Spent Mushroom Substrate as a Soil Amendment for Ornamental Plants

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Fresh spent mushroom substrate (SMS) as a medium amendment for containerized nursery crop production is a promising alternative to disposal of this co-product of mushroom production. Fresh SMS is the material that is removed from a mushroom house and used without further weathering. The two objectives of this study include: (1) identification of key factors involved in its successful use and (2) demonstration of effective use of SMS in plant nurseries.

The plant material includes both bedding plants and woody perennial species. Results demonstrate that the key limiting factor in the use of SMS for plant production is high soluble salts (>30 mmho cm^{-1}). Leaching can reduce these high soluble-salt levels. In addition, special consideration needs to be given to the reduction in potted media volume over time due to the continued decomposition that occurs during plant production. Spent mushroom substrate as the sole growing medium was not as effective as when SMS was amended with a nursery growing mix (pine bark, peat, and gravel). Both *Tagetes* 'Yellow Girl' and *Spiraea* ×*vanhouttei* were grown in 0%, 25%, 50%, 75%, and 100% mixtures of SMS and a nursery potting mix. Both species grew well in SMS and nursery growing (pine bark, peat, and gravel) (1 : 1, v/v) mix.

INTRODUCTION

Chester County, Pennsylvania is the center of mushroom production in the United States (Kelsey, 1996). The majority of the spent mushroom substrate (SMS), a co-product of mushroom production is high in salts, unsightly, odoriferous, and a potential surface and groundwater contaminant. Currently, SMS is piled and weathered in fields at depths no greater than 3 ft per EPA regulation (Kelsey, 1996).

Spent mushroom substrate can be used as an amendment in potting media at nurseries and greenhouses. However, high salt levels found in SMS present significant challenges in growing plants if not managed properly (Szmidt, 1995). Recommendations have involved the long term field weathering of SMS as a means of mitigating the salt effect. Chong and Hauersma (1997) recently reported leaching of fresh material immediately following removal from the mushroom house, or at least prior to planting, can lower the soluble salts to acceptable levels for growing plants (<3,000 mmhos).

Spent mushroom substrate is not physically stable. The material remains biotically active for a period with temperature, moisture, and composition determining the rate of decomposition. Decomposition results in an overall increase in bulk density over the span of a growing season (Gerritis, 1994). This increase results in reduced aeration that can lead to undesirable growth effects and disease problems.

Today, when the idea of recycling by-products and acting in an environmentally conscious manner is encouraged, if not demanded, the utilization of SMS in an environmentally sound method has become necessary.

