DEVELOPMENT OF AUTOMATIC AIR BLAST WATERING MACHINE FOR MUSHROOM GROWING

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ABSTRACT

Watering operation for oyster mushroom growing houses is regarded as drudgery and time consuming farm operation for growers. Most of mushroom growing beds in oyster mushroom growing houses are designed as two-row with four floor beds, therefore the watering and ventilation between the bed floors are much difficult for farmers because of its structural design.

The study aimed to reduce the watering operation and improve the mushroom growing environment through the humidification and air supply on mushroom growing beds.

Results showed that appropriate size of nozzle is between 0.8~0.5mℓ/s for the humidification and higher than the 2.0mℓ/s for the watering. The optimum water supply pressure was regarded as between 1.0~2.0MPa and the uniform distribution of droplet on the bed showed on air flow speed of 14m/s.

The prototype was equipped with twin nozzle with the humidification nozzle of 0.85mℓ/s and watering nozzle of 5.0mℓ/s, and the air blast fan with the air speed of 10m/sec in each air spout. In the field test in a practical scale mushroom growing house, it was well operated dependant on the set desire by a electric control unit. The machine can be practically used as air blast watering and air blast humidification for oyster mushroom growing farms without manual.

INTRODUCTION

Water is essential for growing oyster mushroom and controlling the proper humidity in mushroom growing house during harvesting is equally important. Most farmers have practiced watering manually on mushroom growing bed using water pump with scattering nozzle or power sprayer with spray nozzle two times a day.

The mushroom houses are generally dark inside, and the mushroom growing beds are generally high, as high as four floors, therefore, even watering of the beds cannot be done. In addition, the ventilation is much poor because of the inappropriate structural design, so it need to be improved through a forced ventilation system.

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This study aimed to develop a new watering and humidifying system for multi-story mushroom growing bed as well as the improvement of its ventilation between bed floors.

MATERIALS AND METHODS

1. Experimental Apparatus

A. Water supply test of nozzle

To find out the optimum design factor of watering nozzle and atomization nozzle such as travelling distance of droplet from the nozzle and the droplet size, a testing and measuring apparatus was designed .

A 40A type three plungers power sprayer was used to obtain the high pressure water, and two type centrifugal fan were used to obtain the pressure blast air. To measure the amount of spray water, several corrugate iron sheets were installed with an inclined angle of 30 ° . Water receiving beakers measured the amount of water.

The water spray nozzles tested were 8 types of gun type burner's nozzle measuring between 0.5~8㎖/s.

B. Watering and Atomizing System

Uniform supply of water and maintaining the humidity on the growing bed is essential for the growth of the oyster mushroom.

The system was designed as hanger rail type movable system and it is equipped with its fan and nozzle with a main air duct. The major components of the system are hanger rail, driving device, centrifugal fan, water spray pipe line and their control unit. The driving motor can control its travelling speed.

If the mushroom growing bed need higher moisture content and higher humidity, then the time switches and relay circuits will operate a carrier motor, fan & power sprayer, and it will open the solenoid valves to supply water to the nozzle.

3. Analysis Method.

The droplet size per nozzle, volume of supplied water by travel distance, and Mass Mean Diameter(MMD) of droplet of water were analyzed

In measuring the droplet size, Malvern droplet analyzer with the lens diameter of 63㎜ was used. The droplet size was analyzed between 1.2~118㎛. The laser beam measurement point was indicated a distance of 0.5, 1.0, 1.5, 2.0m from the

nozzles.

After the indoor experiment, practical tests for uniform watering and fog spraying humidification were undertaken.

RESULTS AND DISCUSSION

1. Amount of Discharge by Size of Nozzles

The water nozzle has the capacity to discharge one liter of water per square meter of mushroom growing bed in a day. Mean while, fog spray nozzle discharges to making fine particle for easy evaporation in mushroom growing houses.

Although the nozzle size of less than 1㎖/sec, there is not so much difference in the discharge rate. In the nozzle size larger than 1㎖/sec, the volume of spray water has increased between 1.5 to 2.0 times higher than its original volume as increase the water pressure from 1 MPa to 2 MPa..

