

Part I Shiitake

Chapter 4

Shiitake Bag Cultivation

GRASS

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Shiitake has traditionally been cultivated on tree-based materials such as logs and sawdust, and the tree resources have been over-exploited in many areas partly due to the fast growth of mushroom industry. As an alternative, various grass species have been researched as effective substrates for the cultivation of shiitake and other mushrooms. To date, several grass species have been selected as suitable mushroom substrates and among them, six species are recommended for shiitake cultivation. The Juncao Research Institute has named these selected grass species Juncao, which literally means 'Fungi grass.'

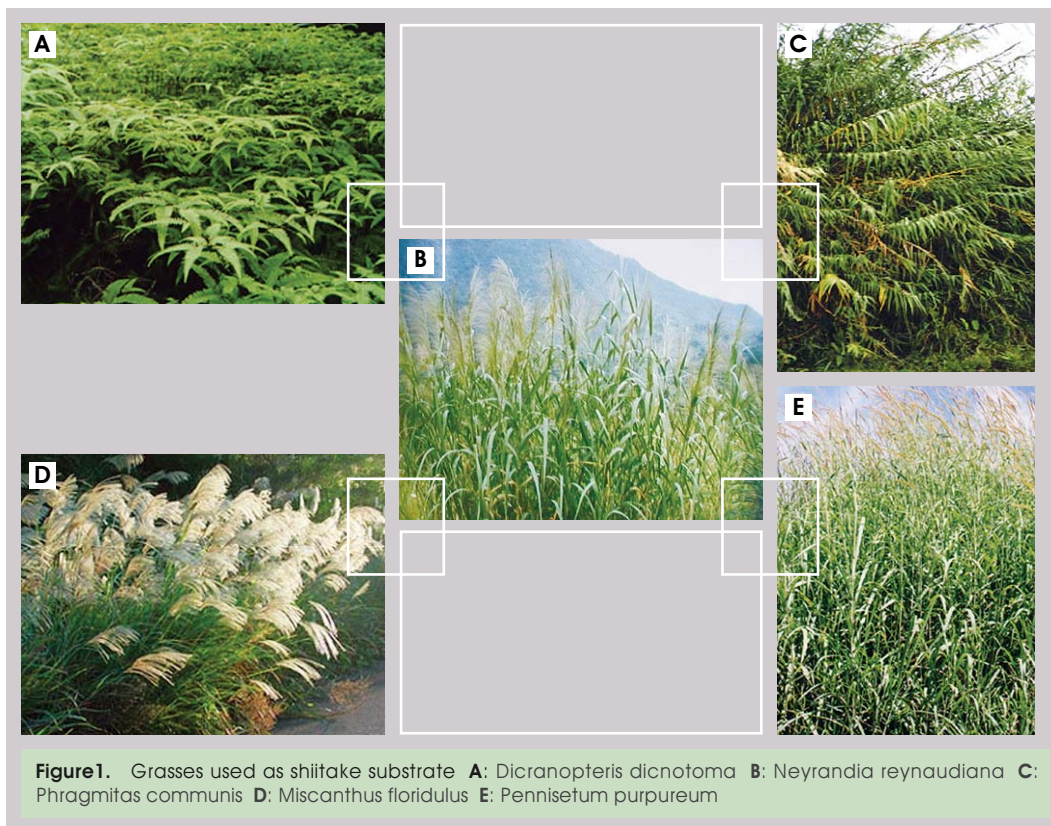
Grass as an Alternative Substrate

The test results of the Fujian Agriculture University Central Laboratory show that the nutrient content of most grass species is richer than those of broadleaf tree sawdust (Table 1). Specifically, the protein content of wild *Dicranopteris dicnotoma*, *Neyrandia reynaudiana*, *Saccharum arundinaceum*, *Phragmitas communis*, *Miscanthus floridulus*, and *Themeda gigantea* is 2-4 times that of sawdust. Their fat, nitrogen, phosphorus, potassium and magnesium contents are 101-216%, 232-353%, 225-685%, 346-908%, 191-303% of those of mixed sawdust from broadleaf trees.

Mushrooms cultivated with the selected grasses have higher nutrition contents than those with sawdust or logs. It can be seen from Table 2 that mushrooms that are cultivated with grass substrates have higher nutritional values than those cultivated with sawdust or logs.

