

2015 Southern Wisconsin
Vegetable Production Workshop
Broccoli



Chris McGuire

Two Onion Farm

Mike Noltnerwyss

Crossroads Community Farm

Steve Pincus

Tipi Produce

Location	Belmont, WI	Cross Plains, WI	Evansville, WI
Acres in vegetables	4	20	45
Acres in broccoli	0.5	0.59	3/4
How these tasks are done for Broccoli			
field prep/tillage	with a tractor	with a tractor	with a tractor
transplanting	by hand	with a tractor	with a tractor
cultivating	by hand	with a tractor	with a tractor
spreading amendments	with a tractor	with a tractor	with a tractor
mulch laying	do not do this task for Broccoli	do not do this task for Broccoli	do not do this task for Broccoli
laying irrigation lines	by hand	with a tractor	with a tractor
laying row cover	by hand	by hand	do not do this task for Broccoli
spraying for pests, diseases, or weeds	by hand	with a tractor	with a tractor
harvesting	by hand	by hand	by hand
hauling harvested crop from the field	with a tractor	with a tractor	with a tractor
mowing cover crops or crop residues	with a tractor	with a tractor	with a tractor
incorporating cover crops or residues	with a tractor	with a tractor	with a tractor
farming style	certified organic	certified organic	certified organic

Propagation

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Varieties	<p>Spring Planting/Summer Harvest: Green Magic - 3-7 days earlier than Gypsy, very heat tolerant, but heads are small. Gypsy - when it does well, it is the best looking variety, with medium-large heads, and nice round dome shape. Fairly heat-tolerant but heads will be deformed in very hot summer conditions. Bay Meadows, Imperial - have only been growing for a few years but have been heat tolerant and are later than Gypsy (Bay M. is 7-10 days later, and Imperial is 7-14 days later) and this spreads out harvest period from a single planting. Autumn: Green Magic, Gypsy - see above. These do well for early fall harvest but have not yielded well in damp cold conditions in late fall; we do not plan to harvest in late fall. Arcadia - tolerates cold and wet but heads are very branched and not very nice looking. Matures between Gypsy and Marathon. Marathon - late maturity, tolerates cold and wet. Huge heads.</p>	<p>Gypsy- we have had consistent crops from gypsy over different conditions throughout the season. it gives us nice large heads and we rarely have ugly non marketable issues with its bead. Imperial- we plant this twice during the summer around may 6th and again two weeks later. this variety is larger then gypsy and does well with the long days and warmer temps in the summer. can produce very large heads.</p>	<p>Blue Wind, Bay Meadows, Gypsy, Emerald Crown in spring/early summer Gypsy, Imperial, Arcadia for fall harvest</p>
Soil Mix	<p>Our own: peat moss, purple cow compost, vermiculite, greensand, soybean meal.</p>	<p>vermont compost fort vee.</p>	<p>We make our own mix with peat, perlite, vermiculite, Purple Cow compost, alfalfa meal, feather meal, Sustane 8-4-4, lime, soy meal, bone meal, kelp, pasteurized soil, Them-X 70.</p>
Seedling Trays	<p>1.5" soil blocks</p>	<p>standard 1020 98's, if we miss a planting date and we want to transplant a crop quicker we sometimes will plant into 128's, but we like to get a nice large broccoli plant in a 98 if possible.</p>	<p>We seed directly into Speedling-size (13x26") 200 cell trays; 1x1x3" cells, 35 cc volume.</p>

