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Optimum Pattern of Compost used for Reducing Energy Consumption in Mushroom Production

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Abstract

In mushroom production it is necessary to design a growing pattern to balance yield against cost and to reduce energy use. Effects of use of multiple layer of compost in cultivation on energy consumption in mushroom cropping rooms were examined. Treatments included 1 layer (control), or 2, 3 or 4 layers of compost applied at the mycelium running stage. Numbers of compost layers did not affect fresh weight of mushrooms, number of mushrooms, yield and biological efficiency but hastened pinheads formation. Since there were no differences between layers of compost and control on yield and biological efficiency it appears that 2 layers will be sufficient to improve time to pinhead formation without negative effect on yield.

Keywords: *Agaricus bisporus*; Biological efficiency; Energy consumption; Yield

Introduction

Agaricus bisporus (Sing) is one of the most important cultivated, edible, mushrooms [1-4]. It contains high amounts of protein, minerals, vitamins D, K, B and sometimes A and C [4,5]. Button mushroom is a natural source of antioxidant agent against the free radicals superoxide radicals (O_2), hydroxyl radical (OH), hydrogen peroxide (H_2O_2) and lipid peroxide radicals and has potential as an anticancer factor [6].

Mushroom production can help contribute to grow food demand [7]. In Iran there are 1033 units for producing edible mushrooms, of which 704 are used for cultivating button mushroom [8] Iran Statistic Center. Button mushroom has vegetative and reproductive stages. Vegetative growth is on compost, or other substrates [4,9]. In the vegetative stage, temperature must be controlled, with the optimum temperature for mycelium growth being between 25°C and 28°C which require consumption of energy [10]. Agriculture and mushroom production (although it is only a small part of agriculture) is a large consumer of energy [11]. There are times when energy required for agriculture competes for that used by other activities [12]. Energy consumption in mushroom production has increased [13]. Energy consumption in Iran is higher than international standards [14].

It is necessary to design the optimum production pattern for mushrooms to conserve energy [15,16]. Moya et al. believed that energy consumption for heating relates to space among plants; densely spaced plants lead to lower energy consumption. There is no research in relation to reduction of energy consumption in mushroom production. In button mushroom, high yield depends on appropriate conditions of growth and the amount of energy used in cropping rooms needs to be considered. One layer of compost is normally used in button mushroom production. It may be that use of more than one layer of compost will affect growing conditions and consequently yield. This research was conducted to evaluate effects of compost layer number on cultivation on button mushroom development and biological efficiency and effects on energy consumption in spawn running rooms.

Materials and Methods

The experiment was conducted with a completely randomized design with 4 treatments and 3 replications in the faculty of Agriculture, University of Guilan, Rasht, Iran (37°16′ N, 51°3′ E). Treatments included 1 (control), or 2, 3 or 4 layers of compost.

Compost blocks (20 kg) were supplied by the Asian Mushroom Company, Karaj, Iran. Block length, width and height were 60, 40 and 20 cm, respectively. Fresh samples of the compost were oven dried at 75°C and dry weight determined. Temperature of compost blocks was measured at 9 AM each day during spawn running for 15 days. After completing spawn running, compost blocks were separated and casing to a 4 cm depth, applied [7] using commercial casing soil (Asian Mushroom Company). After casing, the substrate surface was covered with newspapers and sprayed with water to avoid drying. When the mycelium reached the surface of the casing layer the newspaper was removed and temperature in the room reduced from 25°C to 16°C to provide shocking to induce fruit body formation [17]. Time to pinhead formation was recorded. Mushroom yield was obtained from 2 flushes and mushrooms were harvested daily. During harvesting, numbers and fresh weight of mushrooms were determined. After the final harvest biological efficiency (BE) was determined. Yield and BE were determined according to formulae of Nogueira [18] de Andrade et al. Data were subjected to ANOVA in SAS (ver. 9.1, SAS Institute, Inc., Cary, N.C.). Means were separated with using Turkey's test.

Results

Changes of temperature during spawn running in compost treatments were similar (Figure 1). Temperature increased from day 1 to day 7 for all layers of compost. Temperature decreased, finally reaching 21°C and 23°C for 1 layer and 4 layers of compost, respectively; other

