Growing Hard Shelled Gourds (*Lagenaria siceraria*) in Pennsylvania

A guide for the backyard gardener

It is pretty easy to grow a gourd plant. To increase your chances of getting a large crop of nice, sturdy gourds to craft you can choose to focus on a myriad of details. This guide is a collection of those details practiced by one Pennsylvania grower. It is not meant to be an intimidating, rigid expose' but rather helpful information for you to consider as you have the time and inclination over multiple growing seasons.

Timing

Pennsylvanians live outside of the gourd's natural growing range, a fact borne out by the lack of native wild gourd relatives in the state. Gourds need as much as a 180 day growing season to reach maturity and thus dry successfully. This is especially true for the larger varieties. This season length spans from early May to late September. If you are much above the Mason-Dixon Line it will be too cool to plant your gourd seeds directly into the garden at the beginning of May. Even in Berks County the soil temperature might not remain at 60 degrees or above till after the beginning of June. Not much happens between the gourd roots and the soil below this temperature. And the part of the gourd plant above ground is sensitive to frost and chilly winds.

This is not to say you won't have nice looking, fresh gourds in the fall with less time on the vine. Much of the agricultural literature available is written with fresh fall gourds as the goal. But many of these will fail to dry into lasting craft material.

If you need to, go to this map[1] to check out your growing season length. If you are in a very southern county you may consider planting your gourd seeds directly into well worked soil after the last frost free date. But most of us will have to start our gourds indoors.

Locating and Spacing

Next you will have to decide where to put your gourd patch and how many plants you can accommodate. Gourds need full sun, plenty of space and access to water in times of drought. Gourds do well when the plants are ten feet apart although there is plenty of

[1] Pennsylvania State Climatologist website http://pasc.met.psu.edu/PA_Climatologist/fod/COAS/PA_growing_season.html. Pa. State Climatologist Office, 503 Walker Building, University Park, PA 16802. Phone 814-865-8732.

valid information in the literature about planting them as close as four feet apart in rows that are 30 feet apart (as an example of the extreme). I usually plant mine about 8 feet apart in all directions, but no matter how much space you give each plant they will want more. You might decide to trellis your gourds to conserve space. Trellised gourds have their own pluses and issues. The longer varieties will have a better chance of growing straight as opposed to coiling on the ground. You have a better chance of getting under the leaves when spraying and the gourds will tend to be cleaner and less bothered by things that crawl on the ground like slugs. Trellised gourd patches have a wonderful look and feel. But trellised gourds are more susceptible to drought as they have fewer auxiliary roots growing from the vines to help collect water. Working the soil between seasons may be more difficult with permanent trellises as well.

If the gourds are too crowded they will get higher as they compete for light and the female flowers will tend to be hidden under this canopy, out of sight from pollinators. It will also be more difficult to get into your patch to check for disease and insect damage and set the gourds upright for a more flat bottom.

Soil

Healthy soil is a mix of living organisms, particles collected into little clumps called aggregates, and natural chemicals. It has formed from the breakdown of the rock underlying your area and been added to over millennia by living, growing generations of organisms. It has a structure or form as well as a chemical composition that will be reflected in your mature gourds.

The basic feel of soil is either sandy, clay like or in between which is referred to as loamy. You can slowly amend your sandy or clay like soil to be loamier over multiple seasons. To learn more about influencing this basic soil structure visit http://pubs.cas.psu.edu/freepubs/pdfs/uj234.pdf or request the publication "Soil Management in Home Gardens and Landscapes" from your Penn State Extension office. Look up the number for the Penn State Cooperative Extension in your county in the blue pages of the phone directory or go on line for information here. [2]

It is very valuable to have the soil tested in the area where you plan to grow. Penn State tests soil inexpensively ($9 in 2011- available in the extension offices) and there are private labs which will also do this. You will receive directions for collecting the soil along with an envelope for mailing the sample. The standard Penn State soil test will

[2] Penn State's College of Agricultural Sciences website http://extension.psu.edu/counties. 210 Agricultural Administration Bldg., University Park, PA 16802. (814) 865-2541.

provide results and recommendations for soil pH, Nitrogen (N), Phosphorus (P), and Potassium (K). Your county extension office can also provide help with interpreting your report and its recommendations.