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Propagation Schedule	<p>Spring: 3/26, 4/4, 4/14, 4/21, 4/29. Transplant 21-35 days later depending on conditions.</p> <p>Fall: 6/23, 7/1, 7/4, 7/8, 7/11. Transplant 14 days after seeding.</p> <p>In general we have found that days to maturity from transplanting are very variable, especially in spring. E.g., 4/4 and 4/14 seedings might mature almost together in some years but 8-10 days apart in other years. However, differences between several varieties planted on the same date are fairly consistent. We've found that to ensure a continuous 2x per week broccoli harvest we need to make succession plantings AND plant multiple varieties per date.</p>	<p>in 2014 we planted broccoli 7 times starting in the greenhouse on march 15th, march 30th, april 15th, may 6th, may 20th, june 1st, june 27th. we transplant based on when the plants are able to be pulled out of their cells. they typically come out of the greenhouse about 3 weeks after seeding and are transplanted 2-3 days after hardening off outside of the greenhouse. if a broccoli plant is sitting in a 98 flat for more then 3 weeks it will be nutrient stressed and root bound. the best thing you can do for a transplant is to get it in the ground before it is stressed. 3 weeks is generally when it is strong enough and big enough to be pulled from a 98. if it is in a 128 it will be slightly less time then this, maybe 2.5 weeks that it is ready to come out of the greenhouse. plants grown in 128s will be a little more spindly and smaller, but if they are planted before becoming stressed they will likely yield the same as a plant grown in a 98.</p>	<p>Spring: 1st planting seeded about 3/20, transplant late April. 2nd planting seeded mid-April, transplant mid-May; this is usually our most successful spring planting. Maybe a 3rd planting in early May.</p> <p>Fall: 2 or 3 plantings: June 1st, mid-June (our largest fall planting), July 1st. All are transplanted 4-5 weeks after seeding.</p>
Germination	<p>In spring, set newly seeded trays in germ chamber set at 78 degrees for 48 hours, then take broccoli out and place in heated cold frame or greenhouse.</p> <p>Summer sowing: place directly in unheated cold frame</p>	<p>we make small indentation in the flats by pressing down with another flat. then drop 1 seed per cell. cover with potting mix and put into germ chamber. germ chamber is typically around 80 degrees. broccoli germinates very fast in the chamber, we usually pull it out within 24 to 36 hours to prevent it from stretching in the dark. this is one of the easiest crops to grow for transplanting.</p>	<p>2-3 Days in germ chamber at 72F, or just germinate on benchtop in greenhouse. Not a fussy crop.</p>
Greenhouse Irrigation	Hand water 1-2x daily, as needed	we use dramm yellow head wands as the flats need it. everything is watered by hand and checked 2 to 3 times per day.	By hand, as needed.

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Optimal Greenhouse Conditions	Our greenhouses and cold frames are minimally heated in spring. We try to keep nighttime temps 50-60, but they will go (much) lower on very cold nights in early spring; we vent during daytime to keep temps no higher than 80-85.	broccoli has a strong response to DIF (which is differential between day and night temperatures). at night we heat our greenhouse to around 58 degrees early on and bump it up to 63 once there are peppers in there. broccoli does fine in colder temperatures at night, the bigger differential in day night temps the leggier the plants will be. during the day we try to keep the greenhouse under 85 degrees using exhaust fans on a thermostat.	Broccoli stays in the cooler regions of the greenhouse, but it will grow well in a wide range of conditions. Fall crop plantings grow well outdoors, but can be damaged by heavy rains.
Hardening-off	Spring: unheated cold frames about 7 days before transplanting. Summer seedings are in unheated cold frames from day 1 and do not need hardening off.	bring it out of the greenhouse and put on benches that have plywood sides to protect from some wind. as soon as broccoli will pull from the cell we bring it outside. usually around 3 weeks after seeding.	Move to cooler greenhouse, but keep night temps above 45F, to minimize bolting. Then move outdoors for a week. Fall plantings grow outdoors for 2-3 weeks.
Pests or Diseases in the Greenhouse	No	none that we have noticed.	Problems are rare. We use well-washed or sterilized trays when planting brassicas.
Other Notes on Propagation	Germinates very readily.		Spring seedlings exposed to too many cold hours (<45-50F) are likely to bolt in the field.

