

**LIMA BEANS IN
DELAWARE, NEW JERSEY AND MARYLAND EASTERN SHORE
PEST MANAGEMENT STRATEGIC PLAN**

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Executive Summary

Numbers after items = priority rank on scale of 20 (lowest) – 60 (highest)

Critical Priorities

Regulatory:

- Must keep dimethoate. 60
- Must keep lannate. 60
- Shorten the phi for Topsin on white mold. 59

Research:

- Refine Hyre-Cox predictor for downy mildew – new races, temperature limits, leaf wetness. 58
- Efficacy and timing for biological fungicide Contans for white mold. Efficacy trials and application procedures for BAS 510 and Serenade for white mold. 57
- Resistance management strategies for downy mildew fungicides. 57
- Better morningglory options. 56
- New efficacy trials for Rhizoctonia pod rot (Brown Bean). 53

All identified needs

Regulatory

- Must keep dimethoate. 60
- Must keep lannate. 60
- Shorten the phi for Topsin on white mold. 59
- Raptor broadleaf herbicide like Pursuit label. 54
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Research

- Refine Hyre-Cox predictor for downy mildew – new races, temperature limits, leaf wetness. 58
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Regulatory Priorities

Dimethoate and Lannate are considered critical use insecticides for lima bean production in the Mid-Atlantic region. They provide cost effective options and allow producers to treat only when they encounter threshold levels of key insect pests.. It is considered necessary to maintain labeled uses for dimethoate and lannate on lima beans due to their efficacy against several arthropod pests of that crop. In addition, they are considered essential chemistries to use in rotation with other labeled formulations to prevent resistance to any one class of insecticide, especially the pyrethroids.

BACKGROUND

PRODUCTION INFORMATION

Annually, 51,000 acres of lima bean (*Phaseolus lunatus* L.) are harvested in the United States (1) with production concentrated in the mid-Atlantic, California, the Pacific Northwest, and certain areas in the states of Wisconsin and Illinois (2). Delaware plants more acreage annually for process purposes than any other state. In 1999, 18,000 acres were planted and harvested in Delaware (3). Production in Delaware is concentrated in Sussex County. In 2001, 1,500 acres of lima beans for processing and 100 acres for fresh market were planted in New Jersey. In Maryland 320 acres were planted for fresh market and 310 acres were harvested. Additional processing acreage was produced.

Lima beans are considered the cornerstone crop of the vegetable- processing industry in Delaware and are an important component of the industry in Maryland and New Jersey. They are double-cropped on as much as three-fourths of the acreage, thus offering producers maximum utilization of the land. Limas are often planted in June or July after a pea or small grain crop. Typically, the grower contracts with a processing company for a certain acreage. In most cases, the processing company performs the harvest and raw product delivery functions, although there are instances of growers owning their own harvest equipment. Many factors influence lima bean yields, but weather conditions that affect flower bud development, pollination, and pod maturation have the most impact on yields. (2)

REPRESENTATIVE COSTS FOR PROCESSING LIMA BEANS IN DELAWARE

Yield and Price assumptions:	Yield	Price
Best	3,000 lbs.	\$0.18
Expected	2,000 lbs.	\$0.16
Worst	1,000 lbs.	\$0.14

Item	Cost/Acre
Nitrogen	\$19.50
Mixed fertilizer	30.80
Lime	9.60
Seed	66.00
Herbicide	12.53
Plow	13.00
Disk and harrowing	11.00
Apply fertilizer and chemicals	18.99
Planting	10.00
Harvesting	00.00
Irrigation	56.00
Cultivation	12.00
Interest	5.54
TOTAL CASH COSTS/ACRE	\$263.97

CRITICAL PEST INFORMATION

Insects

Insect pests that attack lima beans include the seed corn maggot, lygus bug species, stinkbugs, spider mites, aphids, leafhoppers, Mexican bean beetles, and corn earworms. Because significant acreage of lima beans is planted in June and July, late-season corn earworms are a major economic pest. In recent years, lygus bugs and stinkbugs have become important pests of lima beans in the Mid-Atlantic region.

Diseases

Diseases that occur on lima beans are, Downy Mildew, White Mold, root rots, Bacterial Brown Spot, lima bean pod blight, and anthracnose. White mold is considered the most damaging disease of baby lima beans. White mold has increased in prominence as irrigated acreage increased and as more growers double-crop lima beans after peas, which are also a host of white mold. Industry personnel estimate that up to 40% yield may be lost in highly infested fields in some years. More commonly yield losses of up to 20% may occur. The increase in white mold severity in the region occurs as fungicide control options are becoming increasingly limited. Downy mildew is also an important disease of lima bean in the region. With the appearance of new races E and F yield losses have increased. There were no resistant cultivars until recently. In 2000 it was estimated that 25% of the acreage was lost to downy mildew worth \$2,268,000. Bacterial brown spot and anthracnose are seen occasionally but little is known about their impact on yield. Lima bean pod blight caused by *Phytophthora capsici* is increasing in areas with poor drainage and after heavy rainfall events. This fungus has a wide host range including cucurbits, peppers, and tomatoes, which is making it problematic for vegetable growers. Root rots (caused primarily by *Rhizoctonia*, *Pythium* and *Fusarium*) are ubiquitous and can reduce stands of lima beans if weather conditions are unfavorable for germination and favorable for infection which can occur when it is very wet or hot and dry.

Weeds

Weeds in lima beans are annual and perennial grasses, and annual broadleaves. Primary weeds include: Annual grasses (foxtails, fall panicum, crabgrass, barnyardgrass, and others), Common ragweed, Morningglory species, Pigweed, Lambsquarters, and Horsenettle. Secondary weeds (defined as not as wide-spread of a problem in lima beans) are: Yellow nutsedge, Johnsongrass, bermudagrass, Summer annual weeds (Nightshades, Jimsonweed, Common Cocklebur, Velvetleaf), and Perennial weeds (Common milkweed, Bindweed, Canada thistle, Pokeweed, Groundcherry)

CRITICAL PESTICIDE INFORMATION

Insecticides:

Several insecticides used in lima beans are organo-phosphates or carbamates: Thimet 20G (phorate), Diazinon 50W (diazinon), Lorsban 50SL (chlorpyrifos), Disyston 15 G (disulfoton), Dimethoate 4EC (dimethoate), Orthene 75S (acephate), Lannate LV (methomyl), and Sevin 80S (carbaryl). Dimethoate and Lannate are critical use insecticides that must be kept to ensure lima bean production. Also used are: Capture (bifenthrin), Kelthane MF (dicofol), Mustang (zeta-cypermethrin), and Gaucho (imidacloprid). Other insecticides are also labeled for lima beans, but are not currently used in the 3-state region due to effectiveness and/or cost.

Fungicides:

At the present only fixed copper is labeled for downy mildew control. Ridomil Gold/Copper (mefanoxam/copper) is in the IR-4 program to establish residue tolerance for this product. It has been one of the best products to date for downy mildew control. Residue

work should be completed this spring and 24-c labeling is possible for the 2003 season. Quadris (azoxystrobin) should be labeled in this quarter for succulent beans including limas and would be labeled as well and provide another mode of action against this fungus. Fungicide testing has demonstrated that other fungicides are effective but none are labeled on lima beans presently.

Three fungicides are currently used to control white mold; thiophanate methyl, (Topsin M), benomyl (Benlate) and iprodione (Rovral). The manufacturer has canceled Benlate. Rovral has structural similarity to vinclozolin (Ronilan), which has been cancelled by the EPA because it is an endocrine disruptor. Therefore, there is some concern that iprodione will not be reregistered. This would leave thiophanate methyl, classified as a B2 carcinogen, as the only fungicide remaining of the three currently used fungicides. Recently the biofungicide *Coniothyrium minitans* (Contans WC) has been registered for use on many vegetable crops, including lima beans. However, lack of research data on the efficacy of Contans in the mid-Atlantic and in the lima bean-White mold pathosystem has limited its' adoption.

Other fungicides may also be labeled for lima beans, but are not currently used in the 3-state region due to effectiveness and/or cost.

Herbicides

No herbicides used in lima beans are classified as OP, carbamate or B2 carcinogen. Common herbicides used in the 3-state region are: Treflan (trifluralin), Dual Magnum (s-metolachlor), Pursuit (imazethapyr), Sandea (halosulfuron), Prowl (pendimethalin), Command (clomazone), Basagran (bentazon), Poast (sethoxydim). Other herbicides may also be labeled for lima beans, but are not currently used in Delaware due to effectiveness and/or cost.

PLANT DISEASES

WHITE MOLD Primary Pest Status - # 1 disease pest of lima beans

The general consensus is that White Mold is the most important disease in lima beans (number 1), and other diseases rank 8 or 9. White mold is endemic, widespread and a "yield-robber" every single year. It is also a contaminant issue for processors (Sclerotia are difficult to eliminate during processing). White Mold was controlled by Benlate until that product was cancelled. Topsin M, an alternative fungicide has a long (14 day) PHI. New materials are untested or will require multiple sprays.

