Table 5. The effect of chemical treatment of rhizomes on days to emergence of Zantedeschia rehmannii superba (*Zrs*), *Z. albomaculata* (*Zam*), and *Z. elliotiana* ×*maculata* (*Zem*) for Expt. 2.

Treatment	Days to emergence		
	Zrs	*Zam*	*Zem*
Inoculation			
No treatment[z]	11 ± 3.8 ab[y]	10 ± 2.1 b	13 ± 3.9 a
5% DAC 10 min	12 ± 4.2 ab	11 ± 2.8 b	9 ± 3.6 a
5% DAC 30 min	13 ± 6.3 ab	13 ± 3.3 b	11 ± 0.7 a
10% Bleach	10 ± 2.9 b	11 ± 2.1 b	13 ± 4.9 a
20% Bleach	10 ± 1.8 b	11 ± 1.6 b	12 ± 4.9 a
4% Formaldehyde	11 ± 3.8 ab	13 ± 3.2 b	11 ± 4.1 a
10% Formaldehyde	15 ± 9.3 a	17 ± 6.1 a	14 ± 5.6 a
100 ppm Streptomycin	9 ± 3.4 b	12 ± 3.1 b	10 ± 2.9 a
200 ppm Streptomycin	10 ± 3.7 ab	11 ± 2.7 b	10 ± 4.2 a
No inoculation			
Control[x]	8 ± 1.6 a	8 ± 1.1 c	9 ± 2.4 b
No treatment	8 ± 2.8 a	10 ± 2.5 bc	9 ± 2.1 b
5% DAC 10 min	9 ± 1.9 a	9 ± 1.5 bc	12 ± 5.1 b
5% DAC 30 min	10 ± 1.8 a	10 ± 2.9 bc	9 ± 1.9 b
10% Bleach	8 ± 1.6 a	8 ± 2.1 c	9 ± 2.2 b
20% Bleach	9 ± 1.5 a	11 ± 1.5 bc	9 ± 3.3 b
4% Formaldehyde	10 ± 2.4 a	8 ± 2.2 bc	11 ± 3.9 b
10% Formaldehyde	10 ± 2.5 a	14 ± 5.4 a	17 ± 3.7 a
100 ppm Streptomycin	9 ± 3.2 a	10 ± 2.8 bc	10 ± 3.2 b
200 ppm Streptomycin	8 ± 1.3 a	12 ± 2.8 ab	10 ± 2.7 b

[y]No treatment = pierced, no chemical treatment dip, 10 min deionized water dip.
[z]Mean separation within columns by Duncan's multiple range test, $P = 0.05$.
[x]Control = no pierce, no inoculation, no chemical treatment or deionized water dip.

trol. Piercing the rhizomes did not increase the bacterial incidence as indicated by the low percentage of infected control rhizomes that were not pierced or treated verses those rhizomes that were pierced, not inoculated, and not chemically treated. Most rhizomes inoculated with *Ecc* took longer to emerge, as was indicated in Expt. 2 (Table 5). Days to emergence was not significantly affected by most chemical treatments.

The susceptibility of the rhizomes to *Ecc* was not as clearly defined as in Expt. 1. After observing infection rates of plants in other *Zantedeschia* experiments, it appears that the condition of the rhizome before planting (i.e., vigor of rhizome, field infection, preinfection, and desiccation) greatly contributes to the incidence of *Ecc* infection. This can vary between species, storage conditions, time of shipment, and time of planting after shipment. Determining which rhizomes are infected before planting is also difficult or impossible; therefore, it is imperative that rhizomes are treated to reduce the incidence of *Ecc* infection.

Although *Ecc* cannot be completely controlled by chemical treatment of the rhizomes, a 200 ppm streptomycin dip for 30 min can significantly reduce *Ecc* infection. Formaldehyde provided the second best control. Chemical treatments did not significantly reduce the days to emergence of most rhizomes or decrease the final size of the plant (data not shown). Before these chemical treatments are used; however, local guidelines for disposal of the chemical should be consulted. Further studies that investigate field infected *Zantadeschia* rhizomes and the use of other chemical treatments such as copper compounds need to be conducted.