Table 1. Nutrients contents of grass species (%)

Nutrients Contents	Protein	Fiber	Fat	N	P	K	Ca	Mg
Mixed sawdust from broadleaf trees	1.19	84.82	0.93	0.19	0.02	0.11	0.22	0.03
<i>Dicranopteris dicnotoma</i>	3.75	72.10	2.01	0.60	0.09	0.37	0.22	0.08
<i>Neyrandia reynaudiana</i>	4.42	58.80	1.72	0.67	0.14	0.96	0.26	0.09
<i>Saccharum arundinaceum</i>	2.75	62.50	0.99	N/A	0.12	0.76	0.17	0.09
<i>Phragmitas communis</i>	3.19	72.50	0.94	0.51	0.08	0.85	0.14	0.06
<i>Miscanthus floridulus</i>	3.56	55.10	1.44	0.57	0.08	0.90	0.30	0.10
<i>Themeda gigantea</i>	3.85	51.1	1.38	0.61	0.05	0.72	0.19	0.08
<i>Pennisetum purpureum</i>	5.91	68.88	N/A	N/A	0.18	0.78	0.40	0.24
<i>Spartina ateniiflora</i>	9.90	23.58	2.96	N/A	N/A	N/A	N/A	N/A
<i>Sorghum propinquum</i>	4.17	49.47	N/A	N/A	0.08	0.46	0.44	0.17

**Table 2.** Comparison of nutritional value of fruiting bodies grown in different substrate

Constituents	<i>Lentinula edodes</i>			<i>Auricularia polytricha</i>			<i>Auricularia auricula</i>	
	Juncao	Sawdust	Log	Juncao	Sawdust	Log	Juncao	Sawdust
Protein (%)	32.836	28.787	19.65	8.212	7.997	7.376	17.832	9.861
Fiber (%)	20.4	17.12	29.81	27.75	19.61	39.8	21.33	13.66
Fat (%)	2.31	2.61	1.71	1.4	0.8	1.2	0.87	0.47
Ash (%)	9.42	8.02	9.55	9.55	9.62	9.71	9.57	9.48
N (%)	5.254	4.606	3.145	1.314	1.28	1.18	2.853	1.578
P (%)	0.965	0.855	0.378	0.228	0.195	0.19	0.356	0.36
K (%)	1.944	1.447	1.372	1.066	0.829	0.696	1.562	1.69
Ca (%)	0.013	0.033	0.023	0.108	0.099	0.249	0.141	0.176
Mg (%)	0.143	0.132	0.137	0.148	0.133	0.136	0.128	0.177
Fe (ppm)	101.95	75.12	78.6	98.05	136.37	248.6	42.09	100.99

■ Preparation of Grass-based Substrate

Due to the different biological character of the grass, its pretreatment, harvesting, processing and storage are different from those of sawdust. The three handling steps outlined below help growers realize the full potential of the selected grasses' nutritional value.

Harvesting

Due to the high nitrogen content of *Dicranopteris dicnotoma*, *Neyrandia reynaudiana* and other grasses, the harvesting season and weather must be chosen carefully. If grass is harvested during rainy days, drying and powdering is more difficult and mildew can cause less of the grass to be useable. Therefore, harvesting must take place during 5-7 sunny days. Harvesting time depends on which grass is harvested and which mushrooms will be cultivated on it. For example, *Dicranopteris dicnotoma* can be cropped during the whole year, though it is best harvested from May to July. The optimal harvesting time for *Neyrandia reynaudiana*, *Miscanthus floridulus* is during the flowering and heading stages. However, *Neyrandia reynaudiana* for cultivation of shiitake or wood ear (*Auricularia polytricha*) and *Auricularia peltata* should be harvested after heading and aging.

Drying

After cropping, grasses must be dried thoroughly in sunlight, and this process is always affected by the weather. Growers are advised to store dried grasses before the rainy season. Two storage methods are commonly employed: indoor storage in dry rooms and outdoor haystack storage. For outdoor storage, waterproof coverings are required. For both methods, great care must be taken for fire-prevention. Loose grasses normally occupy large spaces indoors, and they are easily dampened outdoors, so the grasses should be processed into powder immediately after drying. Powdered grass in a small volume is more convenient than raw grass for both storage and long distance transport.

Powdering

Special grinders are required to powder dried grass. The size of the grinder sieve also depends upon the different grass species. For example, a sieve whose holes are of diameter about 2.5mm is used for *Dicranopteris dicnotoma* while a sieve with holes of a diameter of 3.0-3.5mm is usually suitable for *Neyrandia reynaudiana*. Grass powder must be stored in dry rooms or it will become mildewed or blocked, which will exhaust the nutrients and lower the nutritional value of the powdered grasses.

■ Shiitake Bag Cultivation with Grass-based Substrate

Grass composition for shiitake growing

The composition of grass-based shiitake substrate depends on the local conditions. Growers might want to utilize readily available and abundant grass species in their area. The following composition is recommended as shiitake substrate based on the research results of Juncao Research Institute of Fujian Agricultural University in China.

- 1) *Dicranopteris dicnotoma* 38%, *Miscanthus floridulus* 40%, wheat bran 20%, gypsum powder 2% (appropriate in warm and moist area).
- 2) *Miscanthus floridulus* 48%, *Dicranopteris dicnotoma* or *Pennisetum purpureum* 30%, wheat bran 20%, gypsum powder 2% (appropriate in forest area).
- 3) *Dicranopteris dicnotoma* 23%, *Neyrandia reynaudiana* 20%, *Saccharum arundinaceum* 20%, *Phragmites communis* 20%, wheat bran 15%, gypsum powder 2%.
- 4) *Neyrandia reynaudiana* 53%, *Dicranopteris dicnotoma* 30%, wheat bran 15, gypsum powder 2%.