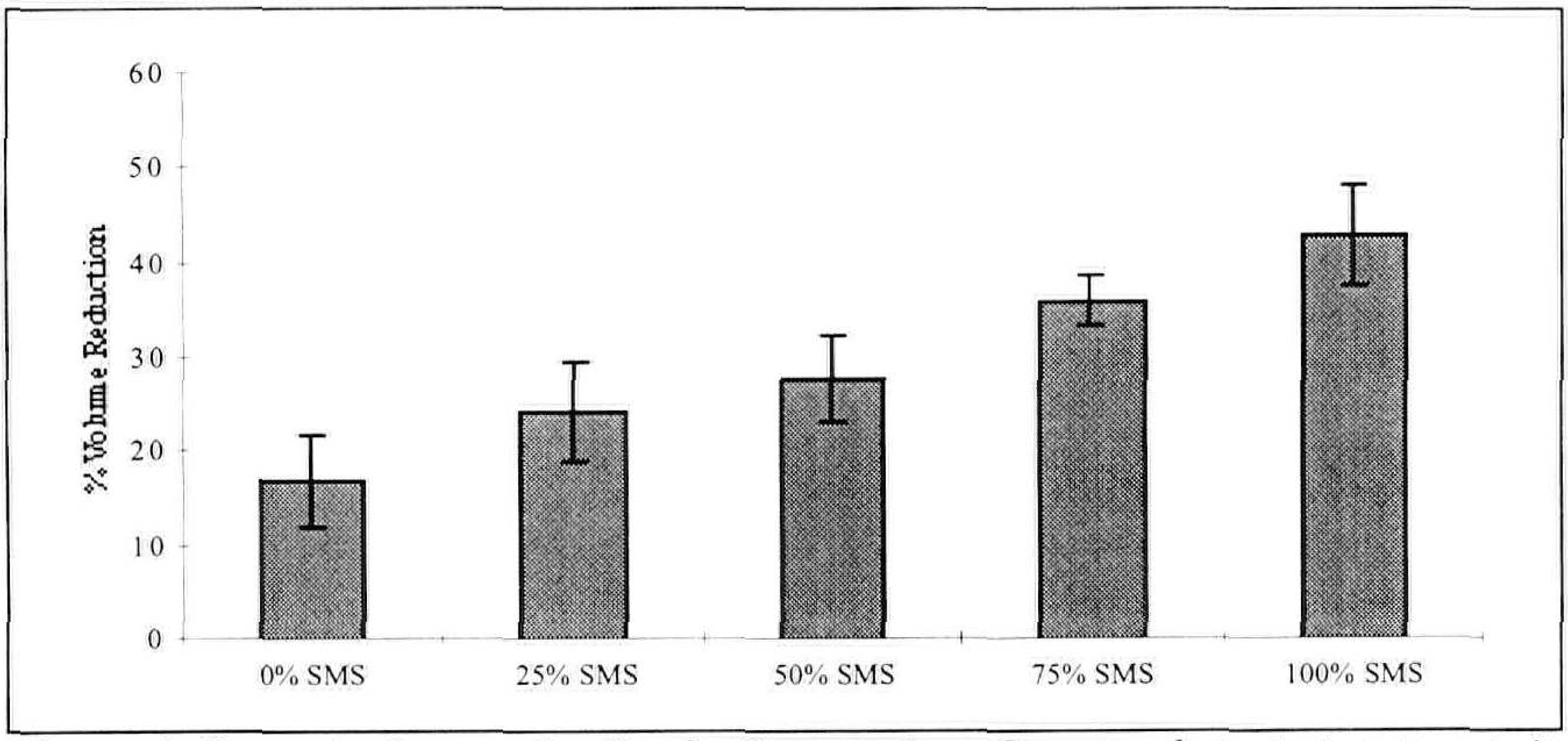

Figure 1. Percent volume reduction for five spent mushroom substrate treatments in 3-gal pots with *Spiraea ×vanhouttei*.

MATERIALS AND METHODS

Objective 1. Spent mushroom substrate was obtained from three different mushroom growers. For each trial, the SMS from each source was individually mixed with a pine-bark-based growing mix (pine bark, peat, and gravel, by volume) at rates of 0%, 25%, 50%, 75%, and 100%.

Marigolds were grown in greenhouses at University Park, Pennsylvania. Three replications, four subsamples from three sources and five ratios for each source were arranged in a randomized complete block design. The SMS was leached to reduce the soluble salts to levels below 3 mmho cm^{-1}. One marigold seedling was transplanted into pre-mixed medium in a 4-inch pot. Marigolds were irrigated as needed to maintain moist conditions and fertilized with 21N-7P-7K at 250 ppm N at each irrigation. Greenhouse temperatures were set at a minimum of 60°F at night and ventilation beginning at 70°F during the day. At the end of an 8-week period, fresh and dry weights were recorded.

Figure 2. *Tagetes* 'Yellow Girl' marigolds grown in 0% to 100% spent mushroom-substrate-amended media.