According to Penn State the optimal pH for gourds is 6.5, nitrogen should be 75 lbs. per acre, Phosphorous should be 60-155 ppm, Potassium should be 100-170 ppm and Magnesium should be 100 ppm.

To amend your soil there are both inorganic and organic fertilizers and other compounds. To learn more about fertilizers and the pros and cons of the two basic types, visit Wikipedia here http://en.wikipedia.org/wiki/Fertilizer . Organic fertilizers are better for the long term sustainability of your soil and for the environment in general. Manure and compost are good for the gourd patch but can come with their own set of problems if over used and not guided by soil testing. Manure improves the quality of your soil structure and harbors beneficial soil organisms but it does not contain a lot of basic nutrients that are immediately available.

Some folks just skip the testing and go right for the fertilizer hoping for the best, but if, for example, the soil pH is fairly high or low for gourds the nutrients that are there may be unavailable to the plant. You may gather tips, hints and secrets from other gourd growers over the years but NOTHING is better than the science based details available through soil testing. If you really don't need fertilizer but you add some anyway it will represent a loss of money, time and effort and may even contribute to polluted wells and waterways.

What kind of gourds?

The next step is to decide what kind of gourds you want to grow. For an average sized gourd such as an apple or a cannonball you will get 15 or so gourds per plant with attention to details. Smaller types yield more and large types yield less.

If you want a certain type of gourd you need to purchase seed from a reputable grower. If you plant saved seed or seed that someone gives you, you cannot be sure what type of gourds you will get. When you take the seeds out of a gourd you are only seeing one parent. This can be fun as long as you are flexible in your gourd crafting designs. Larger garden centers are starting to carry some gourd seed types, but if you have specific needs, you may end up shopping for seed on the Internet or via seed catalogs. PaGS suggests visiting the website of the American Gourd Society (AGS) for

recommendations. Go to AGS[3] and choose "Links and Sources" and then page down to "Seed Sources." If you do not have access to the Internet you may call the phone number at the end of this tutorial for assistance.

You may plant your different types of gourds together and they will still be what the reputable grower promised. If you save the seeds from some of the gourds that you grow for another season, though, they will be a mixture of kinds. There are always gardening horror stories (never really scary) of some kind of gourd crossing with some kind of winter squash or something but these are undoubtedly *Cucurbita pepo* (colorful ornamental fall gourds) crossing with other *Cucurbita* species and not our hard shelled *Lagenaria* gourds.

Remaining Preparations

It is a good idea to clean and disinfect your garden tools and to remove plant debris from your garden area to reduce pests and disease for the coming season. For disinfecting, remove all visible dirt from your tool or portable trellis using a stiff brush and then immerse the item in a 9% bleach solution for 10 minutes.

You can start working on the soil for your growing season as soon as it is thawed. This will allow you to work in any recommended amendments and allow you to concentrate on setting up the actual patch when it is warmer. Just make sure the soil is not too wet. To check for this, push a long handled shovel down into the soil as far as it will go and then push the handle forward to pack the soil. Gently slide the shovel out. You should be able to see the back of the packed soil. If the surface of this packed soil is shiny the soil is too wet to work. Working the soil when it is too wet will damage soil structure.

By April you are going to want to gather all of your seed starting supplies and set up your area for germinating and potting.

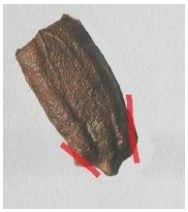
Seed Starting

Just when you start your seeds depends on when you think you are going to be able to move them outside. There must be enough time for the seedling to develop true leaves but not get too big and long and you never want the stem to get thin and leggy. You are

[3] American Gourd Society website http://www.americangourdsociety.org/. P.O. Box 2186, Kokomo, IN 46904-2186.

also going to need time to acclimate the gourd to the out of doors. In Berks County I start mine about the third week in April and give them plenty of light from regular shop lights suspended just above the plants as well as bottom heat. I also use a 5 inch tall pot which is bigger than those used for most seedlings. Within three weeks I am starting to acclimate the plants and they are starting to get tendrils, which is a real nuisance ungrouping them when you move them out from under the lights. By the time they go out into the patch they have a stem almost as thick as my thumb and as many as three sets of true leaves. So you juggle the size of the pot, the amount of light you can provide and the outside growing conditions.