2. Amount of supplied water by travel distance

The volume of water droplet by travel distance decreased as the travel distance from the nozzles increased. In the wind speed of 10㎧, the sprayed droplets from the nozzle with size range of 0.5㎖/s and 0.85㎖/s have mostly settled beyond the mushroom growing bed, while the nozzle with size of 1.25㎖/s and 1.5㎖/s showed comparatively uniform distribution.

At a faster wind speed as in the 14㎧, with a nozzle size of 0.5㎖/s had most of the water droplets settled beyond the mushroom growing bed, the sprayer with a nozzle size of 0.85㎖/s had most of its droplets settled in the both end of the mushroom growing bed.

The even distribution of water droplet was observed in the sprayer with 1.25~2.0㎖/s nozzles, and the large size nozzles between 4.0~8.0㎖/s had water droplets mostly settled near the nozzle area.

In considering the water droplet distribution in the mushroom growing bed, it is recommended that the nozzle size of 0.8~1.5㎖/s with the wind speed of 10㎧ be used for the fog spray humidification system. It is also recommended that the nozzle size of more than 2.0㎖/s with the wind speed of 14㎧ be used for the watering system.

3. Variation of Droplet Size

Fig.7 and Fig.8 show the accumulated droplet size by MMD for the 0.5㎖/s

nozzle by the variation of water pressure from 5MPa to 30 MPa. The mean droplet diameter was 45㎛, 40㎛, 32㎛, 31㎛ under each spray pressure of 0.5MPa, 1MPa, 2 MPa, 3MPa, respectively.

The accumulated droplet size(MMD) ranged from 20㎛~60㎛, and as the spray pressure increased from 0.5MPa to 2.0MPa, the droplet size reduced but the droplet size has no longer reduced beyond the pressure of 2.0MPa.

For the fog spray humidification nozzle without air blast, the mean droplet size(MMD) increases as the size of nozzle increases. On the other hand, the droplet size was reduced as the travel distance from nozzle was increased. In particular, the nozzle size is less than 1.5mℓ/s, the droplet size is about 30㎛ or less, and the droplet size difference between the nozzle size of 0.5~1.5mℓ/s is only 5~8㎛.

In the wind speed of 10m/s, the droplet size was reduced as the travel distance from the nozzle increases, while the droplet size increases as the size of nozzle increases.

Therefore, it is recommended that in the humidification in mushroom growing houses should use fog spray without air blast, but the watering on the bed requires water spray with air blast. As such, watering-cum- humidification is needs spray with low speed wind air blast.

4. Adaptability to Oyster Mushroom Growing Houses

Numerous wires and pipes such as electric wires, system controlling wires and water supply hose were set to a separate hanger rail carrier. The air blast watering machine can travel on a I type beam rail under the ceiling, which is controlled by electric control unit.

When the time-switches for watering, fog spraying, inside ventilation are connected, the system operate individually or simultaneously.

The prototype that was developed and established in a standard oyster mushroom growing house. The performance was tested taking into account the water droplet distribution on the mushroom growing bed for watering, humidification and its effect on the air blast.

The droplet distribution using a sprayer with watering nozzle and fog spray nozzle have heavier water drops near the spray nozzle than that of without air blast. And also, using an air blast spray showed not much difference in the droplet distribution for watering and fog spraying on the bed.

Therefore, the prototype was recommended for use/adoption by oyster mushroom growing farmers.

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Table 1. Specification of atomization unit and measuring apparatus

Items	Specification
Power sprayer	40 ℓ /min, three plungers, 0.5~3.5MPa
Centrifugal fan	10m/s(2.5㎥), 14m/s(4.1㎥)
Inclined plate(W×L)	1.8×3.0m, corrugate iron sheet, inclined angle of 30 °
Type of nozzles	8 types, 0.5, 0.85, 1.25, 1.5, 2.0, 4.0, 5.0, 8.0,㎖/s

Table 2. Specification of automatic watering-cum-humidifying unit

Items	Specification
Carrier motor	Reversible & speed control, AC40W
Fan	$40m^3$/min, 18mm Aq
Power train	Sprocket & chain
Power sprayer	40 ℓ /min, 3.5MPa, 3 plungers, 750rpm
Nozzle size	0.85, 5.0㎖/s, 80°
Control system	Relay switch & time switch