White mold is an endemic disease in Delaware and Maryland and industry estimates are that up to 40% yield may be lost in highly infested fields in some years. More commonly yield losses of up to 20% may occur. The causal fungus (*Sclerotinia sclerotiorum*) overwinters in residue or as sclerotia in and near bean fields. When soil is moist, apothecia form and fungus spores are produced and are carried to bean plants by wind. The fungus infects dying blossoms and injured tissue. Prolonged wet conditions promote disease development. Crop rotation is critical to management, however limited availability

of irrigated acreage results in short rotations. Conversion of acreage from dry land to 50% irrigated production (the percentage is increasing), and the practice of planting lima beans after harvest of an early season pea crop (also a host), has increased white mold pressure. Proper amount and timing of irrigation is very useful for control. There is no host plant resistance, but plant architecture may help with control as may deep plowing and row orientation.

Guidelines for application of fungicide sprays were developed on snap beans, a determinate flowering plant. Lima beans flower determinately and indeterminately (depending on cultivar), however no guidelines for fungicide application have been developed specifically for lima bean white mold and growers rely on information developed for snap beans. Results of a trial conducted in 1999 indicated that fungicides applied when lima bean pods were 1.5 inch long, much later than guidelines would indicate, improved yields an average of 12% over the nontreated control.

Organo-phosphates currently used to manage White Mold: None

Carbamates currently used to manage this pest: none

B2 carcinogens currently used to manage this pest: : thiophanate-methyl (Topsin M and OLF). A shortened preharvest interval on Topsin M could result in a major improvement in quality as Topsin M applications stop progress of the disease. It is difficult to tell when limas will be harvested – A grower may make the assessment that there is one week to harvest and subsequently not harvest for two weeks. Even going to 10 days PHI would help. In regards to shortening the PHI from 14 days to 5: The latest Risk Cup assessment for Topsin M indicates that the risk cup is full at this time. This is an oversimplification of the risk assessment, but basically the limiting end point is cancer and it is calculated at 2.2×10^{-6} for aggregate (food, water, and non-occupational exposure) – EPA does not like to exceed 1.0×10^{-6} for aggregate cancer risk. The risk assessment is considered to be conservative because the dietary contributions that had Pesticide Data Program values were extrapolated from benomyl residue measurements that include both benomyl and thiophanate methyl moieties. Shortening the PHI will probably be difficult to do at this point until there is a better fix on actual food residues from thiophanate methyl alone.

Other pesticides currently used (including biologicals) to manage this pest:

Rovral (Iprodione) is registered, but not widely used because it is cost prohibitive and not as effective on *S. sclerotiorum*. It has a similar chemistry to Ronilan, which was lost on snap beans through FQPA. Contans WG (*Coniothyrium minitans*) was recently registered for control of *Sclerotinia sclerotiorum* on vegetables including lima bean. However lack of information on efficacy has limited its' adoption. University of Maryland preliminary efficacy data looks good, price is OK, but it must be put on long before White Mold is detected; thus, more chemical will be applied than may be necessary. Cost within an individual field is acceptable however, because it must be applied well in advance of disease

development, more fields will be treated. Researchable issues are: efficacy, timing, persistence (perhaps over seasons), and economics.

Non-chemical methods currently used to help manage this pest: Cultural practices that minimize disease severity are crop rotation and deep plowing. Row orientation is not as effective in limas because of timing and closure of the crop canopy. There is no host resistance available. Crop architecture is a possible control measure. Research is needed on Irrigation management for both disease and yield information.

Non-registered (Pipeline materials) pest management tools: BASF is pursuing registration of BAS 510, which is scheduled for succulent beans in time for this season. Tolerance versus registration is especially an issue for BAS products. IR-4 needs efficacy data. Researchers know it's good on sclerotinia, but not necessarily how to use it. There are no requests for BAS products at IR-4 now. Switch, a Syngenta product, has been initiated as an IR-4 project that just started. Project completion estimates are 2004 or 2005. Preliminary data indicates that it might work. Growers will need information on the efficacy of these and other products in the lima bean – white mold pathosystem.

Serenade (*Bacillus subtilis*), a biological, has a broad label but does not currently include lima bean. UD and University of Maryland researchers are investigating efficacy. It might not be hard to get the label expanded to lima. It is not a stand-alone, but might be an “extender” or resistance management tool. However, much more research is needed. EPA has others fungicides scheduled for registrations on other crops, which are efficacious on white mold.

DOWNY MILDEW: Primary Pest Status

Scout fields weekly in late summer/ early fall. Look for white downy mold on pod and flower racemes under humid conditions. Threshold level is “presence in an area.” Once Downy Mildew is seen, it might be too late to control. If Downy Mildew is found in one field, it will be necessary to treat all fields in the vicinity. In 2000, 118 samples of infected lima bean pods were collected from 44 production fields in DE and MD: 86% were race E, 5% were race F, 1% was race B (pole lima) and 8% turned out to be *Phytophthora capsici*. There is limited availability of varieties with resistance to race E at the present time. Conditions favorable for disease development: >1.2 inches rain/7 days + average daily temperatures < 78°F (25.6°C). This information is still useful, but only as an early warning sign. Periods of fog or heavy dew lower amount of rainfall necessary for infection. If a period of 90°F occurs, the cycle is broken and an additional 7-day period with the above weather conditions is necessary to start infection. This model is the Hyre-Cox Prediction System. More research is needed on this model. It needs to be adjusted if cardinal temperatures for new races E and F are higher as is suspected. Research is currently being conducted to determine the maximum temperatures. Leaf wetness should be considered as a factor in the model.

Organo-phosphates currently used to manage Downy Mildew: none

Carbamates currently used to manage this pest: none

B2 carcinogens currently used to manage this pest: none

Other pesticides currently used (including biologicals) to manage this pest:

Fixed coppers: Champ DP and Kocide 2000 are being used. Cuprofix Disperss at 3.0 lb/A is also labeled from Cerexagri. Copper is only a preventative, if we had an eradicant/curative we'd have much more flexibility.

Non-chemical methods currently used to help manage this pest:

Practice cultural control including, rotation, burying old crop debris, and planting resistant baby lima bean varieties. Planting rows aligned with the prevailing winds may increase drying and reduce disease.

Baby Lima Varieties

Races of Downy Mildew change over time. Unfortunately we have no way to predict how long the interval before a new race appears. Developing new resistant varieties to the current races present in the region is important. Race identification is important from a long-term standpoint. "Instant" identification is not required.

- M-15 (80 days) - an early maturing variety with resistance to race A, B, C, D, and F of downy mildew. A small, compact plant, it has been a consistent yielder. Its small size and tendency to set pods on the end of racemes can reduce recovery of raw product by the pod stripper type of harvesters.
- Eastland (82 days) - A dependable variety closely related to M-15. It has resistance to races A, B, C, and D of downy mildew. It is conducive to harvest by pod stripper combines because it has upright plant architecture. It is widely planted in Delaware.
- 8-78 (85 days) - A larger plant type that has yielded consistently well in Delaware. It has resistance to races A, B, C, D and F of downy mildew. Its larger, more upright habit is conducive to harvest by pod stripper combines. It is widely planted in Delaware.
- 184-85 (86 days) - A larger plant type that sets very few pods in the lower portion of the plant, thus making it more conducive to harvest by pod stripper combines. A good yielder, it has resistance to races A, B, C and E of downy mildew. It has been more widely planted in recent years.
- Jackson Wonder (85 days) - A speckled bean grown and packed for specialty markets, primarily in the Southern region of the United States. It has no resistance to Downy mildew. There is a Jackson Wonder AR, which has resistance to anthracnose.
- Cypress (81 days) - An early maturing variety with resistance to race A, B, C, D, and E. It has similar plant characteristics to M-15.
- C-elite Select. (85 days) - It has resistance to races A, B, C, D and E.

- Dixie White Butterpea (72 days). White seeded, small-sized more like a pea. Susceptible to race E. Heat tolerant.

Fordhook Varieties

- F1072 (95 days) - the standard Fordhook variety and is resistant to races A, B, and C of Downy mildew. It has shown sensitivity to high temperatures and drought.
- 90-1 (95 days) - A recent release from the USDA with resistance to A, B, C and D of Downy mildew. It has not yielded significantly higher than the F1072 in Delaware yield trials. It does have a larger berry size than F1072.
- Sussex (95 days) - A new release that has out yielded all other Fordhook varieties in the 1994 and 1995 Delaware variety trials. It has resistance to races A, B, C and D of downy mildew. It is susceptible to race E, and is moderately susceptible to race F. It is recommended for trial plantings, subject to seed availability.