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Interplanted Small Grain Cover Crops in Pickling Cucumbers

Bernard H. Zandstra,[1] William R. Chase,[2] and Joseph G. Masabni[2]

ADDITIONAL INDEX WORDS. living mulch, vegetable, companion crop

SUMMARY. Pickling cucumbers (*Cucumis sativus* L.) for machine harvest were interplanted with barley (*Hordeum vulgare* L.), oat (*Avena sativa* L.), rye (*Secale cereale* L.), sorghum-sudan (*Sorghum vulgare* L.), or wheat (*Triticum aestivum* L.). Cover crops 3 to 5 (7.6 to 12.7 cm) or 6 to 10 inches (15.2 to 25.4 cm) tall were killed with sethoxydim. Cover crops seeded at ≈12 seeds/ft² (129 seeds/m²) provided protection from wind erosion and minimal crop competition. Additional nitrogen to obtain maximum yield was required when small grain cover crops were interplanted with cucumbers. Barley emerged rapidly, grew upright, and was killed easily with sethoxydim, making it ideal for interplanting. All cover crops caused some cucumber yield reduction under adverse growing conditions.

Pickling cucumbers are frequently grown on sandy soils subject to wind and water erosion. Between emergence and the two-leaf stage, cucumber seedlings are especially susceptible to injury from wind-blown sand.

Windbreaks of various types have been used in many crops to protect

[1]Professor, Department of Horticulture, Michigan State University, East Lansing, MI 48824-1325.

[2]Research Assistants, Department of Horticulture, Michigan State University, East Lansing, MI 48824-1325.

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small seedlings from adverse weather (Paine and Harrison, 1993; Wittwer and Castilla, 1995). Cover crops are sometimes used as windbreaks. Traditionally, these cover crops are seeded near the crop and then grown until harvest time. Although they provide protection, their presence requires careful cultural and nutritional management to minimize competition with the crop being produced.

During the past 15 years, development of postemergence herbicides that kill only grasses (graminicides) has allowed for use of a small-grain windbreak system. A small grain can be planted with the crop and then killed before it impacts yield by competing for water or nutrients (Zandstra and Warncke, 1993). The small grain emerges rapidly and provides protection for the young, tender crop during the first few weeks of the season. The practice has been widely adopted in vegetable production on organic soils in Michigan (Zandstra and Warncke, 1993) and is currently being considered for vegetables on sandy soils.

The experiments described in this paper were conducted to develop interplanted small grain technology for use in mechanically harvested pickling cucumbers.

Experiments were conducted from 1991 to 1995 at the Michigan State University Horticulture Teaching and Research Center (HTRC), East Lansing, and in grower fields. The experiments were modified and/or repeated as needed over a 5-year period. Experiments presented herein were selected to illustrate the most consistent results observed.

Materials and methods

Experiment 1: Cover crop planting date and nitrogen application (1992). An experiment was established in 1992 at the Horticulture Teaching and Research Center (HTRC) on a Hillsdale sandy loam (Coarse-loamy, mixed, mesic Typic Hapludalfs, pH 5.5, 1.1% organic matter (OM)) to determine optimum timing of cover crop planting and nitrogen fertilizer application for maximum cucumber yield. The experiment was a split plot with four replications, with cover crop planting date (five weeks before planting cucumber, one week before planting cucumber, and no cover) as main blocks, and nitrogen (N) as ammonium nitrate fertilization regime [30 lb/acre (33.6 kg·ha^{-1}) before seeding small grain, 30 lb/acre before seeding small grain plus 40 lb (44.8 kg·ha^{-1}) at cucumber seeding, and 30 lb/acre before seeding small grain plus 40 lb at the two- to three-leaf stage of cucumber] as subplots. Cover crop (small grain) main blocks were 30 by 30 ft (9.1 by 9.1 m); fertilizer subplots were 10 by 30 ft (3 by 9.1 m). 'Wheeler' rye was planted at 60 lb/acre (67.3 kg·ha^{-1}) with a Moore Unidrill (Antrim, North Ireland). Five rows of 'Flurry' and 'Sumter' cucumber (Asgrow Seeds, Vineland, N.J.) [14-inch (35.6 cm) rows, 3 inches (7.6 cm) in rows] were seeded in the middle of each fertilizer plot on 11 June 1992 with a Heath vacuum seeder (HFE Inc., Ft. Collins, Colo.).

The early cover was killed with paraquat (Gramoxone; Zeneca Agricultural Products, Wilmingotn, Del.) at 1 lb active ingredient (a.i.)/acre (1.12 kg·ha^{-1}) plus 0.5% v/v nonionic surfactant (NIS) (Activator 90; Loveland Industries, Greeley, Colo.) on 11 June before cucumber seeding. The late cover was killed 9 July with sethoxydim (Poast; BASF Corp., Research Triangle Park, N.C.) at 0.28 lb/acre (0.31 kg·ha^{-1}) plus 1% v/v crop oil concentrate (COC) (Herbimax; Loveland Industries) in 20 gal spray solution/acre (187 L·ha^{-1}). The whole experiment was treated with 1.13 lb/acre (1.27 kg·ha^{-1}) ethalfluralin (Curbit; Platte Chemical Co., Fremont, Nebr.) on 12 June for preemergence weed control.