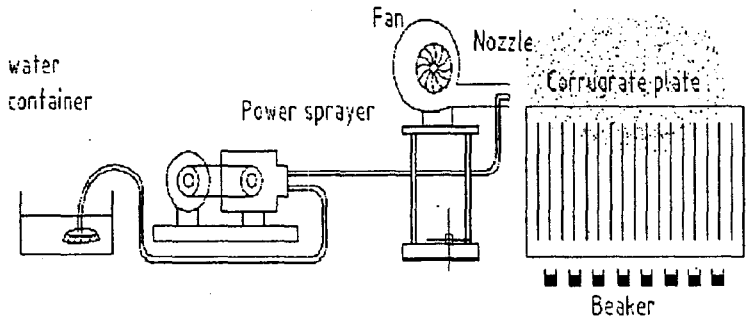

Fig. 1 Layout of atomization testing system

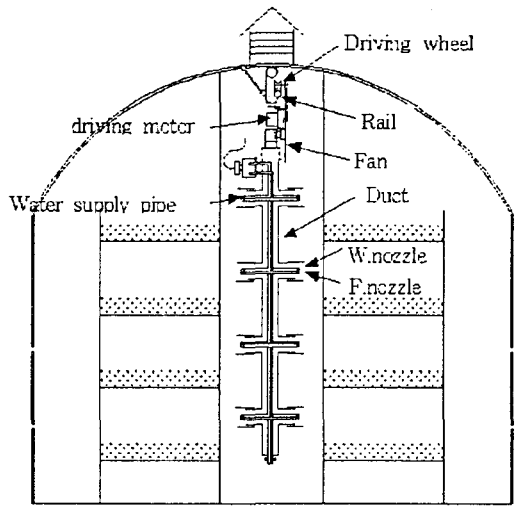

Fig. 2 Automatic air blast watering and humidifying system

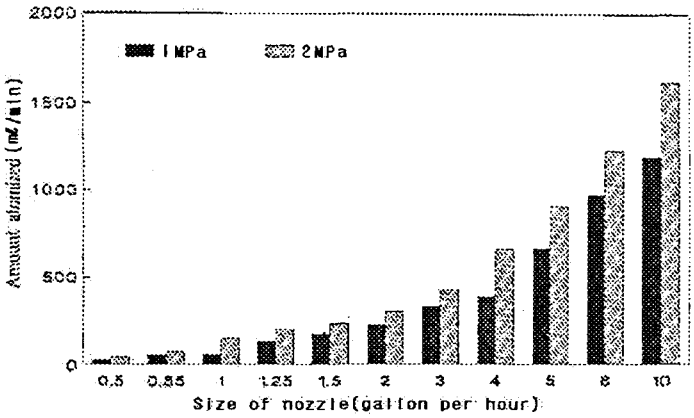

Fig. 3 Volume of atomized water on different size of nozzle under different level of pressure

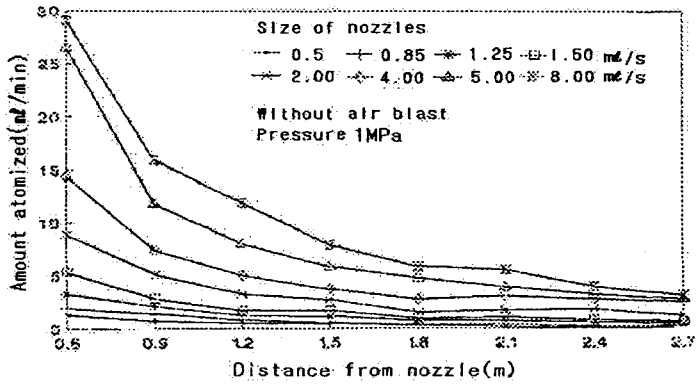

Fig. 4 Volume of atomized droplet on the different distance from nozzle without air blast