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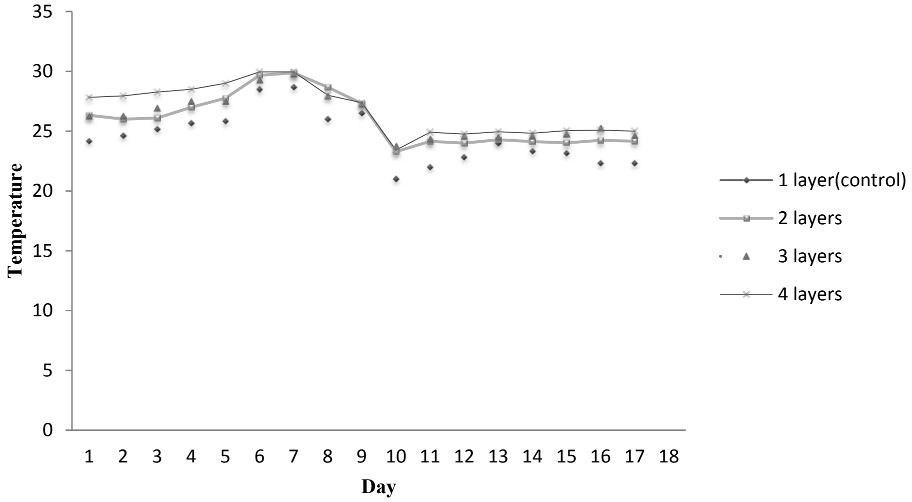

Figure 1: Temperature change during spawn running in treatments.

		Mean squares					
		Fresh weight			Number of mushroom		
Source of variation	df	Flush 1	Flush 2	total	Flush 1	Flush 2	total
Compost layer	3	164908.53 ns	1.88 ns	72692.22 ns	0.41 ns	2.81 ns	1591.16 ns
Error	8	66357.31	2.55	127106.7	0.54	1.49	831.96
CV (%)		18.6	20.94	18.54	18.92	9.55	17.44

ns = non-significant at P < 0.05.

Table 1: Effect of multi-layer cultivation on fresh weight and number of mushrooms in first, second and total flushes.

		Mean squares					
Source of variation	df	B.E. (%) Flush1	B.E. (%) Flush2	B.E. (%) Total	Y (%) Flush1	Y (%) Flush2	Days to pinhead formation
Compost layer	3	45.45 ns	0.19 ns	19.45 ns	4.10 ns	0.07 ns	13.92**
Error	8	17.59	0.32	33.63	1.66	0.07	0.38
CV (%)		18.51	10.16	18.51	18.61	19.19	4.69

ns, **, non-significant and significant at P < 0.01.

Table 2: Effect of multi-layer cultivation on biological efficiency (BE %), yield (Y %) and days to pinhead formation in first, second and total flushes.

treatments were intermediate. Increased temperature in first week may be due to reduced ventilation.

Numbers (average 163.72), fresh weight (average 1828.38 g/tray), and BE of mushrooms (29.79%) and yield (average 6.23) were not affected by treatment. Days to pinhead formation was affected by treatment (Table 1). One layer of compost (control) needed the most time for pinhead formation, 16.33 (average) days. The least time for pinhead formation was for the 3 layer treatment, 11.5 days. The multilayer treatments were similar to each other and less than for the control (Table 2).

Discussion

Growing mycelium produces heat and temperature increases during the first days of growth and then decreases [19]. Increasing layers of compost can increase temperature may be due to reduce ventilation and CO_2 exchange in running room. There was likely insufficient air between compost blocks so heat and CO_2 was retained [20]. Several layers of compost increases temperature and CO_2 stimulating mycelial growth during the mycelium running stage [10]. In other hand a positive correlation between the thermophiles population and amount of air supplied was recorded in previous research [21]. The reason for this needs additional study.

Optimum temperature for mycelium growth is 24°C-25°C and the maximum temperature is 28°C [7]. The temperature in the 3-4 layer treatment was at, or below this temperature. Appropriate ventilation results in moderate environment and CO_2 content stability in fruiting stage [10,19,20]. In compact growth substrate there is low CO_2, and respiration and growth decreases. Increased temperature increases evaporation and transpiration which results in decreased mycelial growth [20]. Growth and development of pathogens could increase because of anaerobic conditions [10].

Imbalanced mycelial running in substrate and weak, or inadequate, mycelial growth is the consequences of less than optimum compost temperature [7]. Temperature increasing to 30°C causes mycelial death and increased activity of microorganisms and insects *Megaselia nigra* M. and *Lycoriella auripila* W. feeding on mycelia [10]. However some authors Vedder and Hussain et al., [22,23] believe that for better mycelial growth average compost temperature should be 30°C and mycelium only die after a prolonged exposure to above 34°C.

Several layers of compost resulted in earlier pinhead appearance [24]. Evaluated this characteristic in different casing soil with maximum and minimum days to pinheads appearance being 23.75 and 12.25, respectively. Our results (maximum 16.33 days, minimum 11.5 days) were lower than theirs indicating multilayer cultivation reduced time for pinhead formation. Use of 2 layers of compost could be beneficial in mushroom cultivation.

Conclusion

Multilayer cultivation may result in consuming less energy for heating the cropping room without reduction in yield. In multilayer cultivation as a new idea on mushroom cultivation we put more compost in a mycelium running room and divide ready to fruiting compost in fruiting room. So only a translocation add to our cost while energy consumption for mycelium running room or cooling for shocking specially in warm season at least two fold decreased.

