



NMC Shiitake Strains for Sawdust-based Cultivation

Dear Mushroom Grower,

This note gives information about some of the strains that we have for sawdust-based shiitake production. These strains can be profitably managed in many different ways depending on the resources available, the target market and the local climate. Specific substrate mixtures, incubation requirements, fruiting characteristics and management options are given for each strain.

Three main types of strains are discussed: fast strains for incubation in the bag, slower strains for incubation in the bag and strains that are to be cured out of the bag prior to fruiting.

The strain descriptions that follow are based on these parameters:

Through-spawning with grain spawn at a rate of about 120 production bags per NMC 7 lb bag of spawn (2.5% spawning rate: wet weight spawn/dry weight substrate).

Bag fill at 5.5 lb wet weight with 60% MC (wet weight-dry weight)/wet weight

Dry weight = 2.2 lbs per bag.

Supplementation rates are given on a dry-weight basis.

Oregon Bio-Bag: 22 filter -bag , 23 filter -bag of PP or HDPE from NMC.

Incubation in the bag: room temperature 68-74F to keep bag temp below 74F.

Light: Florescent cool white bulbs on in incubation room about 8 hrs. per day.

Curing-room: 64-68F, 95% RH, slow air movement to achieve slow drying, irrigation 1-2 times per day with rapid drying after watering to dry free water from block surfaces, uniform light 8 hrs per day, CO² level below 2500 ppm.



NMC Shiitake Strains for Rapid Incubation in the Bag

CS-41

CS-252

CS-132

CS-321

This method typically gives mushrooms of medium to low quality. The strains are generally wide-range to warm-weather strains that pin at temperatures between 60F and 75F. The shiitake mushroom quality is better at lower temperatures. These strains do best with low supplementation, low moisture content in the substrate, low CO² and high O² in the bag, non-synchronous fruiting and drier fruiting conditions. Many of these strains are “one shot wonders” giving one heavy break and then either yielding fewer, lower quality mushrooms in subsequent breaks or suffering from heavy contamination during fruiting after the first break. These tendencies can be overcome by optimizing incubation and fruiting conditions. The 23 Filter-bag is recommended.

NMC Shiitake Strains for longer Incubation in the Bag

CS-53

CS-287

CS-321

CS-420

This method typically gives mushrooms of medium to high quality. This helps offset the longer incubation time required. The strains are generally cool-weather strains that pin at temperatures between 55F and 65F. Pin set and mushroom quality is better at lower temperatures. These strains do best with high supplementation, higher initial moisture content in the substrate, higher CO²/lower O² in the bag, and non-synchronous fruiting. These strains are typically fruited 4 to 6 times with mushroom quality reaching its peak after the first break. Only in latter breaks do the mushrooms begin to get small. These strains are typically resistant to contamination during fruiting given the proper gas levels in the bags. The 22 or 23 Filter -bag is recommended.

NMC Shiitake Strains for Incubation with Curing

CS-420

CS-287

CS-321

This method typically gives mushrooms of medium quality and can result in the highest over-all yields. The shiitake tend to be small, especially on the first break. Blocks are incubated in a “curing” room out of their cultivation bag just after the substrate is fully colonized. Blocks are then soaked to initiate the first fruiting. The advantages of high yield and a short crop cycle can offset the extra labor and facilities needed for this management style. Disease and climate control is critical during the curing stage.



NMC Shiitake (*Lentinula edodes*) strain:

CS-41 This robust strain is a typical fast strain where mushroom quality and shelf life can be adequate to good with proper management and horrible if managed wrong. When grown at cool temperatures it has large caps with white fringe; at high temperatures the mushrooms smaller and almost “bald”.



Supplementation: 80% coarse oak sawdust: 10% white proso millet: 10% wheat bran or 83% sawdust: 17% bran.

Moisture content (MC) of substrate: keep on the low side (58-60%)

Gas in the bags: This strain does best with a lot of gas exchange. Use the 23 filter -bag, or with a 22 filter-bag fill to 5 lb instead of 5.5 lb per bag. This gives more filter area on the bag per dry weight of fill. Your yield will be about the same and of higher quality, and your blocks will last longer. Incubate in a cool room as this strain is a fast metabolizer. Keep the block temperature below 74F. High CO² and low O² during incubation will make the mushrooms small, deformed and they will have a poor shelf life. Additionally, blocks will mold after the first break. Use larger particle size sawdust, low supplementation, low spawn rates, low fill weight and lower incubation temperatures to avoid this.

