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

Project Title:

Weed control with green manure and cover crops

FINAL PROJECT REPORT

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INTRODUCTION

Weeds pose one of the most important threats to crop production. Losses in both yield and quality of crops due to weeds, as well as costs of weed control, constitute an enormous economic problem in crop production. Weeds have a major influence on the production decisions made by producers. Additional land, labor, equipment, fuel, herbicides, insecticides, fungicides, fertilizer, and irrigation water may be required to maintain economical production when weeds are present.

Weed control in commercial agriculture has depended heavily on herbicides for the last fifty years. However, increased public and regulatory agency awareness regarding potential environmental and health problems associated with pesticide use has paralleled our increased dependence upon pesticides. Herbicides comprise 85% by weight of agricultural pesticides used in United States (21), and herbicide residues have been detected in ground water in at least 33 states (16, 22). Therefore, there is great need to reevaluate weed control strategies that are currently dependent on chemicals (20).

Weed control is difficult when eliminating herbicides and integrating farming practices to lower costs and reduce environmental impacts. However, strategies that might replace herbicides include: use of green manure crops, cover crops, mulches, and competitive crops.

Cover crops or mulches that decrease erosion and compaction may suppress weeds. Cover crops can be sown into a standing crop or a stubble after crop harvest. Successfully established cover crops may develop dense enough canopies in the fall to interfere with the growth of perennial and winter annual weeds. In the spring, cover crops that have been killed by winter conditions (spring cereals), or winter-hardy cover crops (fall cereals, perennial clovers) that have been mechanically killed prior to or soon after planting of the main crop, form an organic mulch on the soil surface. In addition to the physical suppression of weeds by the mulch cover, certain plants used as mulches (e.g. rye and barley) contain allelochemicals that further suppress weed establishment and growth (18).

Research has shown that when fall seeded cover crops are killed in the spring, decomposition of plant residues results in the production or release of phytotoxic compounds that are allelopathic to weed growth (1, 2, 13). Rye mulch suppressed aboveground biomass of redroot pigweed (19). Two benzoxazinones isolated from rye shoots suppressed seed germination and seedling growth in three dicot species that were 30% more sensitive than monocots (16). Additional allelochemicals may result from microbial transformed compounds originally derived from residues (14).

Plant residues on the surface also reduce weed seed germination and seedling growth by shading, lowering soil temperature, and acting as a physical barrier (11). Weed suppression has also been correlated with the amount of residue present (12). Weed biomass was reduced when rye residues were greater than 1.5 T/A (7), and when wheat residues were greater than 1.8 T/A (8). Barnes and Putnam (1) reported that rye residues (1.8 T/A) reduced barnyard grass and redroot pigweed biomass 74% and 55%, respectively, but total weed numbers were not reduced.

There have been frequent reports concerning the reduction of weed populations when winter and spring crucifers are employed as intermediate crops. Spring and winter crucifers contain high levels of glucosinolate which showed strong bactericidal, fungicidal, insecticidal, nematocidal, and herbicidal activity (6, 10, 15, 17). Boydston found that 2.5 T/A of rapeseed foliage incorporated in the soil controlled common lambsquarters, redroot pigweed, and barnyardgrass to a level nearly equal to that of the standard herbicide treatment (4). In addition, foliage of white mustard and rapeseed incorporated in the soil significantly reduced sphepherdspurse and kochia population and biomass (5). Research in Russia has shown that weeds were reduced by 40% when winter rapeseed was used as an intermediate crop. Similarly, a 49% reduction in weed population was recorded when rapeseed was grown in spring (9). Bell and Muller (3) have also recommended post-harvest cropping of cruciferous plants in corn fields, which leads to a reduction of weeds by 90-96%.

Incorporating cruciferae and cover crop plants into a rotation system may decrease weed populations in addition to control of other pests. Using **cover** crops or cruciferae plants in a cropping system approach may reduce weed populations and provide farmers with acceptable weed control, especially when used in conjugation with cultivation.

