Mushroom Crops from Beds Cased 7 to 42 Days After Spawning

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Abstract. **Compost spawned with the cultivated mushroom, *Agaricus bisporus* (Lange) Sing. 'White', was cased 7-42 days after spawning. Uncased spawned compost was stored by covering it with polyethylene plastic film. Results indicated that the earlier the beds were cased, the earlier the fruit appeared. The earliest crops tended to yield less than later crops. A 10 to 14–day spawn growth period before casing was optimum. A potential use of plastic film to regulate crop production is discussed.**

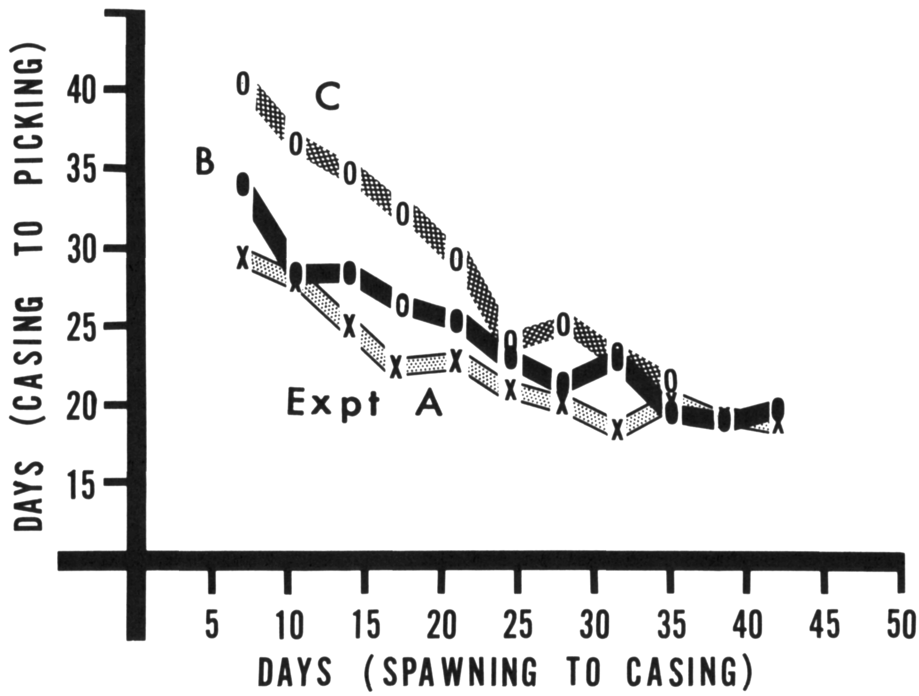

Fig. 1. Effect of the number of days between spawning and casing on the subsequent time required for fruit production.

Though casing (covering the mushroom mycelium-impregnated compost with a layer of soil or peat) is a long–established practice to promote fruiting, relatively little systematic data on the effects of different casing times are available. During attempts to increase the size of white mushrooms by varying certain practices, data on the effect of different casing times on yield and crop time were obtained. Results of these studies are presented here.

General pilot-plant experimental procedures were used (4). Compost for the three experiments (A, B, and C) was taken from the same thoroughly mixed horse-manure compost pile. Beginning with the filling operation (55 lb/3.5 ft^2 tray), each experiment was performed concurrently, however, in a separate pasteurization-growing room.

One commercial spawn shipment of the White variety of the cultivated mushroom, *Agaricus bisporus* was used in all three experiments. In most treatments spawn was "roughed" into the top 2 inches of the compost at a rate of 1 qt/40 ft^2 of bed surface. The compost in some trays of Expt. A and B, however, was "through-spawned"; i.e., a large quantity of spawn (1 qt/15 ft^2) was evenly destributed throughout the compost. The compost of all three experiments was spawned on the same day. By the 7th day after spawning, mushroom mycelium covered about 30% of the compost's surface. At least another week would have been required under these conditions for the mycelium to grow over the entire surface. Beginning at the 7th day after spawning, and at 3-1/2 –day intervals thereafter, compost in different trays was cased with a 1-inch layer of a pasteurized soil-limestone mixture.

Limited facilities made it necessary that all trays of an experiment be placed in the same growing room. Consequently, neither temperature nor ventilation was optimum, nor were they the same for all treatments after the first 7 days of spawn growth. During this first week of spawn growth, air temperature was 73-76, 63-66 during 8–18 days and 57-60°F thereafter. Fresh air, gradually admitted to the growing rooms when mycelial strands began to approach the casing surface, reached a maximum rate of 20 ft^3/ft^2 of bed surface per hr during mushroom production. At the time the first set of trays was cased, the spawned compost of all other casing treatments was tightly covered with 1 mil-thick polyethylene plastic film. Spawned compost, protected in this manner for as long as 42 days before being cased, exhibited no evidence of drying.