Spawn run length and bench marks: Colonization by 2.5 to 3 weeks, fully lumped by 6 weeks, browning beginning at week 5 and completed by week 7 or 8. Pinning in the bag can occur by week 7 or 8. To delay pinning in the bag, do not move bags and do not let the incubation temperature drop or fluctuate. Open bags at 10 weeks for better quality but try opening at week 8 or 9 if there is pinning in the bag. Do not cure this strain.

Fruiting management: Initiation: this strain does not need a cold shock. Fluctuating the temperature 5-10 F per day (60)-65-70F will make pinning less synchronous resulting in bigger mushrooms. Pick days: 7 -10 day after opening. Rest 7-14 days after pick before soaking. Do not over-soak this strain. Yields will be .75 to 1 lb on the first break, 0.25-0.5 lb on the second and third breaks.



NMC Shiitake (*Lentinula edodes*) strain:

CS-252

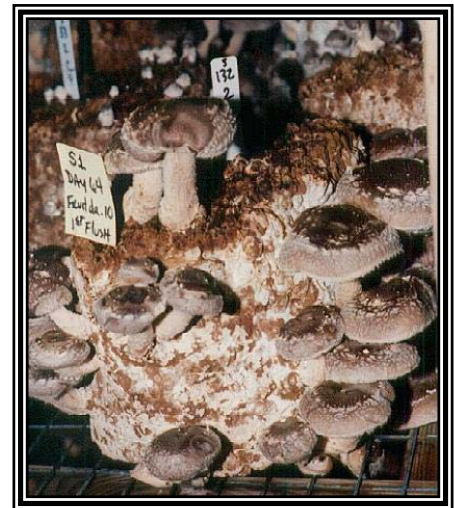
This is a fast and furious strain that should be managed like CS-41. It is used by some growers where they only take one fruiting. The first break can have larger mushrooms if supplement is low, air exchange in the bag is high and the fruiting room is cool and dry. Otherwise it tends to have many small mushrooms. The quality and shelf life of this strain is only moderate but can be passable if grown properly. Again this is one that will do better with the 23 filter-bag or a lighter bag fill. This strain has minimal white fringe on the cap and the mushrooms look a lot like Chinese imports. CS-252 is sensitive to CO² levels in the fruiting room. Stems will be thick and quite long at CO² levels above 800ppm.



NMC Shiitake (*Lentinula edodes*) strain:

CS-132

This is another fast and furious strain that should be managed like CS-41 or CS-252. One or two fruitings are all that are recommended as the blocks only produce heavily on these breaks. With a low supplement, a high air exchange 23 filter-bag and a cool, dry fruiting room, this strain tends to produce, large well shaped mushrooms. Otherwise it tends to have smaller misshapen mushrooms. The quality and shelf life of this strain is only moderate but can be adequate if grown properly. This strain has some white fringe on the cap and the caps can be thick fleshed. Stems tend to be large. The fruiting rooms should be well ventilated to keep CO² levels low.





NMC Shiitake (*Lentinula edodes*) strain:

CS-53

This strain tends to have high quality large mushrooms with a lot of white fringe on the cap and a very long shelf life. This is the most commonly used strain in our area where producers are targeting high quality markets.

Supplementation: Minimum rate of 80% oak sawdust : 10% white proso millet, 10% wheat bran. Higher rates are typically used (70% sawdust sawdust:15% millet:15% bran) Higher yields can be realized with higher supplementation. Lower supplement will give fewer bigger mushrooms and somewhat less yield.



MC of substrate: target 60%, a bit higher is OK. Try not to go lower.

Gas in the bags: This strain does best with moderate gas exchange. Fill at 5.5 lb per bag. Incubate in a cool room (70 -74F). Keep the block temperature below 74F. This strain will do best with moderate levels of CO² and O² in the bag. If the CO² levels get too high and the O² levels too low the first break will be delayed and be very light. Low CO² and high O² will reduce yields. Use high supplementation and spawn rates.

Spawn run length and bench marks: Colonization by 2.5 to 3 weeks, fully lumped by 6-8 weeks, browning beginning at week 6 and completed by week 8 or 9. Pinning in the bag does not usually occur with this strain unless the temperature is lowered. Open bags at 12 weeks for better quality but try opening at week 10 or 11. This strain can be cured but we have found no advantage to this management with this strain.