OBJECTIVES

1. Evaluate and demonstrate the effectiveness of using white mustard, rapeseed, annual rye, and sudangrass as green manure to control weeds without herbicides in green pea, potato, cucumber and mint while renewing soil organic matter and conserving nutrients.

2. Evaluate and demonstrate the value and feasibility of mechanical cultivation to control weeds in green peas in conjunction with green manuring.

GREEN PEAS

The experiment was conducted during 1993-94 growing season at Mount Vernon Research and Extension Unit, Mount Vernon, WA, on Skagit silt loam soil (fine-silty, mixed, nonacid, mesic typic fluvaguents). Soil organic matter was 4.59% and soil pH 5.7. Plots were naturally infested with a high population of common lambsquarters, shepherdspurse, common chickweed, pineappleweed, hedge mustard, common groundsel, redroot pigweed, henbit, and annual bluegrass. Conventional tillage practices were followed.

'Martigena' white mustard, 'Jupiter' rapeseed, 'Wheeler' rye, and 'Cashup' wheat were planted on August 27, 1993. White mustard and rapeseed were planted at 6 lb/A whereas winter wheat and rye were planted at 120 lb/A. Plots contained 18 rows spaced 3.3 inches apart and 120 feet long. White mustard was winter-killed due to below freezing temperatures. Plants were at the bud stage when they froze.

White mustard, rapeseed, rye, and winter wheat plots were subsoil plowed on April 1, 1994, then plants were incorporated into the soil with a rototiller. Immediately after incorporation the soil was compacted by using a roller drum. Total dry weight of white mustard, rapeseed, rye, and winter wheat were 1.7, 3.3, 2.0, 1.6 T/A, respectively.

Ten days after incorporation, plots were rototilled again and 'Bolero' green peas were planted. The seeding rate was 100 lb/A. Plots contained 18 rows spaced 3.3 inches apart. Each plot received three sub treatments, which were 1) weedy check, 2) rotary hoe when pea plants were exposed to 85 heat units, and 3) herbicide (metribuzin at 0.125 lb ai/A). The experiment was a split plot design with four replications. The main plots were cover or green manure crops and the subplots were weed control practices.

Crop injury and total broadleaf weed control were visually evaluated on a percent scale, where 0 = no control or crop injury and 100 = complete mortality. The ratings were made 60 days after planting the peas. In addition, green pea populations and weed populations were measured in 3 m^2 in each plot at 30 days after planting the peas. Number and dry weight of weed plants, green pea population, number of pods per plant, weight of 100 peas, and total yield were determined from 2 m^2 in the middle of each plot.

Weed control varied between pea plots planted after different green manure or cover crops. The highest weed population was in peas planted after winter wheat, whereas the lowest was in peas after rapeseed. Weed population one month after pea planting was 515, 470, 435, and 222 plants/m^2 in pea after winter wheat, rye, white mustard, and rapeseed, respectively. At two months after planting, rapeseed continued to show weed suppression (Table 1). However, at harvest weed pressure was similar in all treatments.

Cultivation with rotary hoe conducted one month after pea planting gave 65% weed control (data not shown). At two months after planting, cultivation with rotary hoe controlled between 25 to 46% of weeds. Weed control with rotary hoe was less effective than standard herbicide (Table 1).

Pea populations were not affected by cover or green manure crops, except rapeseed which reduced pea populations by 33% (Table 2). The reduction in pea populations after rapeseed may be attributed to isothiocyanate or other toxic gas released from rapeseed. Peas were planted ten days after rapeseed was incorporated into the soil. Such a short time period between incorporation and planting peas may not be enough to allow for the complete decomposition of rapeseed foliage and the release of isothiocyanate or any other toxic gas.

Use of the rotary hoe reduced pea population by 18% (Table 2). This pea damage may be higher if multiple cultivations are conducted. Most pea fields may require 2 to 3 cultivations to obtain sufficient weed control without herbicides. However, cultivation with a rotary hoe may have less effect on pea populations if peas are planted deeper into the soil. In this study peas were shallow planted because of high soil moisture due to rain, which may cause seed roughening if pea seeds are planted deep into the soil. Although use of a rotary hoe caused injury to peas, yields were higher in plots cultivated with the rotary hoe compared to the weedy check. This increase in yields was mainly due to lower weed pressure in these plots.