Field Prep

Preceding Cover Crop	Sometimes fall oats before spring broccoli. Sometimes (rarely) buckwheat between spring cash crop and fall broccoli.	generally we grow winter rye after solanaceous crops. some is tilled down very young for the first plantings of brassicas. then we continue to till down as many beds as we need. we try to get the rye tilled down about 3 weeks before planting. for fields that didn't get cover cropped in the fall, planting oats in the spring before later planted broccoli is a good fit.	Fall plantings often follow rye/hairy vetch cover crop. Spring plantings are often made on fields that were bare overwinter, after crops of carrots, celeriac, parsnip, pepper.
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Soil Amendments	Often compost in preceeding fall at 75-95 cu yards per acre Soybean meal at 2100 lbs/acre to supply 150 lbs N/acre. P and K applied if needed per soil test.	we spread a custom micronutrient blend over all of our vegetable ground every year. we order a custom blend from midwest bioag that includes 100 lbs humical (for calcium) 100 lbs of kmag (for magnesium) and 70 lbs of microhume (contains many trace elements including boron). in addition we spread 1000 lbs of 4-3-2 dehydrated chicken manure pellets mainly for the nitrogen source but also providing a lot of calcium and p and k. 1000 lbs of chicken manure is about 40 lbs of Nitrogen, if we are concerned about the nitrogen level in a specific field due to past management or experience (or not much of a cover crop) we may double the chicken manure rate to 2000 lbs.	All brassica fields receive 1-1.5 T/A of dried chicken pellets before fitting. If no cover crop to turn under, we also spread 15-20 T/A of leafs. Most years, all our fields get 1000-1500 lb/A Organi-cal, from Midwestern Bio-Ag. Broccoli thrives with decomposing organic materials in the soil.
Bed Prep	Spring broccoli: chisel plow in preceeding fall, rototill with furrower attached to tiller in spring. Fall broccoli: Incorporate previous cash crop with flail mower and rototiller. rototill with furrower attached to tiller before transplanting broccoli	we like to subsoil in the fall, going right through the winter rye so that it continues growing and the roots can penetrate the open slots from the subsoiler. then in spring we usually rotovate the rye down only going about 3-4 inches deep, just deep enough to makesure the rye is all chewed up and gets killed, we usually wait 2-4 weeks and then we typically rotovate again the day of transplanting to allow us to have nice soft soil to transplant into. sometimes if the rye isn't entirely killed from the first rotovation or there are weeds that need to be controlled we will go through with a field cultivator (usually a quack digger) to stir the soil and bring and plants to the surface to dry out. when coditions are right (not too much residue) we will use a perfecta II field cultivator instead of a rotovator for preplant soil prep and field levelling.	Often chisel plow, 10" deep, then finish with Perfecta field cultivator. Large cover crops are chopped, then disked or moldboard plowed, and allowed to decompose for a month. Fields can be kind of rough, no need for finely-worked surface.
Bed Shaping	no	we haven't done raised beds for broccoli.	We grow flat.

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Other Notes on Field Prep		because we have so many plantings of broccoli we tend to push the envelope in terms of conditions that we will work with for the first planting or two. there have been several seasons that we tilled down a rye cover crop when the soil was wetter than it should be. in general we seem to have gotten away with this and still getting good crops out. our soils are forgiving in that they have a lot of organic matter and nice loose texture that doesn't clod as bad when tilled wet. we realize that one of the worst things you can do for a crop is till the soil when it is wet but sometimes the options are either do it today or the planting is going to have to get skipped.	
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Transplanting

Bed Width	5' on center	60 inch center to center of tire tracks	6 feet
Broccoli Spacing	2 rows per bed, 12" within row except 15" for Marathon and Arcadia	2 rows per bed 30 inch between rows, 17 inches between plants in row.	2 rows/bed, 36" apart. Plants spaced 14-16" within row.
Transplanting Process	Before planting rototill with furrower bolted on rear hood of tiller. This marks each row to be planted with a furrow. Lay tape measure in center of bed. People carry trays of soil blocks and drop blocks in furrow at desired spacing. Following people sit or crawl and sweep in soil from sides of furrow to cover blocks. When bed is done, pull out drip tape and turn on irrigation.	we use a waterwheel transplanter with spikes set at 17 inches. one person per row. we make sure that the root ball is covered with soil after it is placed in the wet hole.	We use a Mechanical Transplanter 5000 carousel for bare-ground transplanting.
Water at Transplant	Crop watered with drip tape immediately following transplant	water is placed with the waterwheel transplanter. we try to run as little water as possible that will come out of the spigot, this still gives a pretty soaked wet spot for the broccoli plant, but by using smaller amount of water and running the spikes so they are just barely touching the ground allows so that the spikes don't clog with mud and have to be cleaned off.	Water is applied through the transplanter. Summer transplantings are irrigated (overhead) soon after setting if soil is dry