Fruiting management: Initiation: this strain needs cool temperatures (57F) to initiate pinning and during pinning. Fluctuating the temperature 5-10 F per day (55)-65 will work in a one room fruiting system as long as the temperature is below 60F for at least 8 to 10 hrs per day. Alternatively the temperature can be lowered to 57F for three days after soaking and then raised back to 65F for the remainder of the week. This requires that all blocks to be induced for the week are soaked during one or two days. Pick days: 8-11 day after opening. Rest 7-14 days after pick before soaking. Do not over soak this strain. Yields will be .75 to 1 lb on the first break, .25-0.5 on the second through the 5th break. Often with sawdust the second break is light, the third and fourth are larger and by the fifth or sixth break the mushrooms are beginning to get smaller. This strain is very resistant to contamination during fruiting, even with high supplementation rates.



NMC Shiitake (*Lentinula edodes*) strain:

CS-287

This strain has high mushroom quality similar to CS-53. They tend to be a bit smaller in size, a bit thinner and lighter in color. This strain does well incubated in the bag or using a curing phase out of the bag. The temperature for pinning and pin initiation is higher than CS-53 (60-63F). This strain is used extensively in the US where it is typically grown with a curing phase during incubation.

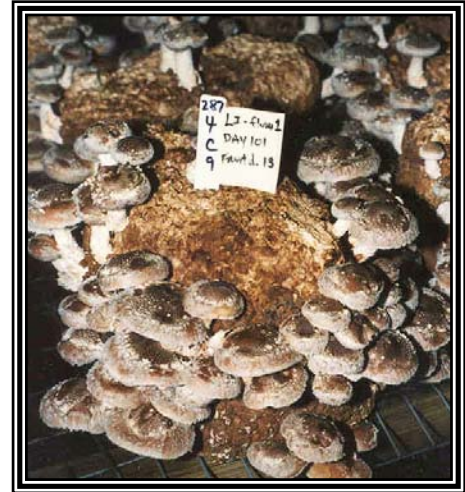
Supplementation: Supplement as you would CS-53.

MC of substrate: target 60% or more.

Gas in the bags: This strain does best with moderate gas exchange. Fill at 5.5 lb per bag. Incubate in a cool room (70 -74F). Keep the block temperature below 74F. This strain will do best with moderate levels of CO² and O² but if the CO² levels get too high and the O² levels too low the first break will be delayed and very light. Use high supplementation, higher spawn rates, average fill weight and lower incubation temperatures to avoid this.

Spawn run length and bench marks: Colonization by 3 weeks, fully lumped by 6-8 weeks, browning beginning at week 6 and completed by week 8 or 9. This strain is a bit “weaker” or “sensitive” during incubation where it typically takes a bit longer for the spawn to recover and take off. Pinning in the bag does not usually occur with this strain unless the temperature is lowered. Open bags at 11 to 12 weeks for better quality but try opening at week 10. This strain is often cured with higher supplementation but does quite well if incubated in the bag as long as the gas concentrations are not too high.

Fruiting management: Initiation: this strain needs cool to warm temperatures (60-63F) to initiate pinning and during pinning. Fluctuating the temperature 5-10 F per day (58)-65 will work in a one room fruiting system as long as the temperature is at or below 62F for at least 8 per day. The temperature is often held at 60 -63 F constantly for this strain although the mushroom quality is better if the temperature fluctuates as with CS-53. Pick days: 8-11 day after opening. Rest 7 days after pick before soaking. Do not over soak this strain. Yields will be .75 to 1 lb on the first break, .25-0.5 on the second through the 5th break. Often with sawdust the second break is light, the third and fourth are larger and by the fifth or sixth the mushrooms are beginning to get smaller. This strain is fairly resistant to contamination during fruiting.





NMC Shiitake (*Lentinula edodes*) strain:

CS-321

This new strain has very high mushroom quality. Mushrooms are well shaped, nicely fringed and have a long shelf life. First-break mushrooms can be small if blocks are allowed to over-pin. This is a very versatile strain; it does well using both short and long incubation periods in the bag or using a curing phase out of the bag. Good pin set will occur even at 65F. This strain is one of our best new strains for most production systems.



Supplementation: Supplement as you would CS-53 if incubation is in the bag. For shorter incubation times, supplement less and use a more aerated bag.

MC of substrate: target 60% or higher. If growing this in a more aerated D2x-bag, keep initial MC over 60%.