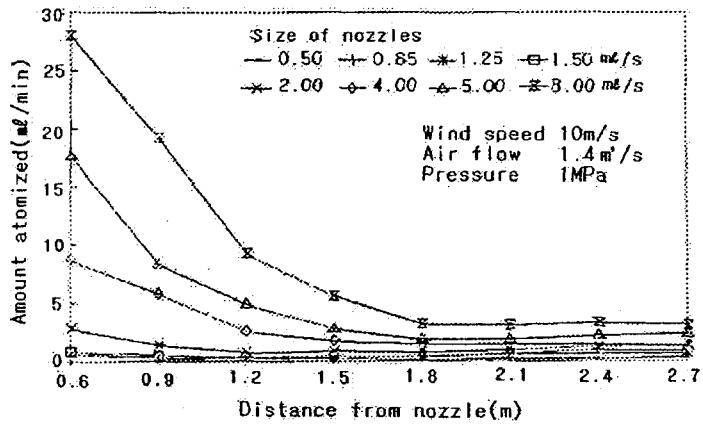

Fig. 5 Volume of atomized droplet on the different distance from nozzle under the wind speed of 10m/sec

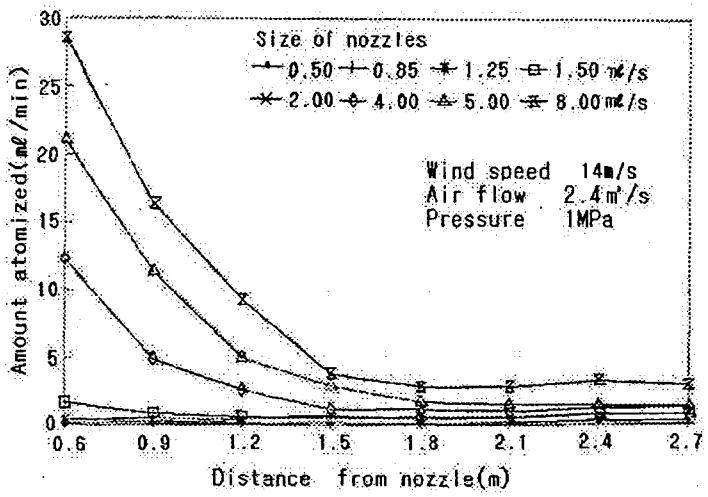

Fig. 6 Volume of atomized droplet on the different distance from nozzle under the wind speed of 14m/sec