Mushrooms were weighed and counted in all experiments. Mushroom yield is expressed on a cut equivalent basis. Each treatment was replicated 4 times in randomized blocks in Experiments A and B, and 6 times in Experiment C. Though the date of the first picking day from the different trays within a treatment varied, the range of first picking dates usually did not exceed 4 days.

The time interval before fruiting: Results indicate that the length of time between casing and the appearance of the first mushrooms was inversely related to the length of time that the spawn grew prior to casing (*Fig. 1*). The total time aspect becomes more apparent when the data are arranged as in *Fig. 2*.

Despite the fact that only the first 7 days of spawn growth of each treatment occurred at optimum conditions, the importance of the length of time between spawning and casing was

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evident. Results of earlier work at Beltsville indicated that fruiting occurred 5.5 days earlier on trays cased immediately after spawning than on trays cased 15 days after spawning.

Differences between results of Experiments A, B, and C probably reflect small temperature differences between the different rooms. For example, the temperatures of the room containing Experiment C was usually in the lower portion of the temperature range described. Comparison of these results emphasizes the important effect that seemingly small variations in environmental conditions may have on the length of time preceding mushroom production. In practice, moreover, the time required for fruiting is affected by variable factors such as residual NH_3, spawn type, nature of casing, humidity, CO_2 concentrations, diseases, and pests.

It is evident that the experimental conditions and mushroom strain used did not result in an early crop in any experiment. Because of the advantage of an early crop several practices are used to decrease the time prior to fruiting. One procedure, commonly used for this purpose in the tray system of mushroom culture, is through-spawning (3). Mushrooms appeared on the through-spawned trays an average of 2 and 4.5 days earlier than on the top-spawned trays similarly cased 14 days later in Experiment A and B, respectively. Through-spawning led to the present trend of increasing the spawn rate for surface-spawned beds. The rate of spawning has, also, been shown to affect both the timing and yield of a mushroom crop (2, 3).

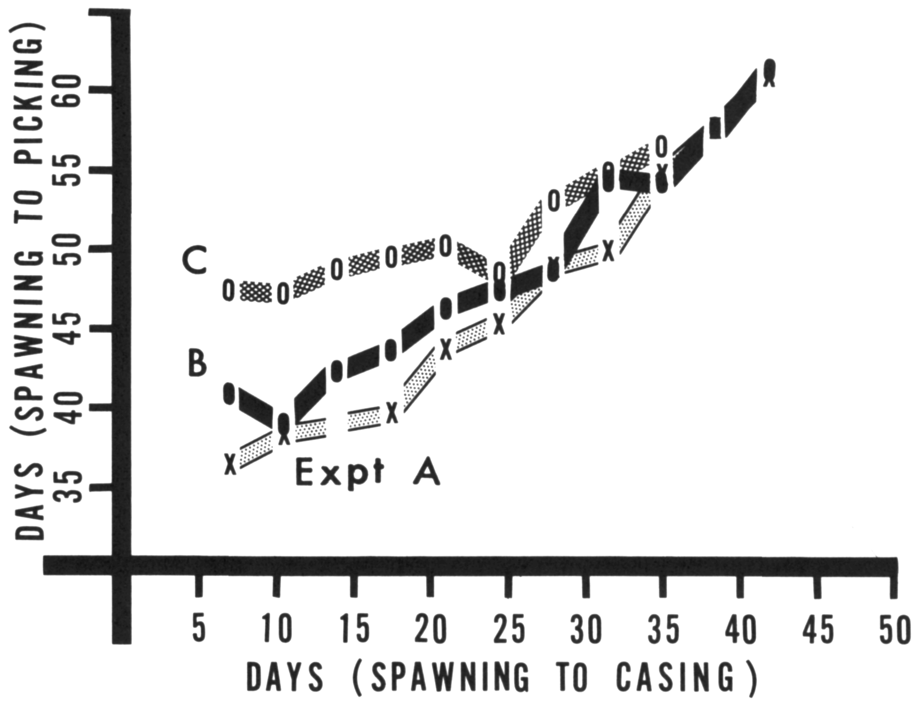

Fig. 2. Data of Fig. 1 arranged to indicate the effect of the number of days between spawning and casing on the total time required for fruit production.

Yield: The correlation of yield with the length of time between spawning and casing is indicated in Table 1. The smallest yields tended to be associated with treatments having the least number of days between spawning and casing. Yield was not increased by through-spawning. The data indicate considerable overlapping of treatment-yield associations within the treatment series. Analyses of 60-day yields showed essentially the same relationship of yields with treatments as in the 30-day yield data. Apparently there was no compensatory yield effect, as may occur with some kinds of fruiting inhibition (5). Data on mushroom number and weight indicated

Table 1. Effect of the number of days between spawning and casing on 30-day yield.