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<p>Row Cover</p>	<p>Row cover placed over most spring broccoli for protection against cold, wind, and cabbage root maggot adults. Wire hoops hold cover off leaves. Hold down cover with sandbags. Remove in early-mid May in calm weather.</p>	<p>we use row cover on all brassica plantings for the first 4 weeks after transplant. we pull it off after 10-14 days to cultivate. we use heavy weight .9 oz row cover in 26x800 foot rolls, \$588 per roll. a half roll will cover 4 of our 400' beds. we typically get 3-4 uses out of a sheet, so the cost breaks down to around \$25 per bed (500 plants). we put soil on the edges every 5' or so and add around 8 sand bags filled with rocks evenly spread 5 to 10 feet in from the edge to help keep it in place. the sand bags can also keep the cover from blowing away should it get lifted up out of the soil, which usually happens at least once a year. we try to plant 4 beds at a time so we can effectively lay the big sheets over all 4, when this does not work we will cover 3 beds with a big sheet and then open it up to do the 4th bed later. or if we have an odd number of beds we will also use 83" wide single bed row cover for a bed or two in a planting. it takes about the same labor to cover a single bed as it does to cover 4 beds with the big sheet, but single beds are easier if it is very windy. the main reason we use row cover is for flea beetles, so all the plants get established and vigorously growing early on leading to very nice crops later. the row cover also protects against cabbage maggot flies from laying eggs and heats up the soil and air for quicker growth.</p>	<p>We normally do not cover broccoli, but are considering using row cover on the 1st spring crop to protect from root maggots and minimize bolting.</p>
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<p>Other Notes on Transplanting</p>	<p>In summer we try to transplant 14 days after seeding, in 1 true leaf stage for minimum transplant shock.</p>	<p>when talking with other growers it sounds like we use row cover way more then most people. we are considering only leaving the cover on until first cultivation in weedy fields so that we can keep up with knocking the weeds down. weeds can grow extremely fast under the row cover.</p> <p>as far as spacing goes, we place our plants very far apart, we have heard from other growers that are planting broccoli 3 rows per bed and 12 inch spacing to get more heads per acre. we find that broccoli is a finnickly plant and we like to give it as much room to reduce its stress load and give it the best chance at producing a nice large head. our objective is to grow the biggest head we can because we sell it by the pound and in the csa box we would rather give one large head then a several smaller ones. i'm not sure if we are getting less yield per acre with this increased spacing or not.</p>	
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Crop Maintenance

<p>Irrigation</p>	<p>Irrigate with drip tape 8-12 hours to stimulate 1>1.5" of rain once every 7-10 days if rain insufficient. After summer transplanting, may irrigate as often as 3 or 4 times in first 10-14 days if conditions are very hot and dry.</p>	<p>we use overhead water reel to irrigate. the rate depends on the weather and stage of plants. in general we shoot for an inch per week but if it is hot and windy we may put down twice that.</p>	<p>Spring crops might get watered as they start to make heads, if conditions are dry.</p> <p>Fall crops are irrigated through summer dry spells. Our sandy-loam soils dry out quickly and often require extra water for good brassica growth.</p>
<p>Irrigation Modifications</p>	<p>More frequent irrigation right after transplanting and when heads are starting to form.</p>	<p>yes when the plants are becoming well established but have not started setting their flower heads we will make sure to get them a little more water to make sure they don't get stressed and set nice big heads.</p>	<p>A 2" irrigation as heads start to form can boost yields and quality</p>