The late N treatment [40 lb/acre (44.8 kg·ha^{-1})] N as ammonium nitrate was topdressed 13 July and watered in. The experiment was sprinkler irrigated as needed to maintain growth. Cucumber plants were counted to determine the effect of the small grain cover crops on emergence and stand.

On 5 and 12 Aug. all fruit and vines from a 10-foot (3-m) section of all five rows in each plot were harvested, separated, and weighed.

Experiment 2: Date of kill and cover crop species (1992). An experiment was established in 1992 at the HTRC on a Capac loam (fine-loamy, mixed, mesic Aeric Ochraqualfs) with 2.2% OM and pH 6.9. The experiment was a split plot with three replications. The cover crops were randomized in 30 × 30-ft main blocks, and kill date treatments were applied to 10 ft (3 m) strips within the main blocks. 'Bowers' barley [48 lb/acre (53.8 kg·ha^{-1})], 'Ogle' oats [33 lb/acre (37 kg·ha^{-1})], 'Wheeler' rye [56 lb/acre (62.8 kg·ha^{-1})], and 'Frankenmuth' wheat [60 lb/acre (67.2 kg·ha^{-1})] were seeded at one bushel per acre (87.1 L·ha^{-1}) on 3 June 1992. 'Flurry' cucumber was seeded 11 June, as described above. The small grain cover crops were sprayed with sethoxydim at 0.28 lb/acre (0.31 kg·ha^{-1}) plus 1% v/v COC on 29 June, 4 July, or 9 July, corresponding to 18, 23, or 28 d after cucumber seeding. Small grain cover crop height at application is presented in Table 1. One square meter of each cover crop was harvested at the first sethoxydim application and then dried to determine biomass production. Cucumber plants and fruit were harvested from 10-foot sections of bed on 5 and 12 Aug.

Experiment 3: Comparison of cover crops planted at the same density (1993). Initial experiments indicated that cucumbers grown with oats as a cover crop performed well. In those experiments small grains were planted at a rate of 1 bushel per acre. Because of its low weight and seed number per bushel, oat plant density was always less than that of the other small grains when planted on a volume basis. An experiment was established 14 May 1993 in a grower field in Bentheim, Michigan, on Oakville Fine Sand (Mixed, mesic Typic Udipsamments), pH 6.0, 1.2% OM. 'Bowers' barley, 'Ogle' oat, 'Wheeler' rye, and 'Augusta' wheat were seeded to obtain a density of 12 seeds/ft^2 (129 seeds/m^2), or 45 (50.4 kg·ha^{-1}), 35 (39.2 kg·ha^{-1}), 34 (38.1 kg·ha^{-1}), and 36 lb/acre (40.4 kg·ha^{-1}), respec-

Table 1. Height of cover crops at sethoxydim application, Expt. 2, 1992, East Lansing, Mich.

Cover	Inches (cm)		
crop	29 June	4 July	9 July
Barley	6–9 (15.2–22.9)	7–10 (17.8–25.4)	13–16 (33–40.6)
Oat	4–8 (10.2–20.3)	8–11 (20.3–27.9)	11–15 (27.9–38.1)
Rye	3–5 (7.6–12.7)	4–7 (10.2–17.8)	7–12 (17.8–30.5)
Wheat	5–7 (12.7–17.8)	7–10 (17.8–25.4)	9–12 (22.9–30.5)

Table 2. Main effects of timing of establishment of the cover crop, and of N application, on cucumber germination and yield, Expt. 1, 1992, East Lansing, Mich.