Pea yield was higher in white mustard plots compared to other crops. The increase in pea yield in these plots may not be solely attributed to the effect of white mustard on weeds (Table 3). Weed control was lower in white mustard than in rye, but yields were higher. It is very likely that white mustard increased yield due to the reduction in nematodes, diseases, and weeds. Pea yield was significantly reduced when peas were planted after rapeseed. This reduction in pea yield was mainly due to reductions in pea stands.

In summary, rapeseed, white mustard, and rye suppress weeds compared to the standard cover crop (winter wheat). However, peas planted after white mustard yielded more than peas planted after rye or rapeseed. This increase in yield may be attributed to less pea injury and good weed control. A rotary hoe controlled weeds and may be used in organic farming under certain soil and environmental conditions.

POTATO

This study was conducted at the USDA-ARS Potato System Research site near Paterson, WA. The site was a Quiency sand with 0.4% organic matter and pH 7.5. Weed control was monitored in 'Russet Burbank' potato planted on April 18, 1994, following fall-planted green manure crops or fallow. Rapeseed var. 'Jupiter' and white mustard var. 'Martigena' were seeded August 5, 1993, at a seeding rate of 9 lb/A for rapeseed and 12 Ib/A for white mustard. White mustard produced 2.7 T dry weight/A and rapeseed 1.7 T/A. White mustard was winter killed and was dry when incorporated. Rapeseed growth was excellent in the fall, but regrowth in the spring was marginal, resulting in the relatively lower biomass. White mustard and rapeseed were incorporated in the soil 1 to 3 weeks before potato planting (WBP). In addition, a weedy control and a standard herbicide treatment (metribuzin at 0.38 lb ai/A) were included in this study for comparison.

Early season weed counts were taken on May 18, 1994 before first cultivation. Redroot pigweed density was reduced in three of the four green manure crop treatments, and in metribuzin, compared to the nontreated check. The density of annual grass weeds (bamyardgrass and green foxtail) was reduced by all green manure crop treatments and by metribuzin, compared to the nontreated check.

Common lambsquarters density was reduced most by metribuzin, followed by white mustard, then rapeseed. All had significantly lower populations of common lambsquarters than the nontreated check. Nightshade (hairy and black) and Russian thistle densities were lower and not significantly different among the various treatments (Table 4).

Total weed density on May 18, 1994 was equal in the metribuzin and white mustard treatments. Rapeseed green manure was not as effective but reduced total weed density by 50% compared to the nontreated check.

Mid season visual weed ratings were taken on June 15, 1994 just after row closure. Pigweed control was best with metribuzin (Table 5). All green manure crop treatments suppressed pigweed similarly. Barnyardgrass was controlled best by metribuzin, followed by white mustard, followed by rapeseed. Nightshade was controlled best by metribuzin; there was little difference among the green manure crop treatments. Lambsquarters were controlled to a similar degree by metribuzin and green manure crop treatments. Final weed biomass (dry weight/$2m^2$) was recorded on August 31, 1994. By the end of the growing season, metribuzin reduced biomass of all weed species compared to nontreated checks. None of the green manure crop treatments reduced final weed biomass in potatoes compared to the nontreated check (Table 6).

Potato population and growth were not affected by any of the treatments (Table 7) early in the season. Total potato tuber yield was greatest in metribuzin treated plots, followed by white mustard green manure treatments, followed by rapeseed, which was greater than the yield in the nontreated check (Table 8). Metribuzin increased the amount of tubers in all size categories greater than 4 oz., compared to green manure treatments and nontreated checks. White mustard plots had more 4 to 8 oz. tubers than did the rapeseed plots, which had more than the nontreated checks. Specific gravities and internal problems of tubers were not affected by treatments.