Gas in the bags: This strain does best with moderate gas exchange. Fill 22 filter-bags at 5.5 lb per bag or use our new 23 filter-bag with twice aeration for a faster incubation period. Incubate in a cool room (70 -74F). Keep the block temperature below 76F.

Spawn run length and bench marks: Colonization in 2-to-3 weeks, fully lumped by 6-8 weeks, browning beginning at week 6 and completed by week 8 or 9. This process will be sped up if more aeration is given using a 23 filter-bag. Pinning in the bag does not usually occur with this strain unless the temperature is lowered. Many growers open bags after 10 - 12 week incubation to enhance first-break quality. Bags can be opened at week 8 when grown in more aerated bags. This strain also does well when cured out of the bag with higher supplementation rates.

Fruiting management: Initiation: this strain needs cool to warm temperatures (60-65F) to initiate pinning and during pinning. It will pin best between 57F and 60F. The temperature is often held at 60 -63 F constantly for this strain although the mushroom quality is better if the temperature fluctuates as with CS-53. Fruiting rooms should be maintained on the dry side for the first break to control over-pinning. Pick days: 8-13 day after opening. Rest 7 days after pick before soaking. Do not over soak this strain. Yields will be .75 to 1 lb on the first break, .25-0.5 lb on the second through the 5th break. Later break mushrooms are typically larger than first break mushrooms as fewer mushrooms are produced. This strain is resistant to contamination during fruiting.



NMC Shiitake (*Lentinula edodes*) strain:

CS-420

This strain does best if it is incubated with a curing phase, however it can be grown without curing.

Supplementation: Supplement as you would CS-53 if incubation is in the bag. Supplement higher if you are curing the blocks. Higher supplement rate used by many with this strain is: 30%-37% millet, 5%-10% wheat berries or rye berries, 5%-10% wheat bran (some use 1% sugar and 0.5% Ca CO³). We have seen no difference in substrates with or without lime. Sugar speeds colonization and increases yield a bit in the cured system but decreases mushroom size.



MC of substrate: target 60%, a bit higher is OK. Try not to go lower.

Gas in the bags: This strain does best with moderate gas exchange if incubated fully in the bag. Fill at 5.5 lb per bag. Incubate in a cool room (70 -74F). Keep the block temperature below 74F. This strain will do best with moderate levels of CO² and O² but if the CO² levels get too high and the O² levels too low the first break will be delayed and very light. Use high supplementation, higher spawn rates, average fill weight and lower incubation temperatures to avoid this. The CO² level in the curing room should be kept between 1500 ppm and 2500 ppm (no higher).

Spawn run length and bench marks: Colonization by 3 weeks, in the bag fully lumped by 6-8 weeks, browning beginning at week 6 and completed by week 8 or 9. This strain is a bit "weaker" or "sensitive" during incubation where it typically takes a bit longer for the spawn to recover and take off. Pinning in the bag does not usually occur with this strain unless the temperature is lowered. Open bags at 12 weeks for better quality; try opening at week 10 or 11.

This strain is typically cured when higher supplementation rates are used. After the blocks are fully colonized and a thin smooth white skin has began to cover the block, the bag is removed (usually 17-25 days after inoculation). The block is then placed in a curing room until it is brown and star pins form (3- 4 weeks in the curing room). The curing room is kept at 64-68F with slow evaporation rates achieved by keeping the RH above 90% to 95%, keeping air movement in the room low and irrigating the blocks once or twice a day. Watering should be followed by ventilation and or increased air speed to dry down the surface of the block while keeping the surface mycelial growth



vigorous. CO² is controlled between 1500 and 2500ppm by ventilation. Light is needed around all surfaces of the block for uniform browning. Disease organisms should be minimized in this room. Many growers routinely use Benlate and chlorine in their irrigation water in these rooms to control molds and bacteria.

Fruiting management: Initiation: this strain needs cool-to-warm temperatures (60-63F) to initiate pinning and during pinning. Fluctuating the temperature 5-10 F per day (57)-65 will help size mushrooms by making the pinning less synchronous. The temperature is often held at 62 -64 F constantly for this strain although the mushroom quality is better if the temperature fluctuates as with CS-53. Pick days: 8-11 day after opening or soaking. Rest 7-10 days after pick before soaking. Do not over soak this strain. If curing is used the blocks will need to be soaked to initiate the first fruiting.