Strain selection

For this non-conventional substrate, new mushroom strains that are appropriate for the new substrate should be selected and improved. Juncao Research Institute has worked on this project, and a list of suitable strains for grass substrate cultivation is provided in Table 3. The yield and quality of shiitake mushrooms differ greatly according to strains though cultivated in the same area and with the same substrate material. Similarly, the same strain gives very much different results if cultivated in different areas or with different substrate material. Therefore, strains must be chosen based on the local climatic conditions and resources, and the quality of the strains should be carefully examined.

Table 3. Various strains of shiitake grown in grass-based substrate

Strain No.	Temperature type	Fruiting temperature (°C)	Size of fruiting bodies
LC214	Fairly high	11 - 15	Large
LC216	Fairly high	10 - 24	Medium-large
LC265	Fairly high	10 - 24	Large
LC202	Middle	10 - 21	Medium
LC206	Middle	8 - 21	Medium
LC207	Middle	8 - 21	Small-medium
LC236	Middle	9 - 21	Medium-large
LC109	Fairly low	7 - 20	Medium-large
Jinxuan No. 1	High	14 - 26	Medium-large
Jinxuan No. 2	High	13 - 26	Medium-large
Jinxuan No. 3	Low to middle	7 - 19	Medium
Jinxuan No. 4	Low	5 - 17	Medium

Shiitake cultivation with grasses at a glance

The growing method of shiitake with grass substrate is not much different from that with sawdust. Due to the tendency of higher water absorption and loss, however, much attention should be paid to grass substrates in order to keep appropriate humidity and water content of substrate for each stage. When watering, it should be kept in mind that grass substrates absorb water more rapidly than sawdust substrates.

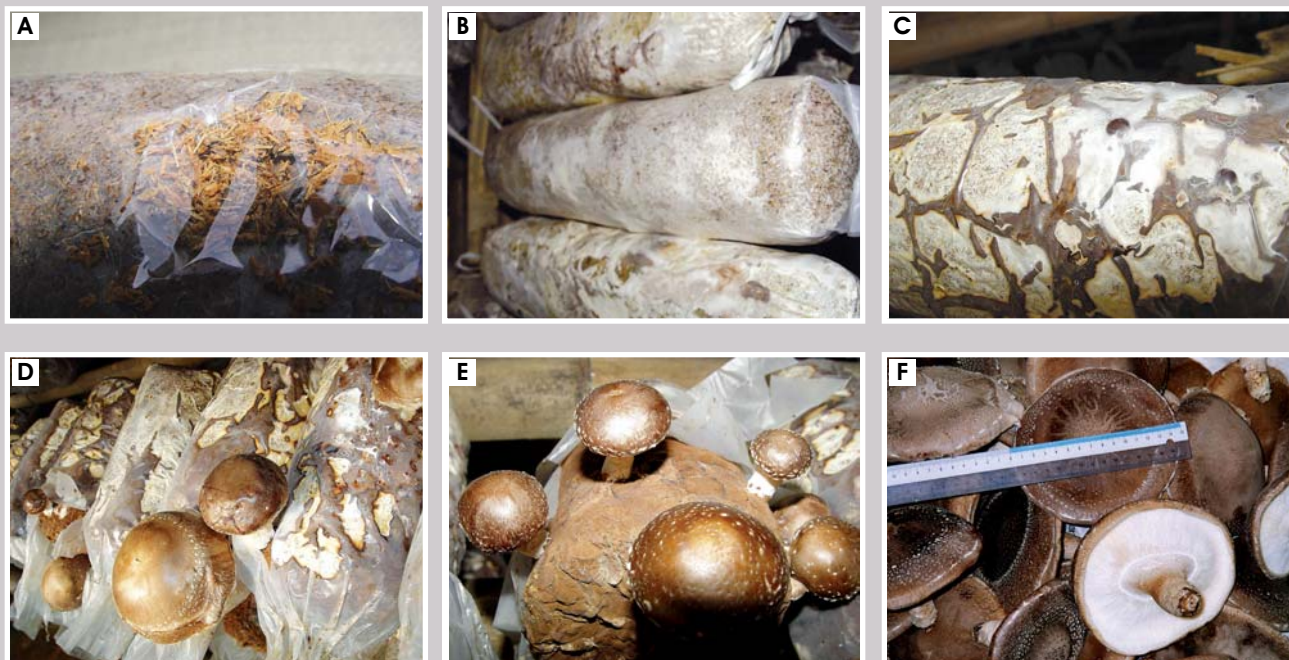


Figure 2. Shiitake cultivation with grass-based substrate **A:** Inoculation hole **B:** Mycelium growing **C:** Primordia formation and buttoning **D** and **E:** Fruiting development **F:** Sizable fruiting bodies