References

1. Gbolagade J, Ajayi A, Oku I, Wankasi D (2006) Nutritive value of common wild edible mushrooms from southern Nigeria. Global Journal Biotechnology Biochemistry 1: 16-21.
2. Toker H, Baysal E, Yigitbasi ON, Colak M, Peker H, et al. (2007) Cultivation of *Agaricus bisporus* on wheat straw and waste tea leaves based composts using poplar leaves as activator material. African Journal of Biotechnology 6: 204-212.
3. Mehta BK, Jain SK, Sharma GP, Doshi A, Jain HK (2011) Cultivation of button mushroom and its processing: An techno-economic feasibility. International Journal of Advanced Biotechnology and Research 2: 201-207.
4. Ebadi A, Alikhani HA, Rashtbari M (2012) Effect of plant growth promoting bacteria (PGPR) on the morphophysiological properties of Button mushroom *Agaricus bisporus* in two different culturing beds. International Research Journal of Applied and Basic Sciences 3: 203-212.
5. Saiqa S, Nawaz BH, Asif HM (2008) Studies on chemical composition and nutritive evaluation of wild edible mushrooms. Iran Journal Chemichal Engineering 27: 151-156.
6. Abah SE, Abah G (2010) Antimicrobial and antioxidant potentials of *Agaricus bisporus*. Advances in Biological Research 4: 277-282.
7. Farsi M, Pouriyanfar HR (2011) Cultivation and breeding of the white button mushroom. Mashhad Jihad University Press, Mashhad, Iran.
8. Iran Statistic Center (2012) Statistical pocketbook of the Islamic republic of Iran.
9. Noble R, Dobrovin-Pennington A, Hobbs P, Rodger A, Pederby J (2009) Volatile C8 compounds and pseudomonas influence primordium formation of *Agaricus bisporus*. Mycologia 101: 583-591.
10. Jafarniya S, Khosroshahi M, Karami SM (2010) Mushroom cultivation: appropriate technology for mushroom growers. Misagh Press, Tehran, Iran.
11. Alam MS, Alam MR, Islam KK (2005) Energy flow in agriculture: Bangladesh. American Journal Environmental Science 1: 213-220.
12. Pahlavan R, Omod M, Akram A (2012) Application of data envelopment analysis for performance assessment and energy efficiency improvement opportunities in greenhouse cucumber production. Journal of Agricultural Science and Technology 14: 1465-1475.
13. Mehrabi H, Esmaili A (2011) Analysis energy input-output in Agriculture in Iran. Agriculture Economic and Development Journal 74: 12-18.
14. Kazemi A, Mehregan MR, Shakouri H, Hosseinzadeh M (2012) Energy resource allocation in Iran: A fuzzy multi-objective analysis. Procedia-Social and Behavioral Sciences 41: 334-341.
15. Faizi F, Nourani M, Ghaedi AK, Mahdavinejad MJ (2011) Design an optimum pattern of orientation in residential complexes by analyzing the level of energy consumption. Proceeding Engineering 21: 1179-1187.
16. Moya A, Mehlitz T, Yildiz I, Kelly SF, Hardin C (2008) Simulated effects of dynamic row spacing on energy and water conservation in semi-arid central California greenhouses. Department of bio-resource and agricultural and mechanical engineering. Polytechnic State University, Marietta, CA.
17. Femor TR, Randle PE, Smith JF (1985) Compost as a substrate and its preparation. In: FLEGG PB, SPENCER DM, WOO DA: The biology and technology of the cultivated mushroom. Wiley, Chichester, UK, pp: 81-109.
18. De Andrade M, Kopytowski J, Minhoni M, Coutinho L, Figueiredo M (2007) Productivity, biological efficiency and number of *Agaricus blazei* mushrooms grown in compost in the presence of *Trichoderma* sp. and *Chaetominum olivacearum* contaminants. Brazilian Journal of Microbiology 38: 243-247.
19. Kashi A (2005) Edible mushroom cultivation. Agricultural Education Press, Karaj, Iran.
20. Peyvast GH, Olfati JA (2005) Improved cultivation of edible mushrooms. Daneshpazir Press, Tehran, Iran.
21. Wakchaure GC, Meena KK, Choudhary RI, Singh M, Yandigeri MS (2013) An improvedrapid composting procedure enhance the substrate quality and yield of *Agaricus bisporus.* African Journal of Agricultural Research 8: 4523-4536.
22. Hussain S, Ali MA, Ahsan A, Ali H, Siddique M (2004) Temperature requirement of button mushroom Agaricus bitorquis for mycelia growth on three different composts. Journal of agricultural research 42: 3-4.
23. Yilmaz F, Baysal E, Toker H, Colak M, Yigitbasi O, Simsek H (2007) An investigation on pinhead formation time of *Agaricus bisporus* on wheat straw and waste tea leaves based composts using some locally available peat materials and secondary casing materials. African Journal of Biotechnology 6: 1655-1664.