Time of cover crop planting (weeks before cucumber)	Plants/ 3 m[z] (no.)	Plant fresh wt (kg/3 m)[y]		Fruit/ 3 m (no.)		Fruit fresh wt (kg/3 m)	
	26 June	5 Aug.	12 Aug.	5 Aug.	12 Aug.	5 Aug.	12 Aug.
5	12.0	2.1	2.1	27.0	45.3	0.53	3.7
1	30.0	2.7	2.6	33.5	63.5	0.52	3.9
No cover crop (C)	31.0	6.3	5.7	89.6	126.9	2.06	9.5
LSD (1%)	5.7	1.2	1.7	22.7	36.7	0.71	3.2
N							
30 lb[x,w]	22.8	2.5	2.4	29.4	55.0	0.33	2.4
30 lb[w] + 40 lb[v,u]	26.3	3.6	3.3	42.0	78.9	0.51	4.8
30 lb[w] + 40 lb[t]	24.1	5.0	4.7	78.8	101.8	2.28	9.8
LSD (1%)	NS	1.2	1.7	22.7	36.7	0.71	3.2
C × N	NS	NS	NS	NS	NS	NS	NS

[z]3 m = 9.84 ft.
[y]1 kg/3 m = 0.22 lb/ft.
[x]At seeding cover crop.
[w]30 lb/acre N = 33.6 $kg \cdot ha^{-1}$ N.
[v]At seeding cucumber.
[u]40 lb/acre N = 44.8 $kg \cdot ha^{-1}$ N.
[t]At cucumber two-leaf stage.

tively. 'Discover M' (Asgrow Seeds, Vineland, N.J.) cucumbers were seeded 1 week later on 21 May. The plots were harvested 16 July, and fresh weights of plants and fruit from 225 ft^2 (20.9 m^2) were recorded.

There were no differences in plant or fruit weights between any of the cover crops and the bareground control (data not presented). Therefore, a seeding rate of 12 seeds/ft^2 was used for subsequent experiments. In these experiments only 30% to 40% of the small grain seed produced plants each year.

EXPERIMENT 4: COVER CROP SPECIES, KILL DATE, AND HERBICIDE TREATMENT (1993). An experiment was established in 1993 at the HTRC on a Capac loam to compare various small grains for use as interplanted cover crops in pickling cucumbers. The experiment was a split block, with cover crop strips 24 ft (7.3 m) wide randomized and planted across the width of each replication. Cucumbers were planted perpendicular to the cover crops in 10 ft wide plots. Ten beds were planted so that the herbicide treatments could be applied to five beds at the first and second kill dates. Cover crops ('Bowers' barley, 'Ogle' oat, 'Wheeler' rye, 'MBS-8319' sorghum-sudangrass, 'Augusta' wheat) were planted at a rate of ≈12 seeds/ft^2 on 4 June 1993. 'Flurry' cucumber was seeded 11 June, with five rows per plot, as described above. Herbicide treatments were applied to half the experiment on 23 June (12 d after seeding cucumbers, when cover crops were 6 to 10 inches tall (15.2 to 25.4 cm) and the other half on 29 June [18 d after seeding cucumbers, cover crops were 8 to 14 inches tall (20.3 to 35.6 cm)]. Herbicide treatments were sethoxydim 0.19 lb/acre (0.21 $kg \cdot ha^{-1}$) plus 1% Dash HC (BASF Corp.), sethoxydim 0.19 lb/acre plus 1% COC, sethoxydim 0.19 lb/acre plus 1% Dash HC plus 2.5 lb (1.14 kg) ammonium sulfate (AMS), and sethoxydim 0.28 lb/acre plus 1% Dash HC plus 2.5 lb

Table 3. Effect of cover crop species and kill date on cucumber growth and yield, Expt. 2, 1992, East Lansing, Mich.

Effect	Cover crop plant dry wt ($g \cdot m^{-2}$)[z]	Plant fresh wt (kg/3 m)[y]		Fruit fresh wt (kg/3 m)	
	30 June	5 Aug.	12 Aug.	5 Aug.	12 Aug.
Cover crop (C)					
Barley	32	7.4	9.8	1.7	10.8
Oat	17	9.3	10.5	2.0	12.7
Rye	31	6.4	7.7	1.6	9.7
Wheat	37	7.4	7.7	1.6	9.5
Bare ground	---	11.2	14.5	2.9	18.4
LSD (5% or 1%)	13*	2.4**	2.4**	1.0*	4.0**
Days after seeding cucumber (D)					
18		9.7	11.7	2.3	14.0
23		8.7	10.2	2.2	12.9
28		6.6	8.3	1.4	9.7
LSD (1%)		1.9	1.9	0.8	3.1
C × D		*	NS	NS	NS

[z]1 $g \cdot m^{-2} = 2.05 \times 10^{-4}$ lb/ft^2.
[y]1 kg/3 m = 0.22 lb/ft.
NS,*,**Nonsignificant or significant at $P = 0.05$ or 0.01, respectively.