Non-registered (Pipeline materials) pest management tools: Ridomil Gold/Copper (mefanoxam/copper), Phostrol (salts of phosphorus acid), Quadris (azoxystrobin), Acrobat (dimethomorph), Cabrio (pyraclostrobin), and Serenade (Bacillus subtilis). Testing of many fungicides has been done since 1998. Ridomil Gold/Copper gives excellent control and IR4 is working with it (scheduled to be registered for brassicas and leafy greens in 4th quarter fy2003). We might have enough information for a Section 18 for 2003. It has curative properties. Resistance management is an issue and will need to be managed. Many products have been tested and are effective. Active are: Quadris (Syngenta might label), Acrobat, Cabrio. There is no efficacy data for Serenade biological. Research is needed on maximizing the effectiveness of sprays by applying at the right time with several fungicides with protectant and curative properties. There is need for a predictive model on the new strains to allow growers to stay ahead of Downy Mildew.

BACTERIAL BROWN SPOT: Secondary Pest Status

Bacterial Brown Spot is not as important as white mold or downy mildew. To determine if bactericide application is needed, 5 plants in 5-10 locations are scouted weekly. Scouts look for reddish-brown irregular shaped spots on leaves. It rarely requires any action, but should be monitored when identified. To avoid spreading the disease, the field should be dry while scouting. There is a tendency to see Bacterial Brown Spot in the course of other field activities. Infected seeds and old plant debris are the source of inoculum.

Organo-phosphates currently used to manage bacterial brown spot: None

Carbamates currently used to manage this pest: None

B2 carcinogens currently used to manage this pest: None

Other pesticides currently used (including biologicals) to manage this pest:

Fixed copper is of some value in reducing spread where incidence is low. The disease can be more prevalent in irrigated fields, but yield impact is still unknown. If we lost fixed

copper, we would have nothing were this to become a problem, particularly if it showed up early in plant growth. Streptomycin can be applied to the seed for control. Western-grown seed free of the pathogen has been the best control and has kept bacterial brown spot in check.

Non-chemical methods currently used to help manage this pest: Planting bacteria free seed and crop rotation (to avoid overwintering of inoculum) are used.

Non-registered (Pipeline materials) pest management tools: none

LIMA BEAN POD BLIGHT: Secondary Pest Status

This disease is a potential problem, especially in New Jersey. It is caused by the soil-born fungus, *Phytophthora capsici*. It is considered an emerging disease. Pod blight may become a greater problem because of other, susceptible crops in the rotation. This disease may occur at a very low level and be misidentified as others (downy mildew, pythium pod blight). There is little experience with the epidemiology of this disease and how fast and how much it moves. Current practice is to scout fields weekly in late summer/early fall. Disease development is characterized by white sparse fungal growth on pods in low areas of fields. Pod blight does not infect racemes or petioles. The disease is favored by heavy rains and/or excess irrigation. Some control is achieved by managing irrigation and avoiding irrigation at night. Rotate away from fields with a history of cucurbit and pepper production. Fixed copper sprays applied for downy mildew control may be beneficial in fields with a history of *Phytophthora* blight. Research is needed on effectiveness of Acrobat. Acrobat has activity on Downy Mildew, and may be beneficial in resistance management with Ridomil. Acrobat may result in pod blight reduction. With more processors on Delmarva and New Jersey, there is the potential towards an increase in processing vegetable acreage that will lead to new needs. Research should be conducted on control of pod blight.

ANTHRACNOSE: Secondary Pest Status

Anthracnose is such a minor pest that it is of no threat to current production in Maryland, Delaware or New Jersey. Scouts look for reddish brown blotches on the upper surface of the leaves on Fordhook and baby lima beans in the fall. Pod infections are not common and impact on yield appears to be none to minimal. Control is accomplished by planting Western grown seed and rotating for at least two years out of lima bean. Topsin M is labeled for control should the need arise. There are varietal differences in susceptibility.

ROOT ROTS: Secondary Pest Status

50% of lima fields have at least 25% infection with *Rhizoctonia* Root Rot and other root rots (anecdotal). Scouting occurs at emergence for problems. Symptoms are pre-emergence and post-emergence damping-off and damaged seedlings. On lima bean *Rhizoctonia solani* appears to be the most important pathogen, but *Pythium* spp. and *Fusarium* spp. also are present. . Our experience is that Ridomil Gold PC 11G has been effective for *Pythium* but ineffective at controlling *Rhizoctonia* at labeled rates and

mefanoxam does not persist long enough to control downy mildew. Stand reduction in lima beans is more of a concern than in soybean because limas do not compensate for leaf loss. In an irrigated field, 4 beans/ft is optimum. Typical plant density however is 3 beans/ft.

Organo-phosphates currently used to manage root rots: none

Carbamates currently used to manage this pest: none

B2 carcinogens currently used to manage this pest: none

Other pesticides currently used (including biologicals) to manage this pest:

Quadris applied in the furrow at planting is labeled but not used at the present time. Although it is effective, it is cost prohibitive. Maxim seed treatment is labeled at .08 oz/cwt. of seed and was shown this past season to be effective. Under heavy disease pressure, the highest labeled rate of 0.16 oz/ cwt performed better. Captan and thiram seed treatment is still available, but Captan doesn't work at the rates we have tested for Rhizoctonia. We don't know the effectiveness of Thiram. Seed treatments and rotation are more commonly used. T-22 (*Trichoderma harzianum*, a biofungicide) has activity but it is not a stand-alone product. More research is needed. It works by excluding pathogens from the root zone. There are questions as to whether T22 is labeled for Root Rots on lima beans. It does have a tolerance exemption.

Non-chemical methods currently used to help manage this pest:

Cultural control practices include rotation with non-legume crops; however, the crops we rotate with often maintain pathogen inoculum. Avoiding planting in poorly drained soils, or very dry soils, and plowing under plant debris rather than disking.

NEMATODES: Secondary Pest Status

Growers have noted an increase in nematodes in lima beans. Soil fumigation is not economical or practical on our lima bean fields for control of nematodes. Mocap, an OP, is the only other pesticide labeled for nematode control in limas. Tight rotation, particularly under pivot, has led to an increase in nematode problems. We don't have an economic rotational crop that is not a host of root knot nematode. Small grains work, but are not in the field long enough. Fosthiazate is a methyl-bromide replacement that might work.

BROWN BEANS – RIZOCTONIA POD ROT: Secondary Pest Status

This disease causes pods to turn brown and the beans are discolored as well. The brown beans cause quality problems. Pods touching the ground are the most likely to be infected. Plant architecture may help control the problem, as may irrigation management. Some differences in varietal susceptibility are documented. Quadris and Cabrio might be effective controls. Research on proper fungicide timing, at or prior to pod formation, is needed.

Efficacy Table

	Downy Mildew	White Mold	root rots	Bacterial Brown Spot	pod blight	anthracnose	nematodes	Rhizoctonia pod rot
Registered Materials								
Fixed Copper	G			G	?			
thiophanate methyl		G				G		
Coniothyrium minitans		?						
iprodione		NU						
Streptomycin				E				
soil fumigation		NU	G		?		E	
ethoprop							G	
thiram			P					
captan			F					
New Chemistries								
mefanoxam/copper	E		nu					
azoxystrobin	G							?
Phostrol	E		nu					
pyraclostrobin								
dimethomorph	G							
cyprodinil								
Bacillus subtilis	?*							
BAS 510	?	?						
fosthiazate							?	
Cultural/ non-chemical								
Crop rotation	G	P	G	E	G	E	G	
deep plowing	G	F	F	G	G	E	nu	
host plant resist.	E	NU	nu	nu	?	E	nu	
row orientation	?	?						
plant architecture		?			?			
irrigation manage.	G	?	G	G	G	G		
bury crop debris	G	P	p	E	p	G		
clean seed				E		E		

Rating Scale:

E = excellent; G = good; F = fair; P = poor; ? = more research needed; NU = not used

* = used but not necessarily a stand alone management tool

INSECT PESTS

CORN EARWORM: Primary Pest Status - # 1 insect pest of lima beans

The corn earworm (CEW) is the major pod feeder of lima beans in the mid-Atlantic region. Although fall armyworm can also be found, population levels are not as high and control decisions would be the same. Egg laying activity in lima beans increases significantly in mid to late August when moths shift their egg laying to late planted vegetable crops. Damage to pin and flat pods results in complete bean loss since these pods will fail to develop or drop off the plants. Damage to larger maturing pods results in bean yield loss and quality loss due to broken beans. Feeding damage from one large corn earworm can cause a loss of 30 to 40 lima beans.