	Two Onion Farm	Crossroads Community Farm	Tipi Produce
Weeding	Usually hoe once, right after removing row cover or when leaves of neighboring plants in row have not quite touched. Wheel hoe between rows, stirrup hoe between and around plants. Follow with exhaustive hand weeding about 1-2 weeks later. May do one more wheel hoe of aisles between beds. Spot hand weeding as needed after that.	we usually get a crew of 2-4 people together to pull back the row cover, on a big sheet that is covering 4 beds, we will often pull up one side at a time so it doesn't blow away. so we would pull up one side cultivate 3 beds, then put that side back down and pull up the other side for the 4th bed. cultivation is done with an offset cultivating tractor setup with side knives and or s tines. we also have a kress 3 point steerable cultivator that we can put finger weeders on as well for in row cultivation. our crew usually hoes in row with a 8 inch scuffle hoe while i cultivate and then they put the row cover right back on when we are done. there are times when we pull the row cover off and the weeds are very tall, due to rainy weather or just not getting in on time and it looks like a lost cause. often i would then run the cultivating tractor through several times to get the weeds knocked back. it is sometimes surprising how quick you can clean up a weedy field of broccoli	Scratch out small weeds with Lely tine weeder 10 days afer transplanting. Tractor cultivate small plants with shields, then without shields as plants grow. Throw dirt into row to cover small weeds. Hoe as needed.
Insects	Cabbage root maggot in spring. Degree day monitoring or use DATCP pest reports to predict adult flight times and make sure seedlings are covered at appropriate times with row cover. Cabbageworm, cabbage looper in summer: spray Entrust or Dipel 1x per 7-10 days with backpack sprayer	other then row cover we rarely do much for insect control. we don't really spray for cabbage loopers or other caterpillars and haven't seen major populations. if we saw the need we have the ability to spray dipel on a crop when necessary with a 20 foot side boom sprayer.	Flea beetles can be a big problem on young plants- control with Entrust or Pyganic. Imported Cabbage Worm (white/yellowish butterfly) show up in late-May/ June. Cabbage Looper (greyish-brown moth) usually only in fall crop. Control both with BT when small, Entrust works on larger instars too. 1-2 applications in spring crop, 2-3 in fall. Spray 5-7 days before harvest to insure no live worms in head. Broccoli can loose 30% of its leaf area during its middle life without any effect on final yield.

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Diseases	Bacterial soft rot in heads just prior to harvest. We do nothing about them, just hope for no extended periods of damp weather before harvest.	we have seen some head rot particularly early on this past season, we try to just harvest the heads a little immature before they rot when we see it coming on. this makes them less marketable as they are not bright green and the head can be a little strange looking. this works for csa but not well for other markets, especially grocery stores.	Broccoli doesn't often show serious diseases, but we do see mild black rot (<i>Xanthomonas</i>) frequently. Rainy warm weather close to harvest can lead to bacterial soft rot on heads. Last year we applied Regalia (a systemic resistance inducer) and the fungicide Double Nickel twice during the month before harvest to (maybe) avoid diseases, particularly on cauliflower.

Harvest and Yields

Harvest Dates	Spring broccoli from about 6/5-7/20; fall broccoli from about 8/25 or 9/1-10/20.	we have 7 plantings total. first harvest is timed to be as early as possible usually in the 3rd csa box june 26th. then we have plantings coming on every two weeks after that.	We grow broccoli for CSA only. We want 4-5 weeks of broccoli from mid-June through July. Fall crop is packed 4-5 times from early Sept to mid-Nov.
Harvest Procedure	Work in teams of 2-3. One person cuts head with sharp field knife leaving at least a hand's length of stem, aiming for straight cut perpendicular to stem. Hands head to helper(s) who peel leaves from head, check for rot, and place head in crate. Full crates placed in tarp-covered bin on tractor for transport to shed.	we have a harvest road every 8 beds to reduce walking during harvest. we harvest into deep black bulb crates (with an empty one underneath in muddy conditions). we use the serrated victorinox red handle knives and cut the broccoli so that there are 8 inches of stem and few leaves, tearing off a leaf or two if needed. we harvest it when you can push into the head and just get a little bit of spring, that way the head has grown to large maturity but is not yet too loose. we walk the crates out to the field road and either put them directly onto a golf cart or in the shade next to the cart. for big harvests when it is cool out we will take a pallet bin into the field with a skid steer and dump the broccoli right into the bin. this is usually for csa so we need to get a count on the number of heads. in that case, we have 10 crates in the field and put the same number of heads in each crate. then we dump 10 full crates in at once and only have to keep track of how many times 10 crates were filled.	We like to harvest broccoli early in the day. For small harvests we carry harvest crates through the field and cut directly into these. Larger harvests use a hydraulically-powered belt that hangs off the edge of a wagon which is slowly pulled along the field edge. 3-5 cutters in the field place heads on the belt, which carries them to the wagon, where they are graded and counted and placed into crates or 12 bushel wooden bins. We leave very little stem, about 2 inches, and remove almost all leaves.