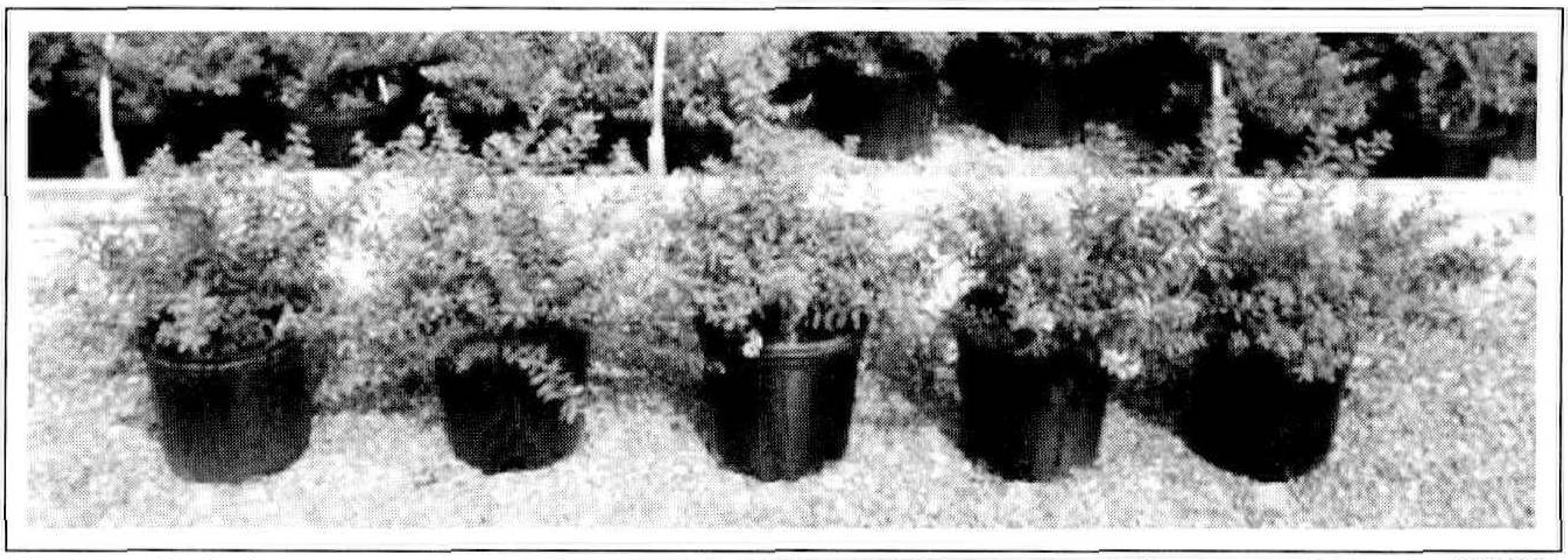

Figure 3. *Spiraea ×vanhouttei* grown in 0% to 100% spent mushroom substrate (SMS) amended media at Hansen Nurseries.

Spiraea plants were grown at Hansen Nursery, Sassamansville, Pennsylvania. Spent mushroom substrate from one source was mixed with the pine-bark-based medium at rates of 0%, 25%, 50%, 75%, and 100%. Each mix was potted in 3-gal containers, replicated 15 times, and arranged in a completely randomized design. Plants were irrigated with an overhead spray system and fertilized with 18N-6P-12K Osmocote (3 tbsp per pot). At the end of the cropping season, nondestructive measurements including height, widest width, and the ninety degree width were taken and averaged to create a growth index.

Objective 2. In planting *Spiraea* in 3-gal pots at Hansen Nursery, the medium was made level with the pot rim. Volume reduction was measured as the depth that the medium had shrunk from the pot rim after a given period of time.

RESULTS

Spent mushroom substrate tends to shrink over time as it continues to decompose. It has been found that the degree of shrinkage follows a straight-line relationship with increasing ratios of SMS : pine-bark-based medium. In situations where SMS constitutes the entire medium, reduction in volume can approach 25% to 30% (Fig. 1). The excessive salt levels associated with SMS can be reduced with approximately 4 to 5 leachings, each equivalent to the volume of water held in the container.

In experiments conducted on *Tagetes* 'Yellow Girl' marigolds, media ratios of 25% to 50% SMS produced plants superior to those grown in standard nursery pine bark, peat, and gravel medium (Fig. 2).

In experiments conducted at Hansen Nurseries, *S. ×vanhouttei* showed no visible difference in growth response between the various SMS treatments. This trial demonstrates that a nursery grower is able to incorporate SMS successfully into a container production operation (Fig. 3).

SUMMARY

- Marigolds showed a positive response at SMS levels between 25% to 75%.
- Spirea showed no visible difference in growth response.
- Volume reduction was linearly proportional to an increasing SMS content.

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Comparison of Propagation Mixes

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The propagation department at Willoway Nurseries in Avon, Ohio is always trying different techniques to increase rooting percentages and rooting quality. With well over 1 million cuttings propagated annually, timing as well as different methods of cutting preparation, including IBA treatments, are always evaluated in order to obtain the best results.

This year we decided to trial a coir medium for some of our hard-to-root species as well as those species that take longer periods of time to root. The mix we used was Sun Gro Horticulture coir mix available in 3-ft^3 loose bags. The components of this mix are simply coir pith and coarse perlite (3 : 1, v/v).

Coir is a waste product of the coconut industry and is produced in Sri Lanka, the Philippines, Indonesia, Mexico, and parts of the Caribbean and South America. Sri Lanka is the leading processor of coir product and is reportedly one of the most reliable and consistent sources. Coir produced there also has the lowest electrical conductivity. Coir is the name given to the fibrous material of the coconut fruit. Coconut husks are ground and the long fibers are screened out. The long fibers are used in the manufacturing of such products as brushes, floor mats, hanging basket liners, and automobile seat and mattress stuffing. After the long fibers are extracted, the coir dust (called pith) is used to produce horticultural growing mixes.

Coir mixes have many desirable properties. These mixes wet rapidly and uniformly. Drying of coir media is also very uniform and requires less watering after root development. These mixes retain high porosity which in turn improves root development and quality. The pH range of coir is between 5.6 to 6.5. Electrical conductivity can range from 0.3 to 2.9 mmhos cm^{-1}. Electrical conductivity is the most important factor that producers and coir users must consider.

Coir has a slightly lower nutrient holding capacity than Canadian sphagnum peat moss. Fertilizer programs may need adjusting when using this product.

Our "in house" propagation mix works well for most of the cuttings that we propagate. Its components are sphagnum peat moss, styrofoam, hardwood bark, sand, haydite (compressed shale product) (5 : 2.5 : 1 : 1 : 0.5, by volume) and 7#