Monitoring: Monitoring is the accepted practice for making management decisions. Sampling for earworm should be done twice a week beginning at full bloom and continue until 5 to 7 days from harvest. A standard 3-foot drop cloth should be placed between 2 rows and the plants shaken vigorously to dislodge larvae from the plants and onto the cloth. Ten sites should be sampled per field. The treatment threshold is 1 or more larvae per 6 ft. of row. When possible, treatment should be delayed until 1/3 of the larval population has reached 1/2 inch in size. Treating too early will eliminate natural controls and may result in additional sprays. These sampling methods generally work well with some adjustments.

No resistance or export issues: Although no resistance has been observed in the Mid-Atlantic region, corn earworm pyrethroid resistance in the south is a concern for lima bean producers in the Mid-Atlantic region. In 2002, a few soybean fields in Virginia experienced reduced levels of corn earworm control at labeled rates. Since migratory and resident populations can both cause economic losses in lima beans, it is critical to watch this issue and maintain registrations for rotational products.

Organo-phosphates currently used to manage Corn Earworm:

Orthene (acephate)- 0 day PHI; 0.67 - 1.33 lb/A; 1 application, to 0% of the acreage; provides poor control. Orthene is not used. It is not reliable. It would not be an issue if it was no longer available for use on lima beans.

Carbamates currently used to manage this pest:

Lannate LV - 1 day PHI; 1.5-2 pt/A; 1-3 applications (3 only in years of extreme pressure), to 30% of the acreage; This rate will only control small corn earworms.

Lannate LV - 3 day PHI; 3 pt/A; 1-2 applications, to 30-40% of the acreage; this rate needed with a mixed size of larvae; applied to 20% of the acreage; good control. The size of the worm is an important factor in determining the rate of the product. Although not used on a high percentage of the acreage, Lannate is a critical component of the total insect management program. If Lannate is lost, significant losses would occur. At this time it is

unclear what EPA decisions will be. Even if Lannate were not used every year, it is important to retain the registration for rotational uses in resistance management.

Pyrethroids currently used to manage this pest:

Capture (bifenthrin) - 3 day PHI; 24 hour REI; 2.1 - 3.2 -6.4 oz/A; 1-3 applications depending on the pressure; 80% of the acres; good control

Mustang (zeta-cypermethrin) - 1 day PHI; 12 hour REI; 3.0 - 4.3 oz/A; 1 application; just labeled in 2002; used on 30% of the acreage; good control. Although Mustang is an older pyrethroid, it appears to provide acceptable levels of control. There is no documented resistance in Delaware, Maryland or New Jersey to pyrethroids, although it has been seen in Virginia. Because we use pyrethroid on many crops, we need to watch it closely. We have both overwintering and migratory CEW, which affects our considerations. So our pesticide choices are limited to pyrethroids and a carbamate.

B2 carcinogens currently used to manage this pest: None.

Other pesticides currently used (including biologicals) to manage this pest: None.

Non-chemical methods currently used to help manage this pest:

Biological: Naturally occurring parasites, predators and disease can **play a role in** controlling the corn earworm. Therefore, the use of an economic threshold becomes critical. A fungal disease present during cool, moist periods in September can help to reduce corn earworm populations. **Caution:** These natural controls often do not work quick enough to prevent losses in lima bean yield and quality during years of heavy population pressure.

Spinosad is labeled for CEW, but it is not listed in the Delaware crop recommendation book. Spinosad must be ingested to work. Although there is data to support that Spinosad provides effective corn earworm in other crops, there is a question as to whether Spinosad will work for this pest in a lima bean system. Data generated in Delaware shows there would still be damaged beans if it used alone. Spinosad does work in Tennessee for budworm control in lima beans when tank-mixed with Capture (a very expensive mix). In soybeans, Tracer (same product) works ok. A narrower spectrum of pests is affected. In other crops (peppers) Spintor alone didn't work very well last year.

Cultural: None

Naturally occurring entomopathogens usually don't reach a high enough level in the field in time to control infestations of CEW. Occasionally they might be of some minor help. They don't have a real impact on a commercial/economic basis.

Non-registered (Pipeline materials) pest management tools: **Avaunt**

Dupont apparently has changed their mind about registering CEW on limas for Avaunt. At this time the status is unsure. There are similar issues with Avaunt as with Spinosad. The pesticide must be ingested to work. It is not a good stand-alone product.

STINKBUG AND LYGUS BUG SPECIES: Primary Pest Status

This grouping represents the second most important insect pest of lima beans. There are several species of Stinkbug. The Green Stinkbug may be considered the main species. It is the same color as the beans and can be a contamination problem. Tarnished Plant Bug is also a major species. Concern among processors varies and the yield impact per species is uncertain. Currently there is a shift toward stink bug which is also more of a yield robber than Lygus. In New Jersey stink bug is a very serious pest and becoming more so in other crops in recent years, possibly due to loss of broad-spectrum materials. In recent years, this complex of insects has caused significant losses in processing lima beans. Yield losses can occur from adults or nymphs feeding on the blossoms resulting in blossom abortion. However, the primary losses occur for processors when feeding damage occurs on pin stage beans. Although a field may be harvested with no apparent damage, the resulting feeding scars appear when the beans are processed at the plant. These feeding scars can result in the loss of an entire load with significant economic loss to the processor.

Monitoring: Sample fields twice a week from the bud stage through harvest for adults and nymphs. A standard 15-inch sweep should be used to take 5 sweeps in 10 locations throughout the field. A treatment is suggested if 15 or more adults and/or nymphs can be found per 50 sweeps. Sampling should be done in early morning or late afternoon when insects are most active. In the South, stinkbugs are becoming more of a pest as a result of boll weevil eradication. There is concern that this pressure will cause more of a Stinkbug problem here. Threshold values are used in decision making and work well. There is question as to whether the thresholds should be separated for Stinkbug Vs Lygus.

No resistance or export issues

Organo-phosphates currently used to manage Stink Bug and Lygus Bug:

Dimethoate 4EC (dimethoate) - 0 day PHI; 0.5 - 1 pt/A; 1 application, to 25%- 85% of the acreage; Only effective on lygus bugs species. It does a decent job on Lygus. Dimethoate is a critical use pesticide. It is most useful and cost effective. The EPA review is not finished and tests are variable. It appears 'safe' for 2003. It is not as good on stink bug; but, it is one of few that works on sucking insects. It increases yield and quality.

Carbamates currently used to manage this pest:

Lannate LV (methomyl) - 1 day PHI; 1.5-2 pt/A; 1-2 applications, to 80% of the acreage; works on lygus species and stinkbug; Good control of both insects

Pyrethroids currently used to manage this pest:

Capture (bifenthrin) - 3 day PHI; 24 hour REI; 2.1-6.4 oz/A; 2-3 applications; 50% of the acres; good control but need higher rates at least 4.5 oz for stink bug

Mustang (zeta-cypermethrin) - 1 day PHI; 12 hour REI; 3.0 - 4.3 oz/A; 1 application; just

labeled in 2002; used on 30% of the acreage. Mustang is labeled only for Stinkbug, not Lygus. Mustang offers suppression, but not control.

B2 carcinogens currently used to manage this pest: None

Other pesticides currently used (including biologicals) to manage this pest: None

Non-chemical methods currently used to help manage this pest:

Biological: None

Cultural: None

Non-registered (Pipeline materials) pest management tools: flonicamid . FMC pending on cotton. It is a reduced-risk pesticide. No data available for use on lima beans.

SPIDER MITES: Primary Pest Status

Spider mites, the third most important arthropod in lima beans, can be a problem in lima beans, especially during hot, dry weather. During drought years, spider mites are a primary pest. Damage will generally first appear in late June and early July as a white stippling on the leaves with eventual plant death if economic levels go undetected. They are primarily found on the undersides of leaves causing the leaves to appear tan or yellow in color. Mites feed on the plant sap and can defoliate fields in a few weeks in hot, dry weather. Defoliated plants will produce poor yields and quality beans.

Monitoring: Since mite infestations can begin along field margins next to grassy areas, be sure to carefully sample these areas early in the season. Once populations explode in hot, dry weather, control is extremely difficult. Look for the early signs of white stippling at the base of the leaflets. Mites can be identified by shaking leaves onto a sheet of white paper and watching for moving specks or by using a hand lens to count the number of mites per leaflet. From early July through mid-August, examine 5 leaflets in 10 locations throughout a field for the presence of mites and feeding damage. A treatment should be applied when white stippling is first noticed or when you find 20 or more mites per leaflet. Monitoring is the basis for management decisions. More research is needed on threshold levels. The current threshold may be too high resulting in losses in outbreak years. We should consider just using leaf damage for the threshold.

RESISTANCE PROBLEMS- Dimethoate and Kelthane both provide good control, especially under irrigated conditions. Although not documented in lima beans, resistance has been documented with these products in other crops.

