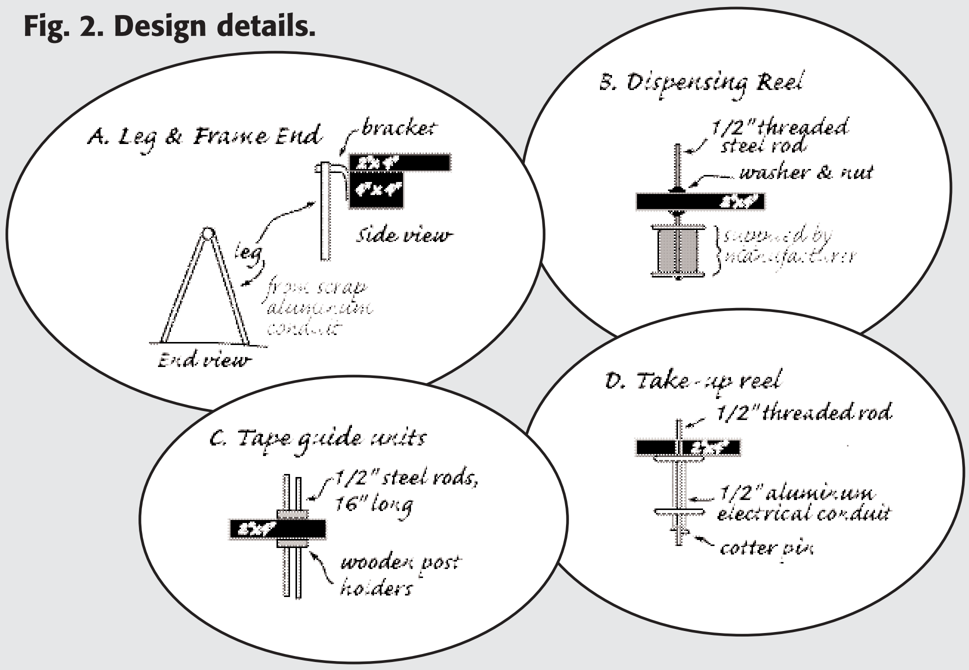
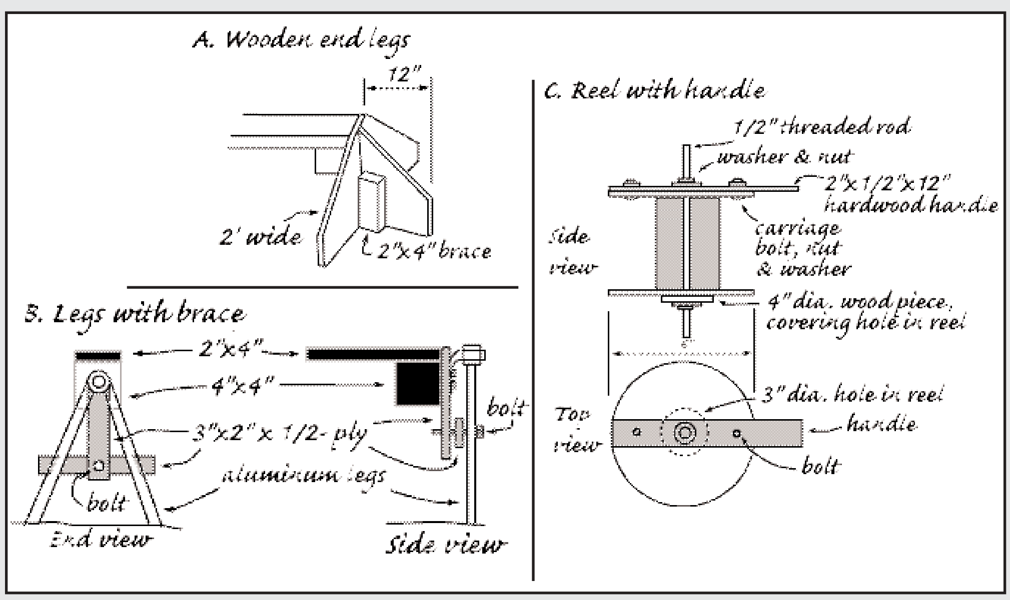


Fig. 3. Suggested design changes



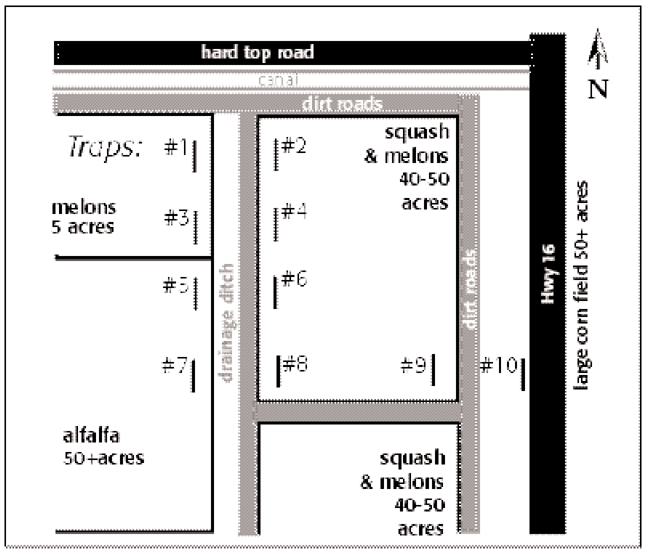


Fig. 4. Field locations of BIRC traps, numbered 1-10,
Durst Farm, Yolo County, CA 1998.