Since the window for starting gourd plants is small, plan to start extra seeds. I do not soak my seeds first, but I do cut their sides with a scissors at the pointy end. (See picture)



A seed is like an envelope with the soft business part inside and a harder, larger outside envelope. You want to cut away a couple of hair widths off the envelope without damaging the soft tissue inside. If you do accidentally cut a little too far in your initial leaves will be damaged but it is not a fatal error.

Once the seeds have been prepared in this way I lay them on white paper towels that have been dampened and then cover them with another layer of damp paper towels and all of this rests between two ceramic plates. I write directly on the old ceramic plate with a Sharpie marker as to what kind of seeds are inside. If I start more than one kind per plate I draw a little map directly on the top plate to indicate which seeds are where.

I put my ceramic plates on cookie cooling racks suspended over seedling heat mats. I used to put the plates directly on the mats but over time the mats run hotter as they age and I actually cooked a batch of seeds once. You want to maintain a temperature of 85 degrees if you can, but not over 90 degrees or under 80 degrees. Keeping a little thermometer in a small plastic bag within the damp paper towels lets you keep a close eye on the temperature.

If the seeds are vigorous they will germinate within two days. If they don't germinate within four days I would start more of that kind. You must be vigilant about not letting

the paper towels dry out. I check mine twice a day and sprits them with water when necessary. You don't want free standing water, just very damp paper towels.

Potting

Meanwhile prepare your pots and potting medium. I highly recommend soiless mix and a larger pot. This near sterile mixture provides the loose support young plants and roots need while reducing exposure to disease. If you do use potting soil or garden soil you should sterilize it in an oven until the internal temperature reaches 180 degrees and remains there for 30 minutes. Make sure there are no small stones in it for if a stone has a cavity it can explode in your oven.

If you are reusing pots, make sure you have washed them and leave them soaking in bleach water, nine parts water to one part bleach for 10 minutes. Rinse and dry.

When your seeds germinate a white, thick protrusion will emerge from the pointy end of the seed… sometimes the seed gets stuck at this stage and needs to be tossed out after a few days, but usually the club like protrusion begins to narrow into a lengthening root with little root hairs. Once you see this elongation it is time to actually plant your seed.

Dampen the soiless mix thoroughly in a large tub, but do not make it so wet that squeezing a handful causes water to drip out. I always put a square of fresh, white paper towel into the bottom of each pot and then fill the pot full with this dampened soiless mix. Take an empty pot and insert it into your filled pot and press down gently to pack the medium. You may need to add more soiless mix after this and re-compact it so that your mix comes up to within a half an inch of the top. Now I poke a finger into the middle of the pot at an angle so that I have a slanting hole going about 3 inches down into the mix. Then I gently pick up my germinated seed and lay it on this slanted surface with the root down and the top of the seed about a half inch to a quarter inch below the surface. Now gently scratch the mix's surface to fill the hole over the seed and press gently to compact it.

Water the pot gently by spritzing. You must keep the seeds moist but not sopping. The seedling's bent-over, white stem should appear within two days. This will straighten and pull from the soil two "seed leaves" that will rapidly become green. These two leaves are the hallmark of a dicotyledonous plant and were formed inside the seed before you got involved! They are not the same shape as the rest of the leaves which on gourds have

lovely lobes and points and are called true leaves. Be sure to move the pots to the light as soon as the bent over stem emerges from the soil.

I support my shop lights on small piles of bricks so that they are only an inch or so above the pots at first, but as the gourd plants grow I add additional bricks. I have no experience growing in a greenhouse or on a window sill, but I know that gourds need 14-16 hours of light per day. More is not better if you have a light system as the growth regulators within the plant need periods of darkness.

You can put two germinated seeds in every pot but you will have to cut the less vigorous of the two seedlings off at some point so that the roots do not become tangled. Sooner is better than later. Never pull one seedling out as this can be very disrupting for the seedling's roots that remain in the pot.

If your original two leaves are stuck together via the seed coat resist the temptation to pull the seed cover off as this may damage the leaves. But if the first set of true leaves is struggling to come out between the two original leaves I would gently snip the tip of those initial leaves off thus freeing them from their seed cover.

You may start fertilizing the plants as soon as they have true leaves, but it is easy to damage them with too much. Make the fertilizer more dilute then instructed on the package (perhaps 40%) and add this every week, gradually increasing the concentration.