					Expt. A							
No. of days	14	10.5	7	14Tx[x]	17.5	21	38	28	35	24.5	31.5	42
Mean yield (lb./ft^2)	1.86 a[y]	1.94 ab	1.95 ab	1.95 ab	2.13 abc	2.30 bc	2.31 bc	2.35 c	2.36 c	2.40 c	2.44 c	2.45 c
					Expt. B							
No. of days	7	10.5	14Ts[x]	17.5	14	24.5	21	35	38.5	31.5	28	42
Mean yield (lb./ft^2)	1.51 a	1.69 ab	1.88 bc	1.88 bc	1.97 bc	2.00 bc	2.03 c	2.15 c	2.16 c	2.18 c	2.21 c	2.21 c
					Expt. C							
No. of days	7	28	10.5	31.5	14	35	24.5	17.5	21			
Mean yield (lb./ft^2)	1.61 a	1.73 ab	1.82 ab	1.85 b	1.86 bc	1.89 bc	1.94 bc	1.96 bc	2.10 c			

[x]Ts indicates compose was through-spawned.

[y]Yield figures without any letter in common are significantly different at the 5% level by Duncan's Multiple Range Test.

only a commonly found trend of decreased mushroom size with increased yield.

Special methods to obtain very early and large yields (1) cannot readily be used in the rather inflexible bed system of mushroom culture currently prevalent in the United States. In practice, moreover, mushroom growers often must balance the element of time against that of yield.

An interesting aspect of these results was the demonstration that the mycelial condition of spawned-compost was apparently unaffected by being covered with plastic film for as long as 42 days beyond the usual casing time. Furthermore, the metabolic energy expended during such a 42-day period did not affect mushroom production.

Some mushroom growers now use plastic film to cover newly spawned compost until casing time. The results of these experiments suggest that instead of casing all beds at the same time, a grower could cover some beds with a material such as plastic film. These latter beds would be cased at different times during the following six (or possibly more) weeks. Some growers could, depending on various factors, find such a means of regulating crop production of value.

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Starch Content in Cherry Stems Near Loci of Graft, Banding and Scoring[1]

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Sweet cherries (*Prunus avium* L.) budded on Mahaleb (*P. mahaleb* L.) in some instances exhibit incompatibility symptoms, but less frequently when on Mazzard rootstock (4). The symptoms of incompatibility of sweet cherry cultivars on Mahaleb are over-growth above the graft union and premature defoliation in the fall. Longitudinal sections through the graft union reveal a thick phloem and bark just above the graft union, whereas, no major abnormalities appear in the xylem area of the graft union (4).

Hansen (1) using young apple trees and Ursino *et al.* (5) using young pine trees, showed that photoassimilated C^{14} is transported to the root at different rates during the growing season. They found that C^{14} accumulated greatly in the root during the latter part of the season, September and October. Using the iodine color reaction test, Herrero (3) noted that four-year-old sweet cherry on the rootstock F250 (acid cherry) stored a large amount of starch above the graft union. Except for the lack of growth in the stock, there appeared to be an entirely uninterrupted vascular connection between the stock and scion.

This study was initiated to determine: (1) whether starch content differed in compatible versus incompatible grafts, (2) whether mechanical restrictions had the same effect upon starch distribution as the graft itself. Thus, if the graft union is a mechanical restriction, could it be reproduced by either banding or scoring the stem of young cherry trees.

A total of 36 uniform one-year-old trees of three different scion/rootstock combinations were planted in 12" pots following a rest period in January 1966, and grown in the greenhouse. The scion/rootstock combinations were Napoleon/Mahaleb, Napoleon/Mazzard, and Montmorency/Mahaleb. Four trees out of each scion/rootstock combination were used for banding, four for scoring, and four as grafted non-treated trees.

The super-imposed treatments on the grafted trees were made by cutting through the bark around the trunk (scoring) five inches above the graft union and by fastening an aluminum strip around the trunk (banding) at the same height (Fig. 1). Seven months later the trees were sampled for starch by taking one-inch stem pieces from above and below the graft union and the treated areas. These samples were dried in a fanned drying oven at 75° to 80°C. The bark was peeled from the stem and ground to pass through 40-mesh screen. The starch content in these samples was determined by the method suggested by Hassid and Neufeld (2).

The soluble sugars were eliminated from the ground material by extracting three times with 80 per cent ethanol. The sugar-free residue was incubated with 52 per cent perchloric acid solution and the mixture centrifuged. Then, the extracted starch solution was precipitated with iodine, and the starch-iodine complex was decomposed with 0.25 N ethanolic sodium hydroxide. The liberated starch was determined colorimetrically with anthrone reagent.

Moderate "swellings" were produced above and below the banding treatment, whereas only an increase in the stem circumference was produced above the scoring treatment (Fig. 1). Stem thickening was mainly a result of an increase in bark thickness.

The trees of the Napoleon/Mazzard combination had a significant low starch content above and below the graft union compared with similar trees on Mahaleb (Fig. 2). On the other hand, the trees which were banded or scored did not show significant difference in the starch content above and below these treatments. Thus, the starch content was altered by the graft union but not necessarily by the mechanical treatments of scoring and banding the

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