It appears that green manure crops of white mustard and rapeseed suppress early season annual weeds in potatoes compared to potatoes following fallow. However, the early season weed suppression is not adequate to prevent yield losses due to weed competition later in the season. Final yields reflect that weed competition early in the growing season was reduced somewhat by the green manure crops, compared to potatoes treated with metribuzin. Green manure crops may give good weed control in potatoes if combined with a timely and effective cultivation.

SPEARMINT

This study was conducted at the Irrigated Agriculture Research and Extension Center, Prosser, WA on a Warden sandy loam soil with 1% organic matter and pH 6.5. Weed control was monitored in '770 scotch spearmint' planted on March 30, 1994, following three fall-planted green manure crops, fallow, or fall-applied Telone C17 (soil fumigant, standard treatment). Sudangrass var. 'Sudan 79' was seeded August 2, 1993, at 32 lb/A, rapeseed var. 'Jupiter' and white mustard var 'Martigena' were seeded August 23, 1993, at 6 lb/A, and Telone C17 applied on November 5, 1993 at 27 gal/A. Sudangrass produced 4.1 T dry weight/A and was incorporated on November 2, 1993. White mustard produced 2.6 T dry weight/A and rapeseed 1.3 T/A, and the entire test was rototilled on March 28, 1994. White mustard was winter killed and was dry when incorporated. Rapeseed growth was excellent in the fall, but regrowth in the spring was marginal resulting in a relatively lower biomass.

Green manure crops affected lambsquarters, redroot pigweed, and green foxtail densities in early May (Table 9). Plant densities of lambsquarters were significantly lower in mint following Telone C-17, fallow, and sudangrass than in mint following white mustard, which had lower lambsquarters densities than mint following rapeseed. Lambsquarter densities in mint following rapeseed averaged $60/m^2$.

Redroot pigweed densities were lowest in mint following Telone C17 or white mustard. Pigweed densities were highest in mint following sudangrass (Table 9). Green foxtail density was $93/m^2$ in mint following sudangrass while all other green manure treatments averaged 15 to $19/m^2$. Common groundsel density was not altered by green manure crops.

Green manure crops affected weed species in mints differently, and in overall results, Telone C17 reduced weed (mainly pigweed) densities the most, compared to mint following fallow. Rapeseed increased lambsquarters density in mint compared to fallow, while sudangrass increased green foxtail and pigweed density compared to fallow. White mustard increased lambsquarters density in mint compared to fallow, but reduced pigweed and green foxtail densities. In summary, the three green manure crops did not control weeds in mint on this type of soil. Ongoing work on sand soils indicates greater weed suppression with green manure crops of white mustard and rapeseed than observed in this study. No weed suppression has been observed in our previous work with sudangrass, but it may have other beneficial effects in terms of nematodes and Verticillium wilt suppression.

Mint height on June 8, 1994, was not affected by green manure crops. Mint following Telone C17 yielded the greatest amount of hay at 5.1 T/A while mint following sudangrass and rapeseed yielded the least amount of hay, 2.7 and 2.8 TIA, respectively (Table 9). Oil yields were greatest from mint following fall-applied Telone C17. Mint following white mustard or fallow yielded greater amounts of oil than mint following rapeseed or sudangrass (Table 9).

Vigor ratings on mint regrowth were taken on September 9, 1994. Mint following Telone C17 in the fall had the greatest vigor, mint following white mustard the next best, and mint following rapeseed, sudangrass, or fallow had the lowest vigor (Table 9). Visual estimates of weed density in September indicated more lambsquarters in mint following rapeseed than in mint following other green manure crops, fallow, or Telone C17 (Table 9). Green foxtail and pigweed densities were greater in mint following sudangrass than in mint following other green manure crop treatments, fallow, or Telone C17. None of the green manure treatments were effective enough on weeds to eliminate the need for hand weeding.

Of the three green manure crops tested, white mustard was the most promising from the standpoint of weed control and mint growth. Oil yields were higher from mint following white mustard than from mint following fallow. In September, mint vigor ratings were greater when mint followed white mustard than when mint followed fallow.

A second green manure crop trial was planted in the fall of 1994 with the same green manure crops, Telone, and a fallow plot. Peppermint will be planted in the spring of 1995 after incorporating green manure crops, and weeds, nematodes, and Verticillium wilt will be monitored.