Hardening Off

You can start acclimating or hardening off your plants as soon as they have true leaves and whenever the outside conditions permit. This process can take up to two weeks. Hardening off involves taking the plants outside for a half an hour at a time in a sheltered location, gradually increasing this time each day by another half an hour. Do not put them out in a strong wind unless you can shelter them. You can rush this process if you need to but not when it is extremely hot or the weather conditions change drastically. It is possible for the sun to burn plants if they are too tender. A little burn gives them a metallic sheen. A bad burn can cause it to defoliate and start over. Beware of inadvertently giving them extra light by putting them in full sun near a reflective surface such as light colored aluminum siding or along the driveway where the delivery truck idles. I have learned all of this from experience!

Gourd plants can be moved outdoors permanently when the soil temperature stays above 60 degrees. I measure the spring soil temperature first thing each morning beginning

about mid May but often don't see the temperature staying above sixty multiple mornings in a row until the end of the month.

The Gourd Patch

I usually set up my gourd patch well before the plants are ready to go outside. After spreading my amendments on the entire surface of the patch I might just scratch them in or I might plow and till them in. This depends where I am with my no-till efforts which is an entire other learning curve not covered in this guide.

I place a stake at each plant's location and then place soaker hoses for later season watering. I also put down a 4 foot square of black plastic with a hole cut in the middle to accommodate each stake and plant. The plastic will warm the soil. Additionally, I use aqua cones/bottles for hand watering early in the season. To see what these aqua cones look like visit here.[4]

The aqua cones allow me to add something like compost tea or water to each plant without having to use a large amount. This is great when the plants are small. But as the plants grow it is harder to get to and find the cones as the patch fills with foliage, so at some point the hoses are needed. I usually flag the end of each soaker hose that needs to be hooked up to my household hose for no matter how obvious the location is at the beginning of the season, it will be obscured by thousands of leaves before long.

Once you can no longer add things like compost tea via the aqua cones you might be able to use a fertilizer siphon to siphon into your soaker hose lines. See information of these siphon's here[5], but I hear mixed reviews on how they work.

Mulching

Anytime after the stakes, hoses and plastic are in place I like to mulch my entire patch, just taking care not to place the mulch while the soil is cold. Mulched soil warms more slowly so it is best to leave this go until the soil is warmer. Straw is ideal but I don't produce my own and seem to be unable to purchase straw that is seed free enough. After a few weeks I would start getting rye grass growing up through my rye straw and

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[4] Gardener's Supply Company website http://www.gardeners.com/Aqua-Cones/18034,default,pd.html?utm_medium=cpc&utm_source=Google&utm_term=aqua_cones&SC=XNET8019&gclid=CJao8db186YCFcbd4AodUkCbHQ%20%20 . 128 Interval Road, Burlington, Vermont, 05401. 1-800-876-5520.

[5] Home Harvest Garden Supply at http://homeharvest.com/waterfertilizerinjectors.html

I would have to weed it out which is a lot of extra work. So for the last few years I have been using chopped leaves which my neighboring municipality is willing to deliver to my home cost free. Chopped leaves drives your pH up and I have had to accommodate this using sulfur as an amendment. I guess there really is no free lunch.

Whatever mulch you use, three inches is enough. More is not better… it will cut down the infiltration of water and air into your soil. My mulch runs up and over a bit of the black plastic but if you are not using the plastic do not run the mulch up to your gourd stems… keep it away a few inches to reduce the invasion of pests and disease. I usually line up some sort of covers for my young plants in case we get extreme weather while the plants are young. Peach baskets are ideal but in a pinch I have used paper bags held down with rocks.

Gourd Plants June through the Fall

Once the weather, plants and patch are ready soak your potted gourds thoroughly with a high phosphorous starter solution such as 2 TBS of 10-55-10 fertilizer dissolved in one gallon of water. Phosphorous is the middle number of the fertilizer x-x-x ratio. Submerge the entire pot till the bubbles stop and then let the pot drain.

Dig a hole slightly bigger than your pot and gently tap the gourd plant from its pot, set it in the hole, fill in with the surrounding soil and press down firmly all the way around it. Because I use a larger pot I never see any of the roots. If you are seeing roots you might want to use a bigger pot next year or start the plants later.