PEST RELATED EXPORT ISSUES – none

Organo-phosphates currently used to manage Spider Mites:

Dimethoate 4EC (dimethoate) - 0 day PHI; 48 hour REI, 1 pt/A; applied 2- 4 times per acre to 85 % of the acreage in outbreak years. In recent years, control has been reduced under stress conditions. However in most situations, dimethoate will help to suppress populations below a threshold level. Reduced levels of control may also be a result of poor

coverage, resistance, storage conditions of the chemical, and/or high pH/iron content of the spray water. With water management, dimethoate can be more effective – the plant has to be able to take it up. Dimethoate should be sprayed early to avoid stress in lima plantings. In addition, the addition of adjuvants to the spray mix has been shown to improve control. In 2002, the use of Hyperactive with dimethoate greatly improved the efficacy of dimethoate when used for spider mite control in soybeans.

Carbamates currently used to manage this pest: None.

Pyrethroids currently used to manage this pest:

Capture (bifenthrin): 3 day PHI; 24 hour REI; 5.12-6.4 oz/acre; applied 1-2 times for spider mites when they are an economic problem; provides good spider mite control; can cause aphids to flair if used frequently. Works only with very high rates, but only use once or you will flair mites. Mites might be a reason to change rates given other pests. Expensive at high rates.

B2 carcinogens currently used to manage this pest: None.

Other pesticides currently used (including biologicals) to manage this pest:

Kelthane MF (dicofol) - 7 day PHI; 12 hour REI; 1 pt/A; Applied 2- 3 times per acre to 20 % of the acreage in outbreak years. In recent years, control has been fair to good.

Non-Chemical methods:

Biological: None

Cultural: None

Non-registered (Pipe line materials) pest management tools:

Acramite. Low risk (registrant going for it on succulent beans)

Agri-Mek. (might be bumping the risk cup limit, and not scheduled until last quarter)

POTATO LEAFHOPPER: Primary Pest Status

Although Potato Leafhopper (PLH) is more of a pest of snap beans, significant damage can occur on seedling stage lima beans. Early migratory populations combined with dry weather conditions can result in an early increase in leafhopper populations. Plants appear yellow and stunted, with the typical "hopper burn" damage on the tips of the leaves. Both yields and plant maturity can be affected by leafhopper feeding from the seedling to pre-bud stage. Once pods are present, economic damage is less likely to occur. In recent years, at least 20% of the early planted lima bean acreage is treated at the cotyledon stage. Lima beans can tolerate more potato leafhopper activity (compared to snap beans) if not stressed and are actively growing

Monitoring: Sample for leafhopper adults and nymphs on a weekly basis from the seedling through the pod development stage. A standard 15-inch sweep net should be used to take 10 sweeps in 10 locations. A treatment should be applied if you find 5 or more leafhoppers per sweep during the prebloom stage, 10 per sweep during the bloom stage,

and 25 per sweep during pod development. Initial signs of infestation are leaf cupping on seedling stage. The threshold level is affected a great deal by other stresses.

No resistance or export issues

Organo-phosphates currently used to manage leafhoppers:

Dimethoate 4EC (dimethoate) - 0 day PHI; 48 hour REI; 0.5 - 1 pt/A; 1 application, to 20% or less of the acreage; excellent control

Orthene 75S (acephate) - 0 day PHI; 24 hour REI; 0.67 - 1.33 lb/A; 1 application, to 0% of the acreage. good control

Carbamates currently used to manage this pest:

Lannate LV (methomyl) - 1 day PHI; 48 hour REI; 1.5 - 2pt/A; 1 application, to 20% of the acreage; good control

Sevin 80S (carbaryl) - 0 day PHI; 12 hour REI; 0.67 lb/A; 1 application, to 0% of the acreage; fair control

Pyrethroids currently used to manage this pest:

Capture (bifenthrin)- 3 day PHI; 24 hour REI; 1.6 - 6.4 oz; 1-2 applications, up to 0% acreage treated; good control. Only used if PLH is a secondary pest

Mustang (zeta-cypermethrin)- 1 day PHI; 12 hour REI; 3.0 - 4.3 oz/A; 1 application; just labeled in 2002; used on 0% of the acreage; good control

B2 carcinogens currently used to manage this pest: None.

Other pesticides currently used (including biologicals) to manage control this pest: None.

Non-chemical methods currently used to help manage this pest:

Biological: None

Cultural: None

Non-registered (Pipeline materials) pest management tools: Cruiser commercial applied seed treatment; excellent PLH control - longer control compared to Gaucho which is labeled on lima beans but does not have leafhopper on the label. Cost needs to be investigated.

SEED CORN MAGGOT: Secondary Pest Status

This insect is primarily a problem in early-planted lima bean fields, especially during cool, wet growing seasons or in fields using poultry manure. Limas are often planted later in the year, thus the Seed Corn Maggot is not a major pest. For those limas planted early, only a few maggots per seed or plant can significantly reduce stands. Maggots overwinter as puparia in the soil with flies emerging as early as late February. Outbreaks are favored

by planting into freshly plowed ground that is high in organic matter; freshly manured fields; and/or heavy crop residues (e.g. small grain covers) where spring tillage is delayed and/or surface residue is visible after spring tillage operations.

Monitoring: Scouting and applying rescue treatments after the damage is observed are ineffective. Management options must be applied to high-risk fields prior to planting.

No resistance or export issues.

Organo-phosphates currently used to manage Seed Corn Maggot:

Currently available seed treatments and soil insecticides provide only fair control, especially under heavy seed corn maggot pressure. Diazinon 50W hopper box treatment can be used through July 2004. Chlorpyrifos (Lorsban 50SL - 2 oz/100 lbs. of seed) can be used and there are no plans for cancellation at this point. . It can help to reduce damage. Diazinon 50W as a seed treatment at a rate of 1/2 oz per bushel of seed has provided the most effective control. The use of soil insecticides labeled for lima beans has only provided fair control. Gaucho 480 commercial seed applied treatment was labeled in 2001 on beans but was pulled in 2002 because of a major SCM control failure in New York.

Disyston 15G (disulfoton) - 60 day PHI; 48 hour REI; Apply 6 - 12 oz per 1000 foot of row. Provides only poor to fair control. Applied at planting to less than 5% of the acreage.

Thimet 20G (phorate) - 60 day PHI; 48 hour REI; Apply 4.6 - 6.9 oz per 1000 foot of row. Provides only poor to fair control. Applied at planting only, to 5% of the acreage.

Carbamates currently used to manage this pest: None.

B2 carcinogens currently used to manage this pest: None.

Other pesticides currently used (including biologicals) to manage this pest: None.

Gaucho seed-applied treatment resulted in a massive SCM control failure in NY on snap beans in 2002 due to cool-weather and heavy manure use. These conditions resulted in severe seed corn maggot pressure. SCM was removed from the Gaucho label in 2003. It is still labeled on beans for bean leaf beetle, wireworm and aphids.

Non-Chemical methods:

Biological: - None Available

Cultural: The use of cultural management practices before planting is critical to reduce the potential for economic problems. A combination of the following cultural strategies can be used: (1) plow down cover crops at least 3-4 weeks before planting or transplanting, (2) completely bury cover crops or previous crop residue to reduce fly attraction to rotting organic matter on the soil surface, and (3) avoid the use of heavy manure applications close to planting

Non-registered (Pipe line materials) pest management tools: Cruiser (thiamethoxam) seed treatment from Syngenta -- slated for a 2003 bean label but not sure it will provide effective SCM control.

MEXICAN BEAN BEETLE: Secondary Pest Status

Mexican Bean Beetles (MBB) are rare in limas, but were seen last year. They are usually only on the edges of fields, but can be very bad when found. This insect is the major defoliating pest of beans in the mid-Atlantic region. In recent years, weather conditions have helped to reduce population levels in the region. Adult beetles overwinter in hedgerows, ditch banks and woodlands near host crops. Adults become active in late April to mid-May. If overwintering populations are heavy, damage can occur in early-planted lima beans at plant emergence. In general, economic levels of the Mexican bean beetle (MBB) are not found before late July. Both adults and larvae can cause damage to beans. Feeding damage can reduce bean yields and pod quality if defoliation exceeds 10%, especially after bloom.

Monitoring: The current sampling scheme is tried and true. The figures are still valid. Begin sampling at plant emergence along field margins next to overwintering sites. When plants are small, examine the undersides of all plants in 3 foot of row and count the number of adults and larvae and estimate the percent stand reduction or defoliation. Since populations of overwintered adults tend to occur in "hotspots", be sure to note the predominant life and the location of the infestation. When plants are larger, a sweep net or drop cloth should be used to assess the population. Before the first trifoliolate stage, a treatment should be considered if you find 6 or more beetles per row foot and no more than a 25% stand reduction. At the first to third trifoliolate, the treatment threshold is 2 or more beetles per plant and 20% defoliation. After the third trifoliolate and before the bud stage, treatment is suggested if defoliation exceeds 20 percent. From the bud stage until harvest, treat if defoliation exceeds 10% and populations are increasing.