CUCUMBER

This experiment was conducted during the 1994 growing season at Mount Vernon Research and Extension Unit, Mount Vernon, WA, on Skagit silt loam soil. Plots were naturally infested with a high population of common lambsquarters, shepherdspurse, common chickweed, redroot pigweed, ladysthumb, smartweed, cornspurry, and purple deadnettle. Soil organic matter was 4.6% and soil pH 6.7. Conventional tillage practices were followed.

'Martigena' white mustard was planted on May 6, 1994 and incorporated in the soil on June 21, 1994, when mustard plants were at bud stage. The plants were incorporated as described in the pea section. White mustard foliage dry weight incorporated into the soil was 0.5 T/A. The plot size was 16 feet wide and

40 feet long. In addition, a plot of similar size was included as fallow treatment (standard practice).

'Calypso' cucumber was planted on July 15, 1994 at 110,000 seeds per acre. Plots contained six rows, spaced 32 inches apart and 10 feet long, with each plot divided into three subplots. The subplots received 1) no further treatment (control), 2) handweeded as needed, or 3) herbicide (clomazone applied pre-planting incorporated into the soil at 0.125 lb ai/A). The experimental design was a split plot with four replications. The main plots were cover or green manure crops and the subplots were weed control practices.

Weed population and crop injury were estimated as described earlier. The cucumber population was determined by counting the number of cucumber plants in the middle four rows. Cucumbers were harvested from the middle four rows when 50% of the fruits were 1 to 1.5 inches in diameter. Fruits were separated into normal and malformed fruits. The normal fruits were graded by diameter into the following groups: less than 1 inch, 1 to 1.5 inch, 1.5 to 2 inch, and greater than 2 inches in diameter. Each group was weighed separately, and total cucumber yield was determined by adding the weight of all grades of normal fruits.

Growing conditions were warm and dry during the 1994 cucumber growing season, so only limited information was obtained from this study. Weed populations did not differ between cucumber planted following white mustard or fallow (Table 10). The lack of weed suppression by white mustard may have been due to the low amount of biomass produced (0.5 T/A0. In addition, weed populations were similar between the weedy check and the standard herbicide treatment.

In general, yields were lower when cucumber was planted after white mustard, compared to fallow. White mustard appeared to deplete soil moisture prior to cucumber planting, which caused water stress on the cucumber plants. In addition, cucumber quality was similar between treatments (Table 11).

SUMMARY

Growing Brassica green manure crops may suppress certain weeds, but could potentially injure succeeding crops. In these studies, potato, spearmint, and cucumber were not injured by green manure crops incorporated only a few days before planting. Green pea was injured by rapeseed but not by white mustard.

Growing a green manure crop of rapeseed prior to planting potatoes may suppress nematodes, certain fungal diseases, and weeds. When used primarily as a method to suppress nematodes or diseases, green manure crops may allow organic growers to reduce or delay cultivation.

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Table 1. Weed control one and two months after planting pea as affected by cover crops, green manure crops, and weed control practices.

Crop	Treatment	Weed population	Weed control
		Plants/m^2	%
White mustard			
	Herbicide	51[a]	83[b]
	Rotary hoe	215	23
	Weedy check	470	16
Rapeseed			
	Herbicide	80	74
	Rotary hoe	72	46
	Weedy check	222	23
Rye			
	Herbicide	74	68
	Rotary hoe	140	34
	Weedy check	435	15
Wheat			
	Herbicide	71	81
	Rotary hoe	192	25
	Weedy check	515	3
LSD (0.05) between treatments within the same crop		75	12
LSD (0.05) between crops within the same weed control practice		133	18

[a]Measurement was taken one month after planting pea.
[b]Measurement was taken 2 months after planting pea.

Table 2. Pea population and visible pea injury as affected by cover crops, green manure crops, and weed control practices.