Once your gourds are planted in the garden, you may fertilize them as often as once every two weeks but be sure to follow the instructions for the specific product that you have and switch to a fertilizer without nitrogen once the vines begin to blossom. Nitrogen is the first number in the standard x-x-x ratio

Many sources in the literature claim that the gourd plant will have to rest for awhile to recover from being transplanted. I have never found this to be true as long as the soil temperature is above 60 degrees. Don't worry about any short periods of slow growth… there is a lot happening under ground to establish the root system at this stage.

Pinning the Vines

Especially if you are going to be training the gourd to grow up a trellis you might want to consider letting the main vine grow along the ground for a time before training it to go

up the trellis. At each leaf axel (the place where the leaf comes off the vine) the vine has the opportunity to put down auxiliary roots which can gather more water to help withstand drought. You can encourage this by making sure the axel makes good contact with the ground, brushing away the mulch and even pinning it in place gently with a landscape pin. A second benefit to pinning is less injury if a strong wind arises.

You should plan to visit your gourd patch every day. Close scrutiny might reveal a few gourd pests or early diseases when they are much easier to deal with. I take a small tool carrier into the patch which includes a dental mirror and small paint brush. A quick check with the mirror along the undersides of the main stems for a few inches can reveal the early work of a stem borer when it is easy to deal with. Small infestations of aphids on the undersides of the older leaves can be brushed off before they have a chance to spread to the entire plant. Early action can allow you to use fewer chemical products in your gourd patch- better for you and for the environment.

Pests and Disease

A very good treatment of gourd pests and diseases is in Ginger Summit's book, Gourds in Your Garden[6]. Becoming familiar with these potential pitfalls (especially learning to identify the adult insects and their eggs) early on will allow you to be more proactive than reactive. Remember, some bugs are good bugs and are there to eat the bad guys. There aren't that many bad guys so if you can identify them just assume everything else is either good or neutral. To learn more in general about this topic, search for "Integrated Pest Management." A good place to start is Penn State's Integrated Pest Management site here[7]. Searching for diseases and pests of Cucurbits will also yield great information such as Cornell's site here[8] , Texas A&M here[9] and information on organic options from Cornell here[10].

It is important when working in your gourd patch not to do so when the leaves are wet. Also try to avoid wounding the plants in any way as this often creates an entry point for disease and pests. When watering try to do so in a way that does not wet the leaves. Enemies of gourds are splashed soil and the diseases it carries, spore fronts such as

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[6] Gourds in Your Garden. Ginger Summit. Sterling Publishing Co., Inc. New York. 1998. ISBN 0-8069-2699-6.

[7] Penn State's College of Agricultural Sciences website http://extension.psu.edu/ipm . For non-electronic contact see footnote number 1.

[8] Cornell University's Vegetable MD on line at http://vegetablemdonline.ppath.cornell.edu/factsheets/Cucurbit_List.htm .

[9] Texas A&M University website http://aggie-horticulture.tamu.edu/publications/cucurbitproblemsolver/

[10] Cornell University's website at http://web.pppmb.cals.cornell.edu/resourceguide/cmp/cucurbit.php

those for powdery and downy mildews blowing from other areas, and uncontrolled pests. Whatever pest or disease comes your way try to learn everything you can about it. Often understanding the culprit's life cycle can hold the key to dealing with it successfully. You can always turn to your county's Penn State Extension office for assistance. And remember, you shouldn't spray anything until you know what you are spraying for. Some sprays are preventative but since they cost money, require your time and effort and may kill off your good insects you want to be wise in their use.

Watering

It is important that your gourd plants get enough water without getting too much. Avoiding the latter is a matter of planting them at a well drained site in well drained soil. A rain gauge should be placed into the patch and checked often. An inch of rain a week is the general recommendation. Sometimes it seems to rain a lot but when you check the gauge it is only 2 tenths of an inch, so be sure to use the gauge rather than your recollections.

It is normal for the leaves to show some signs of wilting in the very hottest part of the afternoon but they should be well recovered by evening. If recovery is not complete you should water. Watering in the early morning is best especially if you have to overhead water with a hose. Just be aware that when the vines are very young, and especially if they are thin, that before the sun is shining on the leaves to start photosynthesis for the day the spindly vine can split from too much internal water pressure. Too much water for too long (as in heavy clay or poorly drained areas) can result in thin shelled gourds, but thin shells can also be a sign of missing nutrients and not enough time on the vine.