No resistance or export issues

Organo-phosphates currently used to manage MBB:

Disyston 15G (disulfoton) - 60 day PHI; 48 hour REI; 6 - 12 oz per 1000 foot of row; applied at planting only, to less than 5% of the acreage; only provides fair control of the overwintering generation.

Orthene 75S (acephate) - 0 day PHI; 0.67 - 1.33 lb/A; 1 application, to 0% of the acreage; provides good control

Thimet 20G (phorate) - 60 day PHI; 48 hour REI; 4.6 - 6.9 oz per 1000 foot of row; applied at planting only, to 20% of the acreage; only provides fair control of the overwintering generation.

Carbamates currently used to manage this pest:

Lannate LV (methomyl) - 1 day PHI; 48 hour REI; 1.5 - 2 pt/A; 1 application, to 10 % of the acreage; provides good control

Sevin 80S (carbaryl) - 0 day PHI; 12 hour REI; 0.67 lb/A; 1 application, to 0% of the acreage.

Pyrethroids currently used to manage this pest:

Mustang (zeta-cypermethrin) - 1 day PHI; 12 hour REI; 3.0 - 4.3 oz/A; 1 application; just labeled in 2002; used on 10% of the acreage; good control (Capture not labeled for this pest)

B2 carcinogens currently used to manage this pest: None.

Other pesticides currently used (including biologicals) to manage this pest: None.

Non-Chemical methods:

Biological: On farms with a succession of bean plantings, the release of the parasite, *Pediobius foveolatus*, may provide effective control. Caution: This system has only been demonstrated on soybeans and additional information will be needed to demonstrate its effectiveness on lima beans.

Cultural Controls: The use of an early planted trap crop for overwintered beetles may be effective for controlling MBB in later plantings of lima beans. A trap crop consisting of a mixture of snap beans and soybeans planted at least 3 weeks before the main crop will attract overwintering beetle. Plowing under or spraying the trap crop with an insecticide could control beetles. Caution: This system has only been demonstrated on soybeans and additional information will be needed to demonstrate its effectiveness on lima beans

Non-registered (Pipe line materials) pest management tools: None

BEAN APHID: Secondary Pest Status

The black bean aphid is the predominate species of aphid found in Delaware lima bean fields. In recent years, it has only been a sporadic or occasional pest. It overwinters in the egg stage on euonymus shrubs and migrates to weed hosts in the spring. Movement from weed host to lima beans generally occurs in June. Aphids are found on the undersurface of leaves and on the terminal buds. Infested plants appear yellow with puckered foliage. Feeding damage results in bud and blossom abortion. A dark sooty mold also grows on the honeydew excreted by the aphids resulting in reduced photosynthesis and reduced yields.

Monitoring: Fields should be sampled weekly from the seedling to the pre-bud stage. Examine 5 terminals in 5 to 10 locations for the presence of aphids and beneficial insects. Treatment is suggested if 50% or more of the terminals are infested with 5 or more aphids/terminal, aphids can be found throughout field and few beneficial insects can be found.

No resistance or export issues

Organo-phosphates currently used to manage Bean Aphid:

Dimethoate (dimethoate)- 0 day PHI; 48 hour REI, 1 pt/A; applied 1 time to less than 5% of the acreage; good control

Orthene (acephate)- 0 day PHI;24 hour REI; 0.67 - 1.33 lb/A; 1 application, to less than 5% of the acreage; good control

Carbamates currently used to manage this pest:

Lannate LV (methomyl) - 3 day PHI; 48 hour REI; 1.5-3 pt /A; 1 application, to less than 5% of the acreage; good control

B2 carcinogens currently used to manage this pest:

Other pesticides currently used (including biologicals) to control this pest:

Gaucho seed treatment at a rate of 2-4 oz per hundredweight of seed; good control.

Non-chemical methods currently used to help manage this pest: None

Non-registered (Pipeline materials) pest management tools: Cruiser seed applied insecticide - potential label 2003

Occasional Insect Pests – Although the following insect pests may not affect lima beans every year, they can cause significant economic losses during outbreak years.

Thrips – During the past 5 years, thrips problems have increased in seedling stage lima beans. Although lima beans can tolerate higher numbers than snap beans, significant damage can occur when populations are high from plant emergence through the third trifoliate stage. Controls are recommended when plants are stressed and plant damage is visible.

Capture (bifenthrin)- 3 day PHI; 24 hour REI; 2.1- 6.4 oz; 1 application on up to 5% acreage ; good control; only used when treating for other insect pests like CEW or PLH; pyrethroid

Dimethoate(dimethoate)- 0 day PHI; 48 hour REI, 1 pt/A; applied 1-2 times to 20% of the acreage; excellent control; preferred material labeled for the crop but not the pest; organophosphate

Lannate LV (methomyl) - 3 day PHI; 48 hour REI; 1.5-3 pt /A; 1 application on up to 5% of the acreage; good control; only used when treating for other insect pests like CEW or PLH; carbamate

Orthene (acephate) - 0 day PHI;24 hour REI; 0.67 - 1.33 lb/A; not used on lima beans; organophosphate

Provado 1.6F(imidacloprid) – 7 day PHI; 12 hour REI; not used on lima beans due to cost; provides fair to good control of thrips

Sevin 80S (carbaryl) - 0 day PHI; 12 hour REI; 1.25 lb/A; applied to 0% of the acreage.

Green Cloverworm – This insect is generally a defoliator but can also feed on the pods when populations are high. Significant defoliation can result in premature maturity and reduced yields. No thresholds are available for this pest.

Capture (bifenthrin) - 3 day PHI; 24 hour REI; 2.1- 6.4 oz; 1 application on up to 20 % acreage in outbreak years; good control; pyrethroid
Mustang (zeta- cypermethrin)- 1 day PHI ; 12 hour REI; 3.0-4.3 oz; 1 application on up to 20% acreage in outbreak years; good control; pyrethroid
Orthene (acephate) - 0 day PHI;24 hour REI; 0.67 - 1.33 lb/A; not used on lima beans; organophosphate

Cabbage Looper – This insect is a migratory pest generally being found in the region in late June to early July. Cabbage loopers can cause significant defoliation, reduced maturity and yields. A treatment is recommended when you find 30 worms per 3 foot of row.

Bts - Numerous materials are labeled on lima beans; used on less than 1% of the acreage; only provide control of small worms.

Capture (bifenthrin)- 3 day PHI; 24 hour REI; 2.1- 6.4 oz; 1 application on up to 10% acreage ; good control; pyrethroid

Lannate (methomyl) - 3 day PHI; 48 hour REI; 1.5 /A; 1 application on up to 10% of the acreage; good control; carbamate

Mustang

Orthene(acephate) - 0 day PHI;24 hour REI; 0.67 - 1.33 lb/A; not used on lima beans; organophosphate

Spintor (spinosad) – 3 day PHI; 4 hour REI; 4-6 oz/A; used on less than 1% of the acreage due to cost; provides good control

Beet Armyworm – This insect is a migratory pest found in our area by mid-July. Although an occasional pest, this insect can cause significant losses in outbreak years. This insect has developed resistance to labeled pyrethroids and Lannate.

Bts- Numerous materials are labeled on lima beans; used on less than 1% of the acreage; only provide control of small worms.

Lannate (methomyl)– 3 day PHI; 48 hour REI; 1.5 /A; 0 applications; carbamate poor control due to resistance in southern migratory populations

Capture (bifenthrin)- 3 day PHI; 24 hour REI; 2.1- 6.4 oz; 0 applications; pyrethroid; poor control due to resistance in southern migratory populations

Mustang – poor control in 2002

Spintor (spinosad) – 3 day PHI; 4 hour REI; 4-6 oz/A; used on less than 1% of the acreage due to cost; provides excellent control

Pipeline – Avaunt

Efficacy Table

	Seed Corn Maggot Lygus Bug Sp.	Stinkbug sp.	Spidermites	aphids	leafhoppers	Mexican Bean Beetle Corn	Earworms
Registered Materials							
phorate	P-F	NU	NU	NU	P	F	NU
diazinon	G-E	NU	NU	NU	P	P	NU
chlorpyrifos	G-E	NU	NU	NU	P	P	NU
disulfoton	P-F	NU	NU	NU	P	F	NU
dimethoate	NU	G	F	F-G	F	F	NU
acephate	NU	P	P	NU	G	G-E	P
methomyl	NU	G	G	NU	G	G	G
carbaryl	NU	P	P	NU	P	F	P
bifenthrin	NU	G	G	G	P	G-E	G
dicofol	NU	NU	NU	G	P	P	NU
zeta-cypermethrin	NU	G	G	P	P	G	G
imidacloprid	NU	?	?	NU	G	F	P
New Chemistries							
indoxacarb	?	?	?	?	?	?	G
thiamethoxam	?	?	?	?	?	?	?
bifenazate	?	?	?	G	?	?	?
abamectin	?	?	?	G	?	?	?
Cultural/ non-chemical							
plow down cover crop	*	NU	NU	NU	NU	NU	NU
bury cover crop	*	NU	NU	NU	NU	NU	NU
avoid heavy manure	*	NU	NU	NU	NU	NU	NU
parasites	?	?	?	P	P-F	P	P
trap crop	NU	NU	NU	NU	NU	G	NU
predators	?	?	?	P	P-F	P	P
pathogens	?	?	?	P	P-F	P	F

Rating Scale:

E = excellent; G = good; F = fair; P = poor; ? = more research needed; NU = not used

* = used but not necessarily a stand alone management tool

Toxicity to Beneficials Table – This information is not available for this region. Labels do not provide specific information. The information in this table for general predators and parasites comes from a fruit publication in California. In this publication they state that “ toxicities are averages of reported effects and

should only be used as general guidelines. Actual toxicity depends on species, environmental conditions and application rate.