Table 4. Cover crop plant stand and dry weight at sethoxydim application, Expt. 4, 1993, East Lansing, Mich.

Cover crop	Cover crop stand (no./m²ᶻ)		Cover crop dry wt ($g \cdot m^{-2}$)ʸ	
	23 June	29 June	23 June	29 June
Barley	42	36	6.8	15.8
Oat	45	60	4.8	19.9
Rye	43	43	8.9	27.2
Sorghum	45	44	2.7	12.7
Wheat	43	45	5.1	13.5
LSD (5%)	NS	NS	2.5	3.2

ᶻNo./m² = no. ÷ 10.76/ft².
ʸ1 $g \cdot m^{-2}$ = 2.05 × 10^{-4} lb/ft².
NSNonsignificant.

Table 5. Cover crop kill ratings and cucumber yield after sethoxydim application 23 June or 29 June (12 or 18 d after seeding cucumbers), Expt. 4, 1993, East Lansing, Mich.

Cover crop	Cover crop injury ratingᶻ		Cucumber fresh wt (kg/3 m)ʸ
	14 July	27 July	2 Aug.
Barley	7.7	8.1	14.7
Oat	8.1	7.5	14.6
Rye	7.1	7.5	14.4
Sorghum	8.1	7.0	18.0
Wheat	6.2	6.5	14.4
Bare ground	---	---	13.6
LSD (5%)	0.3	1.1	2.8

ᶻRating 1 = no injury, 10 = dead.
ʸ1 kg/3 m = 0.22 lb/ft.

AMS. Before seeding the cover crop, 300 lb (136.4 kg) of 18–18–18 fertilizer was applied, and then 40 lb N per acre, as ammonium nitrate, was broadcast over cucumbers at the two- to three-leaf stage. Cover crop plant numbers and dry weights were evaluated at sethoxydim application. Cover crops were rated for kill on 14 and 27 July 1993. Cucumbers were harvested on 2 Aug. and fresh weights of plants and fruit were recorded.

Results and discussion

Experiment 1: Cover crop planting date and nitrogen application (1992). Cucumber emergence was delayed and stand reduced when the small grain cover crop was planted 5 weeks before cucumber planting (Table 2). Planting cover crops 1 week before the cucumbers did not affect emergence or stand compared with no cover crop. The N fertilization regime had no effect on emergence.

At harvest, cucumber plant weight in the no cover crop treatments was greater than that in the early- and late-planted cover crop plots (Table 2), and weight increased with fertilizer application. Fruit weight and fruit numbers were greatest in no cover crop treatments and in the late N treatment. 1992 was a cool year, and the cover crops may have shaded the soil and kept it cool. This may have caused the reduced emergence and reduced plant growth in the cover crop plots. Rain may have leached some N applied before or at seeding of cucumber, so the plots with N applied at the two- to three-leaf stage produced a greater number of fruit and total fruit weight. However, there was no visual evidence of N deficiency in any of the plots. There was no interaction between cover crop and N regime.

Experiment 2: Date of kill and cover crop species (1992). Oats had the lowest biomass when sampled at sethoxydim application; barley, rye, and wheat had about double the dry weight of oat (Table 3). Cucumbers in the oat plots had greater yields than cucumbers in the other small grain plots for all kill dates, but yields were always less than that of the no cover control. Competition from small grains appeared to have an adverse effect on yield. Cucumber yields declined with a longer period of competition from the cover crop. Interaction of cover crop by days after seeding was significant for cucumber fresh weight. This was a result of cucumbers in oat plots having more biomass at 23 d than at 18 d after seeding. This was not unexpected because of lower competition from oat. However, fruit weight was not affected.

Experiment 4: Cover crop species, kill date and herbicide treatment. In this experiment, cover crops were killed earlier than in Expt. 2. The date of killing had no effect on yield, so data for kill dates were combined. Since cover crops were planted at the same seed count per unit area, the plant count was similar for all small grains (Table 4). However, rye had the greatest dry weight of the cover crops on 23 and 29 June. Barley and oats were intermediate, and sorghum-sudan and wheat had the least dry weight on 29 June. At harvest, sorghum-sudan treatments produced the greatest cucumber fruit weight. The other small grain treatments produced fewer cucumbers than the sorghum-sudan plots, but were similar to each other.

Wheat was the most difficult cover crop to kill with sethoxydim (Table 5). However, sethoxydim 0.19 lb/acre plus Dash HC gave good kill of all cover crops. Ammonium sulfate did not improve kill of the small grains by sethoxydim (Table 6).