Trimming the Vines

Ginger Summit and others recommend trimming your vines when they get to be about 10 feet long or when they reach the top of your trellis. This encourages lateral branches. It is on the lateral branches that the female flowers develop. Watch for the male flowers, which appear first and are on the main vine. The flowers of hard shelled gourds blossom in the evening and are white. The blossoms only last for one evening. Each female blossom can result in one gourd if it receives enough pollen.

Flowering

Most seasons you don't see the first male flowers until the vine is 6 feet long or so, but one hot spring I had my first male flowers just a few inches from where the gourd was planted! That same season I had female flowers by the middle of June but most seasons it is late June till I see the first gourds developing. As the lateral vines age they may begin producing male flowers and female flowers will be prevalent on the tertiary vines. Sometimes near the end of the season I am seeing male and female flowers on the same vines. Extremes of temperature can also effect the maturation of female flowers especially, so nothing is really set in stone. See photos of the female (left) and male (right) flowers.

If you watch the base of the female flowers on the lateral vines, you should see the future gourds beginning to develop. If you notice these tiny gourd-like growths, but they don't seem to be growing into gourds, pollination is likely the problem. You can always remove the male flowers just after they open and tap and brush them over the female flowers. You can also use a Q-tip or small paint brush to take pollen from the center of the male flower and brush it gently onto the center of the female flower. Doing this routinely most evenings from when the female blossoms first appear till near the end of July will increase your yield substantially. Night time pollinators are facing the same pressures as day time pollinators. I suspect that pollen production drops when it is very hot and that transferring pollen in the rain doesn't work well so those are the nights to take a break.

Each seed within a gourd represents a different pollen grain that successfully grew down from the top of the center of the female flower into the future gourd. If not enough pollen grains make the trip, the vine will abort the tiny gourd rather than waste energy producing a gourd with little seed.

Winding Down

As the patch matures in mid July and August you might want to spend some time setting the gourds upright so that they have flat bottoms. At some point you are going to want to stop pollinating the larger gourds and to remove extra gourds that start growing on the really big varieties. Two large African kettles or 3-4 large zuccas are enough for the vine. For the smaller varieties you can continue with pollination through part of August. I might actually hand pollinate banana and submini gourds till early September. Especially with the first frost date creeping further into fall you can get away with this for the really small varieties. For a mid sized gourd such as an average sized martin or apple I usually stop pollinating at the beginning of August.

As you stop pollinating and let the gourds begin the final push to maturation you might want to consider cutting down on watering to help them dry out. I never like to see my plants really drought stressed, though so I play it by ear.

Once September arrives, the productive stages of the vine are winding down in the lower tier of Pennsylvania. The first frost will kill the vines, but allow the gourds to remain in place until the stem that connects the gourds to the vine are brown and dried. If you have a type of gourd that was slow to mature, however and the stems are still bright green- and even drip sap when they are cut, do not despair. I have been marking such stems with twist ties for several seasons and many of them still mature and dry quite well.

Some folks leave the gourds outside in the gourd patch until after the first snows of winter or even till the following spring. Others harvest them and move them into a shed or barn until they are dried and ready for cleaning. They should be very light weight. The seeds may or may not rattle. A gourd that seems mostly dry but has a semi-translucent patch somewhere on the lower part of its surface as it sat needs more time to dry. Don't bring the gourds into the house or any enclosed space to dry. The thin, outer layer that covers the gourd gets moldy. This is normal, but the spores of the mold will decrease your indoor air quality and may even be unhealthful.

Once your gourds are harvested they will dry on their own. You don't need to do anything special. Gourds left outside to dry in the weather will likely be easier to clean than those stored in a dry environment.

This guide is by no means exhaustive… if you want to learn more building healthy soil is a great area of concentration. Learning about aggregates, mycorrhizae and micronutrients is worthwhile. Reading about organic farming and no-till will lead you to

better and better gourds as well as a healthier environment. Research on growing Lagenaria for lasting crafts as opposed to fresh fall decorations is sadly lacking in academia in my opinion. You may have to search and learn about pumpkin production in order to learn what might help your gourds. You may have to struggle with farming terms, equipment references and production formulas but weeding out those tidbits of information that will help grow better gourds is worth it.

One of the best books I have found to date is the "Pumpkin Production Guide", edited by Dale Ila Miles Riggs and produced by the Natural Resource, Agriculture and Engineering Service. For more information on this book visit http://www.nraes.org/nra_order.taf?_function=detail&pr_booknum=nraes-123

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