(www.ipm.ucdavis.edu/PMG/r602900411.html). The predatory mite information comes from the 2002 Cornell Fruit information since the species are the same ones that occur on the Delmarva.

Single active ingredient products	Big-eyed Bug	Damsel bug	Green Lacewings	Ladybird Beetles	Spiders	Minute Piate Bug	Predatory Mites entomo-pathogenic nematodes	Syrphid fly larvae	Parasites	General Predators
Registered Materials										
phorate	?	?	?	?	?	?	?	?	?	?
diazinon	?	?	?	?	?	?	?	?	H	H
chlorpyrifos	?	?	?	?	?	?	M	?	H	H
disulfoton	?	?	?	?	?	?	?	?	?	?
dimethoate	?	?	?	?	?	?	H	?	H	H
acephate	?	?	?	?	?	?	?	?	?	?
methomyl	?	?	?	?	?	?	H	?	H	H
carbaryl	?	?	?	?	?	?	M	?	H	H
bifenthrin	?	?	?	?	?	?	H	?	H	H
dicofol	?	?	?	?	?	?	M	?	?	M
zeta-cypermethrin	?	?	?	?	?	?	H	?	H	H
imidacloprid	?	?	?	?	?	?	S	?	?	M
New Chemistries								?		
indoxacarb	?	?	?	?	?	?	S	?	M	M
thiamethoxam	?	?	?	?	?	?	S	?	L	L
bifenazate	?	?	?	?	?	?	S	?	L	L
abamectin	?	?	?	?	?	?	M	?	?	M
Cultural/ non-chemical								?		
plow down cover crop	?	?	?	?	?	?	?	?	?	?
bury cover crop	?	?	?	?	?	?	?	?	?	?
avoid heavy manure	?	?	?	?	?	?	?	?	?	?
parasites	?	?	?	?	?	?	?	?	?	?
trap crop	?	?	?	?	?	?	?	?	?	?
predators	?	?	?	?	?	?	?	?	?	?
pathogens	?	?	?	?	?	?	?	?	?	?

Toxicity scale:

S = slightly toxic; M = moderately toxic; H = highly toxic; O = nontoxic; ? = no data available

WEEDS (4,5)

Primary weeds (mostly in terms of acres) include:

Annual grasses (foxtails, fall panicum, crabgrass, barnyardgrass, and others)

Common ragweed

Morningglory species

Pigweed species

Lambsquarters

Horsenettle

Common purslane (also contaminant)

Jimsonweed

Common cocklebur

Mustard species

Wild radish

Secondary pests (defined as not as wide-spread of a problem in lima beans):

Yellow nutsedge

Johnsongrass

Bermudagrass

Summer annual weeds:

 Nightshades

 Velvetleaf

 Spurred anoda

Perennial weeds

 Common milkweed

 Bindweed

 Canada thistle

 Pokeweed

 Groundcherry

WEED THRESHOLDS (established by Rutgers University)

Zero tolerance weeds:

Nightshades, horsenettle, morningglory species, jimsonweed, perennials, common cocklebur, and common purslane

Zero tolerance weed seeds or fruits are a contaminant in raw and processed product or are highly competitive. Berries of nightshade species are toxic and they have the potential to stain light skinned lima beans. Jimsonweed fruit are hallucinogenic. Horsenettle berries and morningglory seed capsules are difficult to separate from harvested beans.

Emergence to third trifoliolate (three weeks after planting)

The number of annual weeds/100 square feet determines the severity of infestation:

<1 weed: very light

1-5 weeds: light

5-20 weeds: medium
 20-50 weeds: heavy
 >50 weeds: very heavy

Threshold levels and control are shown in the following tables:

Threshold	
<u># weeds/10 ft. row or 1 sq. yd.</u>	<u>Action</u>
Zero Tolerance Weeds: Presence	Control required
Summer annuals: < 1.0 weed 1-5 weed > 5 weed	None Control may be required Control required

Flowering stage (five to six weeks after planting) zero tolerance weeds:

Threshold	
<u># weeds/10 ft. row or 1 sq. yd.</u>	<u>Action</u>
Zero Tolerance Weeds: Presence	Control required.
Summer Annuals: < 0.25 weed 0.25 - 1 weed > 1 weed	None Control may be required. Control required.

The size of the weed is important in determining a threshold. Weeds less than 4 inches tall at five to six weeks after planting will have no impact on yield. Broadleaf weeds over 6-8 inches tall will probably not be adequately controlled with Basagran. Most grasses can be effectively controlled up to 8 inches tall. Cultivate if weeds are predominantly between the rows. Cultivate in a way that leaves the field as flat as possible to improve harvest recovery of limas.

HERBICIDE FOR LIMA BEANS (6)

Pre-Planting Decisions: Use information obtained from the past season's scouting in planning weed control programs for the current year. Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Labeled herbicides for lima beans:

Soil-applied herbicides:

Treflan (trifluralin) (pre-plant incorporated treatment only) 4L formulation: 1 pt/A - 60 – 75% of acres. Treflan is used predominately for grass control (also for enhanced morningglory control when used in combination with Dual plus Pursuit). Treflan is used as a companion herbicide with Dual Magnum plus Pursuit.

Dual Magnum (or Dual II Magnum) (s-metolachlor) 2/3 to 1 pt./A - 90 to 100% of acres. May be used preemergence or preplant incorporated. Used predominately for grass control and yellow nutsedge suppression. Yellow nutsedge control is improved if Dual Magnum is used as a pre-plant incorporated treatment.

Pursuit (imazethapyr) 75DF formulation: 0.5 to 1 oz./A - 90% of acres. When using Pursuit, consider rotational crop restrictions. Pursuit is used predominately for broadleaf weed control.

Sandea (halosulfuron) 75DF: 0.5 to 1 oz/A - similar chemistry to Pursuit, would be used in place of Pursuit and tank-mixed with Dual Magnum (and other grass herbicides). Improves common ragweed, common lambsquarters, and yellow nutsedge compared to current herbicides. Sandea was recently labeled and no historical use data is available. Sandea does not control grass species

Prowl (pendimethalin) 3.3 EC formulation: 1 pt/A - 25-40% of acres. Very similar to Treflan (growers would use Treflan or Prowl, but not both). University extension has concerns regarding crop safety with Prowl in lima beans. Prowl is used as a companion herbicide with Dual Magnum plus Pursuit. Used predominately for velvetleaf and common lambsquarters control.

Command (clomazone) 3ME formulation: 4-6 oz./A - 10% or less of acres. Command is recently labeled and University extension has little experience on which to recommend it. Previously there was crop injury concern with another formulation of Command).

Used predominately for annual grass, velvetleaf, and common lambsquarters control.

Postemergence herbicides:

Basagran (bentazon) 1.5 to 2 pts/A - 20-25% of acres. Used for broadleaf weeds and yellow nutsedge control. Does not control pigweed, but will control cocklebur, mustards, jimsonweed, common lambsquarter, common ragweed, and morningglory (fair to good control if applied to small weeds, less than 2 inches tall). Will have some effect on Canada thistle. Temporary pronounced crop injury might occur. Use crop oil concentrate, or if temperatures above 90 degrees F, a non-ionic surfactant. Do not mix with Basagran or any other fungicides or insecticides.

Poast (sethoxydim) - 1 to 1.5 pints/A - 5-10% of acres. Used exclusively for grass control. Will control annual grasses and certain perennial grasses. Use with crop oil concentrate at 1 percent solution (1 gallon/100 gallons of spray solution). Grass control will be best when the plants are treated while actively growing.

All the herbicides have a PHI, however it is not an issue since the herbicides are sprayed well in advance of harvest and the REI is 24 hrs.