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Cleaning	Full crates of broccoli dunked in tubs of cold well water for about 15 minutes.	broccoli comes out of the field pretty spotless. our main objective is to get it cooled down fast. we usually leave it right in the crate and dunk it in a stock tank of cold water. when we harvest and dump right into a pallet in the field, we will just wand off the pallet for a couple of minutes and put it in the cooler. we have a seperate pull down unit in one of our coolers that can help bring the field heat out of product. we generally rely on a quick cool down of wanding or dunking and then putting it right into the cooler to be brought down to temperature. we rarely hold broccoli for more then 3-4 days but when we have a big harvest we sometimes will hold it for over a week and it seems to hold just fine.	Often we just hose the harvest crates or bins with cold water, then move directly into a 35F cooler. If havesting smaller amounts in warm weather, we will cool in a tank of cold water before grading and refrigerating.
Sanitizer in Wash Water			Nothing is used.
Packing	Remove crates from tubs of well water, let drain briefly, place four crates on a mini pallet (15"x24") and cover entire stack with a single tall gusseted plastic bag (24x20x72x.008 mil drum liner from flexpack.com). Move stack into cooler with pallet fork.	broccoli always stays in the crate that it was harvested in, either dunked or wanded off and put right into the cooler. it is then either taken to market in the crates, put on the csa line to be packed out of the crates or packed into wax boxes for wholesale. we usually pack 20 lb cases into leafy greens boxes for wholesale.	Flaked ice would be great, but we do not yet make ice.
Storage	One night close to 32 degrees before packing CSA boxes next morning.	we store broccoli in a humidified cooler set to very cold temperature. usually around 35 with 3 degree differential.	Cooler at 35-37F. We cover with plastic bag/sheet when broccoli is cold.
Yields	We do not weigh harvest. Typically 70%-95% of plants transplanted produce a marketable head. Occasional much lower yields seen, usually due to lots of bacterial soft rot after wet periods or because of high losses to cabbage root maggots in spring.	we usually weigh a couple of crates and extrapolate what the total harvest was. we can usually get around 15-20 lbs of broccoli in a deep black crate. in 2014 we harvested 5,716 lbs on .59 acres which translates to 9,700 lbs per acre. in 2013 we had above average yields in our first two plantings and overall a great year. we harvested 6,046 lbs on .46 acres which translates to 13,100 lbs per acre	2014 yields: summer harvest - 0.4 lbs./bed foot fall - 0.5 lbs./bed foot

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Other Notes on Harvest and Yields		we sometimes leave a planting in the field after the main harvest for side shoots, but not always because side shoots take a lot longer to harvest per pound. if the field is weedy we will likely till it in after main harvest. but if the field is clean and there are healthy plants then there can be side shoots that grow into good sized heads.	

Marketing

Markets	CSA	CSA, farmers market, direct to grocery, direct to restaurant	CSA, direct to grocery
CSA	6 weeks in early summer, from about June 7- July 18. 6-8 weeks in fall from very end of August to mid October. Amounts vary with harvest: as low as 1 head for each large and each small box, or as high as 2 per small box and 4 per large box. We try to use succession plantings and multiple varieties to ensure continuous harvest, but yields and amounts in the boxes do vary a lot from week to week. Broccoli maturity is pretty weather dependent, especially in fall when alternating cool and warm periods can cause boom and bust yield fluctuations.	we usually grow large heads and give one head per share. these can range in weight but are usually around 1.2 lbs on average. we give broccoli to a regular share between 6 and 8 times in a 20 week season.	We grow broccoli for CSA only, although our wholesale customers will usually buy any over-production. We want 4-5 weeks of broccoli from mid-June through July. It is our main brassica in early summer. Fall crop is packed 4-5 times from early Sept to mid-Nov, in rotation with cauliflower and romanesco. We often split small broccoli harvests, sending it to just some of our sites.
Farmers Market Prices		we usually charge between \$2.50 and \$3.00 lb at the farmer's market. when we have really big heads we will sell them by the each as people shy away from buying a big heavy head at a by the lb price.	
Direct to Grocery Prices		if a grocer is buying a large volume we will sell a 20 lb cs for \$32. \$1.60 per lb	\$1.60/lb
Direct to Restaurant Prices		we sell a 20 lb cs for \$36	
Wholesale Prices			