Crop	Treatment	Pea population	Visible injury
		plants/m²	%
White mustard			
	Herbicide	109[a]	11[b]
	Rotary hoe	89	16
	Weedy check	114	1
Rapeseed			
	Herbicide	43	54
	Rotary hoe	43	51
	Weedy check	56	29
Rye			
	Herbicide	89	13
	Rotary hoe	82	16
	Weedy check	88	3
Wheat			
	Herbicide	79	10
	Rotary hoe	67	5
	Weedy check	84	0
LSD (0.05) between treatments within the same crop		10	
LSD (0.05) between crops within the same weed control practice		15	

[a]Measurement was taken one month after planting pea.
[b]Measurement was taken 2 months after planting pea.

Table 3. Weed dry weight at pea harvest, and pea yields and yield components as affected by cover crops, green manure crops, and weed control practices.

Crop	Treatment	Weed dry weight	plants/ m2	pods/ plant	100 pea weight	Total yield
		g/m^2	no/m^2		g	Kg/A
White mustard						
	Herbicide	91	114	3.6	42	1546
	Rotary hoe	136	94	3.9	38	1077
	Weedy check	205	97	2.7	42	819
Rapeseed						
	Herbicide	184	60	2.6	41	459
	Rotary hoe	174	49	4.0	30	456
	Weedy check	243	52	1.9	40	192
Rye						
	Herbicide	119	92	2.9	47	1107
	Rotary hoe	128	83	3.5	38	1036
	Weedy check	175	92	2.0	46	680
Wheat						
	Herbicide	91	94	2.5	47	947
	Rotary hoe	158	78	3.4	41	933
	Weedy check	121	90	2.1	46	670
LSD (0.05) between treatments within the same crop		32	24	0.7	5	151
LSD (0.05) between crops within the same weed control practice		47	38	0.9	8	296

Table 5. Weed control in potato plots as affected by green manure crop treatments and herbicide. Visual estimate of weed control were made on June 15, 1994.

Treatment	Timing	Redroot-pigweed	Barnyard-grass	Hairy nightshade	Lambsquarters
		% control[a]			
Rapeseed	3 WBP[b]	80	81	68	86
Rapeseed	1 WBP	84	73	79	98
White mustard	3 WBP	89	93	79	99
White mustard	1 WBP	88	88	78	91
Metribuzin	PRE[c]	100	100	100	100
Weedy check		0	0	0	0
LSD (0.05)		10	5	16	15

[a]weed control ratings were based on 0 = no weed control and 100 = complete weed control
[b]WBP = weeks before planting
[c]Metribuzin was applied preemergence at 0.38 lb ai/A

Table 6. Weed biomass in potato plots as affected by green manure crop treatments and herbicide. Weed biomass was estimated on August 31, 1994.

Treatment	Timing	Redroot-pigweed	Russian thistle	Barnyard-grass	Hairy nightshade	Lambsquarters	Total weed
		g dry weight/m²					
Rapeseed	3 WBP[a]	580	22	287	291	534	1796
Rapeseed	1 WBP	549	63	502	150	547	1633
White mustard	3 WBP	848	102	137	460	371	1917
White mustard	1 WBP	410	174	545	163	458	1750
Metribuzin	PRE[b]	1	14	152	17	12	195
Weedy check		887	52	581	161	514	2196
LSD (0.05)		524	ns	346	284	526	34

[a]WBP = weeks before planting
[b]Metribuzin was applied preemergence at 0.38 lb ai/A

Table 7. Plant height and potato population as affected by green manure crop treatments and herbicide. Measurements were made on May 23, 1994.

Treatment	Timing	Plant height	Population
		cm	plants/m
Rapeseed	3 WBP[a]	26	4
Rapeseed	1 WBP	25	4
White mustard	3 WBP	26	4
White mustard	1 WBP	27	4
Metribuzin	PRE[b]	25	4
Weedy check		27	4
LSD (0.05)		ns	ns

[a]WBP = weeks before planting
[b]Metribuzin was applied preemergence at 0.38 lb ai/A

Table 8. Yield and tuber quality of potato as affected by green manure crop treatments and herbicide.