No problems with water quality or worker related problems for all herbicides beyond standard safe use information.

Herbicide-resistant weeds:

Pursuit-resistant pigweeds have been identified in DE. These plants have been selected for by repeated Pursuit applications in vegetables. At this point, Pursuit-resistant pigweeds are a localized problem.

Organo-phosphates currently used to manage weeds: None

Carbamates currently used to manage weeds: None

B2 carcinogens currently used to manage weeds: None

Non-chemical methods currently used to help manage weeds: All lima bean fields are cultivated at least once for weed control. 60% are cultivated twice. This is an important IPM component. Whether weeds are within the row or between the rows determines if cultivation will be an effective control. Cultivate in a way that leaves the field as flat as possible to improve harvest recovery of limas. No biological control agents are currently being used for weed control.

Non-registered pest management tools:

Non-registered herbicides being evaluated and considered for registration by manufacturer:

Raptor (imazamox) has a tolerance and could replace Pursuit. It has a similar chemistry. It will be used as a preemergence herbicide, but it is unclear if it will have a postemergence label.

Authority (sulfentrazone) will get some attention from IR4 this quarter. A soil-applied herbicide to be included as a tank mixture to broaden and improve broadleaf weed control. It provides good morningglory control and very good nightshade control. Authority is eligible for a Section 18. Irrigation will probably be involved to avoid 'splash' onto leaves.

Non-registered herbicides evaluated and may have potential in lima beans based on University of Delaware data:

Define (flufenacet) replacement for Dual

FirstRate (cloransulam) has postemergence or preemergence broadleaf weed control.

DowAgroSciences is not interested in supporting registration on lima beans.

Select (clethodim) replacement for Poast

TABLE 1: RELATIVE EFFECTIVENESS OF SOIL-APPLIED LIMA BEAN HERBICIDES FOR INDIVIDUAL GRASS AND GRASS-LIKE WEED SPECIES

Legend - based on adequate moisture, good growing conditions, and proper herbicide application

E = Excellent (>90% control)

G-E = Good to Excellent

G = Good (80-90% control)

F-G = Fair to Good

F = Fair (60-80% control)

P-F = Poor to Fair

P = Poor (20-60% control)

N = None (<20% control)

an “-“ indicates that insufficient data or experience available.

Prowl and Command are labeled for lima beans but not recommended for use in Delaware due to lack of experience (Command) or concern of injury (Prowl).

Authority, Define, FirstRate, and Valor are not labeled for lima beans, but have been part of our lima bean screening program.

Single active ingredient products	Barnyardgrass	Bermudagrass	Broadleaf signalgrass	Crabgrass	Fall panicum	Foxtails	Goosegrass	Johnsongrass (seedling)	Johnsongrass (rhizome)	Quackgrass	Sandbur	Shattercane	Texas panicum	Yellow nutsedge
Authority	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Command	F-G	P	G-E	F-G	F	F	F	P	N	P	G-E	P	G	N
Define	G	N	F-G	G	G	G	G	P	N	N	P	N	P	P
Dual II Magnum	G-E	N	F-G	G-E	G-E	F	F	P	N	N	F	P	P	F
FirstRate	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Prowl	G-E	N	F-G	F	F-G	G	F	F	N	N	F	F	P-F	N
Pursuit	P-F	N	N	P-F	P-F	P-F	P	N	N	N	N	N	N	P
Sandea	N	N	N	N	N	N	N	N	N	N	N	N	N	G
Treflan (PPI only)	F	P	G	G	G	F	F	G	P	P	G	G	G	N
Valor	P	N	P	P	P	P	P	N	N	N	N	N	P	N

TABLE 2: RELATIVE EFFECTIVENESS OF SOIL-APPLIED LIMA BEAN HERBICIDES FOR INDIVIDUAL BROADLEAF WEED SPECIES

Single active ingredient products	Eastern black nightshade	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters	Morningglory (annual spp.)	Pigweed	Giant ragweed	Common ragweed	Smartweed	Spurred anoda	Prickly sida or teaweed	Tropic croton	Velvetleaf	Purslane
Authority	G	N	F-G	G	G	F-G	F-G	N	N	P	P	P	P	P	G
Command	P	P	P	F-G	G	N	P-F	P-F	F	F-G	E	F-G	G	E	G
Define	P	N	N	N	P-F	N	E	N	P	N	N	N	N	N	G
Dual Magnum	F	N	N	N	P-F	N	G	N	P	P	N	P	N	N	F-G
FirstRate	N	P	G	G	E	G	P	F-G	G	G	G	N	N	G	P
Prowl	N	N	N	N	F-G	P	G	N	P	P	N	P	P	F	F-G
Pursuit	G	N	F-G	G	F	F	E	-	G	F	-	-	-	G	P
Sandea	N	N	F-G	G	G	P-F	E	N	E	F-G	-	-	-	F-G	F
Treflan (PPI only)	N	N	N	N	G	P	G	N	N	P	N	N	P	N	G
Valor	G	N	N	F-G	G	F-G	G	N	N	P	F-G	G	F-G	P	G

Treflan in 3-way combination with Dual and Pursuit enhances morningglory suppression to F-G.

TABLE 3: RELATIVE EFFECTIVENESS OF POSTEMERGENCE LIMA BEAN HERBICIDES FOR INDIVIDUAL GRASS AND GRASS-LIKE WEED SPECIES

Legend - based on adequate moisture, good growing conditions, and proper herbicide application

E = Excellent (>90% control)

G-E = Good to Excellent

G = Good (80-90% control)

F-G = Fair to Good

F = Fair (60-80% control)

P-F = Poor to Fair

P = Poor (20-60% control)

N = None (<20% control)

an “-” indicates that insufficient data or experience available.

Single active ingredient products	Barnyardgrass	Bermudagrass	Broadleaf signalgrass	Crabgrass	Fall panicum	Foxtails	Goosegrass	Johnsongrass (seedling)	Johnsongrass (rhizome)	Quackgrass	Sandbur	Shattercane	Texas panicum	Yellow nutsedge
Basagran	N	N	N	N	N	N	N	N	N	N	N	N	N	F
Poast	F	F-G	G	G-E	F	F	G-E	F	G	G	G	G	G	N
Raptor	F-G	N	F-G	F-G	F-G	G	P	G	P-F	N	F	G	P-F	P
Select	F	G-E	G-E	F	F	F	G	F	G-E	G-E	G	F	G	N

TABLE 4: RELATIVE EFFECTIVENESS OF POSTEMERGENCE LIMA BEAN HERBICIDES FOR INDIVIDUAL BROADLEAF WEED SPECIES

Single active ingredient products	Eastern black nightshade	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters	Morningglory (annual spp.)	Pigweed	Giant ragweed	Common ragweed	Sicklepod	Smartweed	Spurred anoda	Prickly sida or teaweed	Tropic croton	Velvetleaf	Purslane
Basagran	P	P	G-E	F	P-F	P	P	P-F	F-G	P	G-E	F	F	F	G	F-G
Raptor	F-G	P-F	F	G	F	F-G	F	F	F	P	F-G	F	F	-	F-G	F-G

Poast and Select do not provide control of broadleaf weeds.

Efficacy Table

	Seed Corn Maggot Lygus Bug Sp.	Stinkbug sp.	Spidermites	aphids	leafhoppers	Mexican Bean Beetle Corn	Earworms
Registered Materials							
phorate	P-F	NU	NU	NU	P	F	NU
diazinon	G-E	NU	NU	NU	P	P	NU
chlorpyrifos	G-E	NU	NU	NU	P	P	NU
disulfoton	P-F	NU	NU	NU	P	F	NU
dimethoate	NU	G	F	F-G	F	E	NU
acephate	NU	P	P	NU	G	G-E	P
methomyl	NU	G	G	NU	G	G	G
carbaryl	NU	P	P	NU	P	F	P
bifenthrin	NU	G	G	G	P	G-E	G
dicofol	NU	NU	NU	G	P	P	NU
zeta-cypermethrin	NU	G	G	P	P	G	G
imidacloprid	NU	?	?	NU	G	F	P
New Chemistries							
indoxacarb	?	?	?	?	?	?	G
thiamethoxam	?	?	?	?	?	?	?
bifenazate	?	?	?	G	?	?	?
abamectin	?	?	?	G	?	?	?
Cultural/ non-chemical							
plow down cover crop	*	NU	NU	NU	NU	NU	NU
bury cover crop	*	NU	NU	NU	NU	NU	NU
avoid heavy manure	*	NU	NU	NU	NU	NU	NU
parasites	?	?	?	P	P-F	P	P
trap crop	NU	NU	NU	NU	NU	G	NU
predators	?	?	?	P	P-F	P	P
pathogens	?	?	?	P	P-F	P	F

Rating Scale:

E = excellent; G = good; F = fair; P = poor; ? = more research needed; NU = not used

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