No-cover-crop controls were consistently among the highest-yielding treatments, which indicates that cover crops often had an adverse effect on cucumber growth, even when killed early. In Expt. 4, yield in the no-cover-crop plots almost doubled at first harvest, compared to treatment with small grains planted one week before cucumbers. At second harvest, the difference in yield between treatments was much less.

Adequate N is important to maximize cucumber yield. Since cucumbers mature in 45 to 50 d, growers historically have applied all N before planting. Results from these experiments indicate that top-dressing to cucumber in the two- to three-leaf stage usually is needed for maximum yields. The decaying small grains may tie up some N during the short cropping cycle of machine-harvest cucumber.

Each cover crop has unique growth characteristics. In our experi-

Table 6. Kill of cover crop and cucumber yield after application of sethoxydim, Expt. 4, 1993, East Lansing, Mich.

Herbicide treatment	Cover crop kill rating[z] 14 July	Cover crop kill rating[z] 27 July	Cucumber fresh wt (kg/7.3 m[w]) 2 Aug.
Sethoxydim 0.19 lb/acre[y] + Dash HC 0.5% v/v	9.4	8.4	18.6
Sethoxydim 0.19 lb/acre + COC 1% v/v	7.7	7.8	15.4
Sethoxydim 0.19 lb/acre + Dash HC 0.5% v/v + AMS 2.5	9.4	7.5	16.0
Sethoxydim 0.28 lb/acre[x] + Dash HC 0.5% v/v + AMS 2.5	9.8	8.8	16.0
Untreated control	1.0	3.9	8.8
LSD (5%)	0.3	1.4	2.6

[z]Rating 1 = no injury, 10 = dead.
[y]0.19 lb/acre = 0.21 kg·ha^{-1}.
[x]0.28 lb/acre = 0.31 kg·ha^{-1}.
[w]1 kg/7.3 m = 0.092 lb/ft.

ence, barley has erect growth with moderate tiller number. Since it emerges quickly from cool soils, it is ideal for spring plantings. Oat also emerges quickly and grows vigorously in cool soils. It has erect growth with few tillers. Oat has less shoot biomass than barley at 3 to 4 weeks after seeding. Rye is the most vigorous of these small grains in cool soil and emerges quickly. It has a spreading but upright growth habit with many tillers, and covers the soil surface rapidly. This gives good wind protection, but may maintain cool soil resulting in slow cucumber growth. Its vigorous growth may lead to crop–rye competition. Wheat is the slowest to emerge of these small grains. It has semi-erect growth and moderate tiller number. During the first 2 to 3 weeks of growth it does not produce biomass sufficient to provide much protection from wind erosion. Sorghum-sudan emerges moderately well during cool conditions. However, it grows slowly and produces minimal biomass during the first few weeks of growth, and thus does not provide much protection from wind erosion. In Expt. 4, sorghum–sudan plots produced the greatest cucumber yield. On 23 June, sorghum–sudan had the least dry weight of all the small grains, which suggests that it may not be highly competitive with cucumber. Since biomass is needed for protection from wind, sorghum-sudan probably is not acceptable for this purpose, unless cucumber is produced in late summer to fall.

Considering the characteristics of all small grains, barley is a good choice for interplanting with cucumbers and other crops. It has rapid emergence, erect growth, moderate tillering, and can be killed easily. One difficulty some growers have experienced is finding a source of vigorous, weed-free barley seed.

The cover crop must be killed early to minimize competition with young cucumber. In the 1993, 1994, and 1995 trials, killing the small grain covers at 3 to 4 inches (7.6 to 10.1 cm) or 5 to 6 inches (12.7 to 15.2 cm) had no effect on yield (1994 and 1995 data not presented). In those years, there appeared to be sufficient N and water to sustain the cucumbers until the cover crops were killed. The plots were established when cool soil temperature was not a problem.

Sethoxydim at 0.19 lb/acre plus Dash HC 0.5% v/v gave acceptable kill of the small grains under most conditions. However, during the cool, wet 1992 season, we did not obtain acceptable control of rye, wheat, and barley with one application of 0.19 lb/acre sethoxydim. In fact, some rye survived two applications. Therefore, if the small grains are under stress, or are more than 6 inches tall (15.2 cm), 0.28 lb/acre of sethoxydim should be applied. Dash HC, crop oil concentrate, or another recommended adjuvant should always be included with the sethoxydim to obtain optimum kill of the small grain cover crops.

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