Treatment	Timing	<4 oz	4-8 oz	8-12 oz	>12 oz	Culls	Total yield	Specific gravity
		T/A						
Rapeseed	3 WBP[a]	7.5	3.3	0	0	0	10.8	1.09
Rapeseed	1 WBP	7.2	5.4	0.2	0	0.1	12.9	1.09
White mustard	3 WBP	7.4	8.7	0.6	0	0	16.7	1.09
White mustard	1 WBP	6.0	7.7	1.3	0.1	0.1	15.2	1.09
Metribuzin	PRE[b]	4.5	16.0	4.6	0.9	0.2	26.2	1.09
Weedy check		5.2	0.6	0	0	0	5.8	1.09
LSD (0.05)		1.5	3.7	1.2	0.9	ns	3.5	ns

[a]WBP = weeks before planting
[b]Metribuzin was applied preemergence at 0.38 lb ai/A

Table 9. Effect of three green manure crops and Telone C17 on weed control and yield of newly planted 770 spearment.

Treatment	5/4/94 Lambs-quarters	5/4/94 Pigweed	5/4/94 Green foxtail	5/4/94 Common groundsel	7/18/94 Hay Yield	7/18/94 Oil Yield	9/8/94 Mint Vigor	9/8/94 Lambs-quarters control	9/8/94 Pigweed control	9/8/94 Green foxtail control	9/8/94 Barnyard grass control
Green Manure Crop	(no./m²)	(no./m²)	(no./m²)	(no./m²)	(T/a)	(lb/a)		(%)	(%)	(%)	(%)
Sudangrass	14[a]	34	93	0.5	2.7	26	3.1[b]	91	71	5	100
Rapeseed	60	16	19	1.0	2.9	26	3.2	66	84	71	73
White Mustard	31	10	15	0.4	3.5	34	3.8	95	93	84	98
Fallow	11	19	22	0.6	3.5	32	3.4	83	93	78	95
Telone C17	8	9	19	0.6	5.1	42	4.9	98	93	95	98
LSD 0.05	10.4	6.2	20.1	N.S.	0.5	3.9	0.4	20.1	11.4	13.0	N.S.

[a]Weed counts taken from two lm² quadrants per treatment, prior to Poast, Basagran, and Buctril applications.

[b]Mint vigor ratings on 9/8/94 were on a scale of 1 = poor to 5 = excellent.

Table 10. Weed population in pickling cucumber as affected by white mustard green manure.

Treatment	Weed population	Weed dry weight
	plant/m^2	g/m^2
White mustard		
Hand weeding	0	0
Clomazone[a]	3.8	86.5
Weedy check	5.8	80.3
Fallow		
Hand weeding	0	0
Clomazone	5.5	99.3
Weedy check	4.0	78.5
LSD (0.05)	3.5	70.7

[a]Clomazone was applied preplant incorporated at 0.125 lb ai/A

Table 11. Yields and yield components of pickling cucumber as affected by white mustard green manure crop.

Treatment	Population	Malformed	Grade 1	Grade 2	Grade 3	Grade 4	yield
	plants/m²	% ot total	----------------% of marketable yield			------------------	T/A
White mustard							
Hand weeding	42[a]	13.1	17.9[b]	37.4[c]	37.5[d]	7.2[e]	6.5
Clomazone[f]	46	15.0	23.6	33.5	28.5	14.5	7.0
Weedy check	42	11.1	22.1	43.5	31.1	3.4	7.0
Fallow							
Hand weeding	53	8.6	18.6	33.5	42.3	5.6	7.4
Clomazone	51	4.5	9.2	37.1	43.8	9.9	10.7
Weedy check	51	3.5	11.2	40.1	41.9	6.8	10.9
LSD (0.05)	ns	ns	ns	ns	ns	ns	ns

[a]Cucumber population was measured at harvest
[b]Grade 1 = up to 1" diameter
[c]Grade 2 = 1 to 1.5" diameter
[d]Grade 3 = 1.5 to 2.0" diameter
[e]Grade 4 = > 2" diameter
[f]Clomazone was applied preplant incorporated at 0.125 lb ai/A