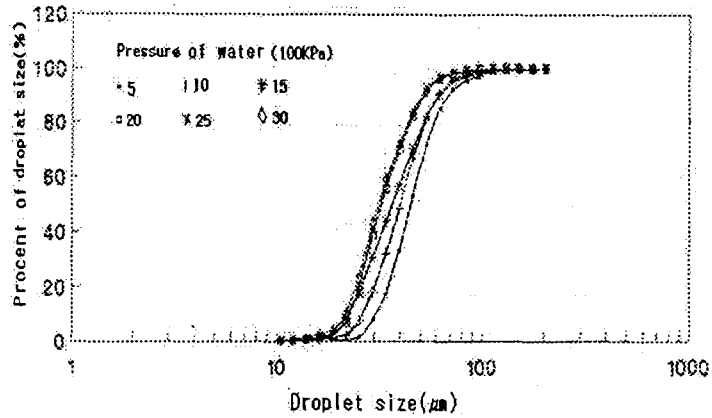

Fig. 7 Accumulated droplet size(MMD) by different pressure

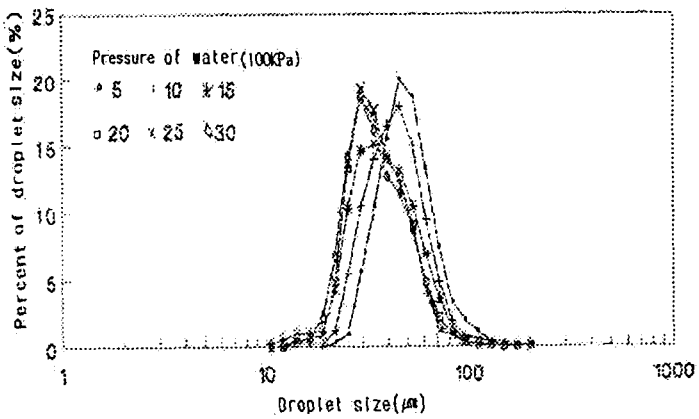

Fig. 8 Distribution of droplet size(MMD) by different pressure

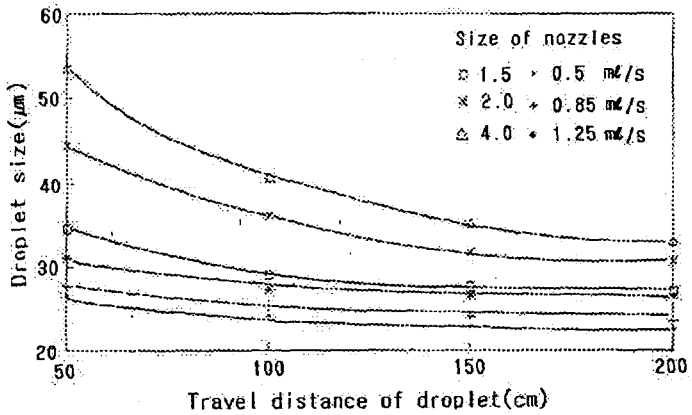

Fig. 9 Effect of droplet size on the droplet travelling distance from nozzle without air blast

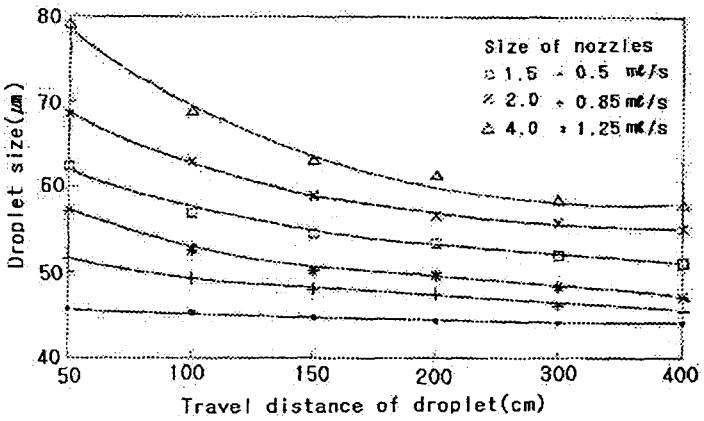

Fig. 10 Effect of droplet size on the droplet travelling distance from nozzle in the wind speed of 10m/sec

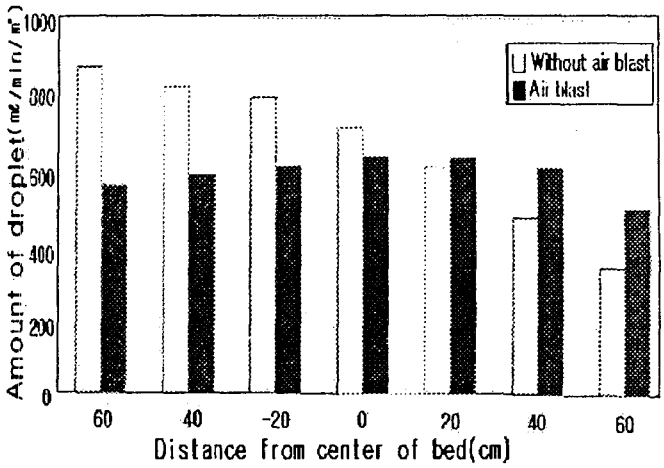

Fig 11. Droplet distribution for watering nozzle splayed

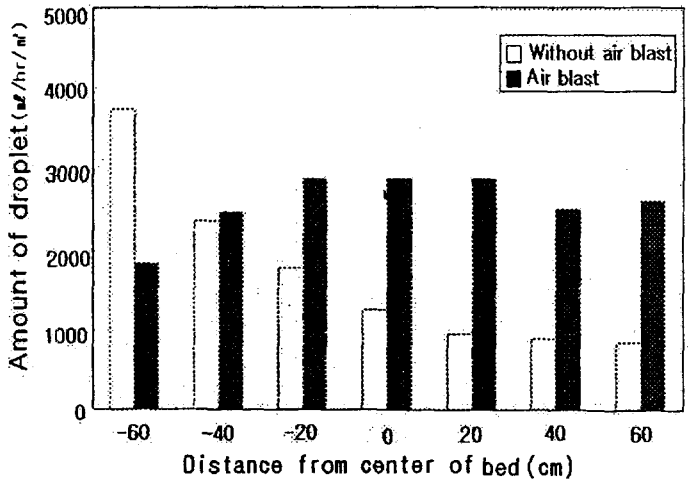

Fig 12. Droplet distribution for humidification nozzle sprayed