N. By September 1983 plants given the lower rate of dolomitic limestone had developed interveinal chlorosis of the mature leaves. These symptoms are characteristic of magnesium deficiency, and this suggests that although comptie benefited from a very acidic growth medium (pH 4.2), magnesium should be added when the medium is amended with low rates of dolomitic limestone.

Increasing rates of NH_4NO_3 decreased growth medium pH and increased soluble salts at both sampling dates. Higher liming rates increased growth medium pH, but did not affect soluble salts levels in the medium at either sampling date.

Container volume had no effect on either leaf number or growth index of comptie (data not shown). These results differ from those reported in other studies in which an increase in container volume produced more growth (1,3,7); however, in several of these studies, fertilizer was applied on a volume basis. Consequently, response to a greater growth medium volume may have actually been a response to increased fertilizer. Goodale and Whitcomb (4) reported that in a study in which both fertility and container size were varied, plant response to container size was species-dependent, whereas increased fertility generally produced more growth.

Significance to the Nursery Industry

Comptie responded to both reduced levels of shading and to nitrogen applications up to 200 ppm N per week, by forming more leaves, thus showing that production time can be shortened by manipulating cultural practices. Low levels of dolomitic limestone were beneficial, whereas container size was not critical, provided that 200 ppm N per week was supplied. Because of the positive response to management of certain cultural practices, nurserymen should be encouraged to grow this versatile, attractive cycad.

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Automated Fertilizer Applicator for Potting Machines[1]

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Abstract

An automatic fertilizer metering device was designed, built, and mounted on a nursery potting machine. The device senses the presence of a container under the fertilizer spout, and automatically deposits a metered charge of fertilizer into the planting hole in the medium in the container. Fertilizer rate is readily adjustable. Operation is fully automatic.

Index words: Dibble, fertilizer application, metering

Introduction

Research on placement of fertilizers in containers has given highly variable results. Better plant performance was obtained with the placement of Osmocote in the planting hole than with incorporation over a range of 0.44 to 1.78 kg N/m^3 (0.75 to 3.00 lb N/yd^3) with 4 cultivars of azaleas (*Rhododendron* sp. cvs. 'Formosa,' 'G. G. Gerbing,' 'Judge Solomon,' and 'Fashion') and 2 holly species (*Ilex crenata* Thunb. 'Compacta' and *Ilex vomitoria* Ait. 'Nana') and equal results with 3 other species (2). In later work, dibble application was best for 3 species of plants, but surface application was better for 3 cultivars of azaleas ('Fielder's

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White,' 'Formosa,' and 'Daphne Salmon') (3). In several cases, equal or better plant performance has been obtained with dibble application using smaller amounts of fertilizer than with incorporation (3, 4). Surface application was better than incorporation or dibbling with a sulfur-coated urea product, Scott SREF 20N-1.7P-8.3K (20-4-10) (1, 3).

Dibble application of fertilizer by manual means is labor-intensive and is subject to human error in metering. An automatic metering device to mount directly on the potting machine can increase accuracy of fertilizer application and reduce labor requirements during container filling and planting. The objective of this project was to develop a fertilizer metering device that would mount on a conventional potting machine and automatically deposit precise amounts of fertilizer in dibble holes in the potting media in the containers.

Materials and Methods

A fertilizer dispensing device was designed to fit on a commercial container-filling machine at the Hammond Research Station, Hammond, LA (Pot Master machine). The selected metering mechanism is a Scott Progrow Model OA-1 Ornamental Applicator, designed for discharging accurately measured amounts of fertilizer onto the surface of planted containers in beds. The operating characteristics of the applicator are described in the patent on the device (5). The applicator consists of a plastic hopper over a stainless steel metering cylinder. Within the cylinder, a series of hourglass-shaped rotors are stacked on a horizontal shaft. As the shaft is rotated 180 degrees, a charge of fertilizer is metered out by one of the cavities in the stack of rotors. Delivery rate is adjusted by varying the number and thickness of rotors stacked in the cylinder, and by turning the rotor multiples of 180 degrees for multiple discharges. Precision of this metering system is very good. Since metering rate is determined by stacking finite rotors, the rate can be varied only in finite steps.

For the automatic applicator, the basic metering unit is rotated by an electric motor. In the test installation, a 0.05 kw (1/15 hp) gearhead motor with magnetic brake was used. The motor has a 23:1 gear ratio, yielding an output speed of 30 rpm. The brake is needed to assure that the rotor of the metering unit stops at the proper point and doesn't free-wheel when the motor is stopped.

The motor and metering unit are both mounted on a frame above the container line on the container-filling machine, as shown in Figures 1 and 2. The motor drives a jackshaft through a chain drive. Since the amount of fertilizer desired per container exceeds the capacity of a single discharge, it is necessary to turn the metering rotor 360 degrees to deliver two discharges. A 2:1 sprocket ratio is used to obtain 360 degrees of rotor rotation for each 180 degrees of the motor output shaft. Other ratios are possible to obtain lower or higher rate ranges. The driven jackshaft is connected to the metering unit with a piece of rubber heater hose to provide a shock-absorbing coupling.

In this installation, the straight aluminum drop tube supplied with the basic applicator was replaced with a flexible plastic tube of the same interior diameter (approximately

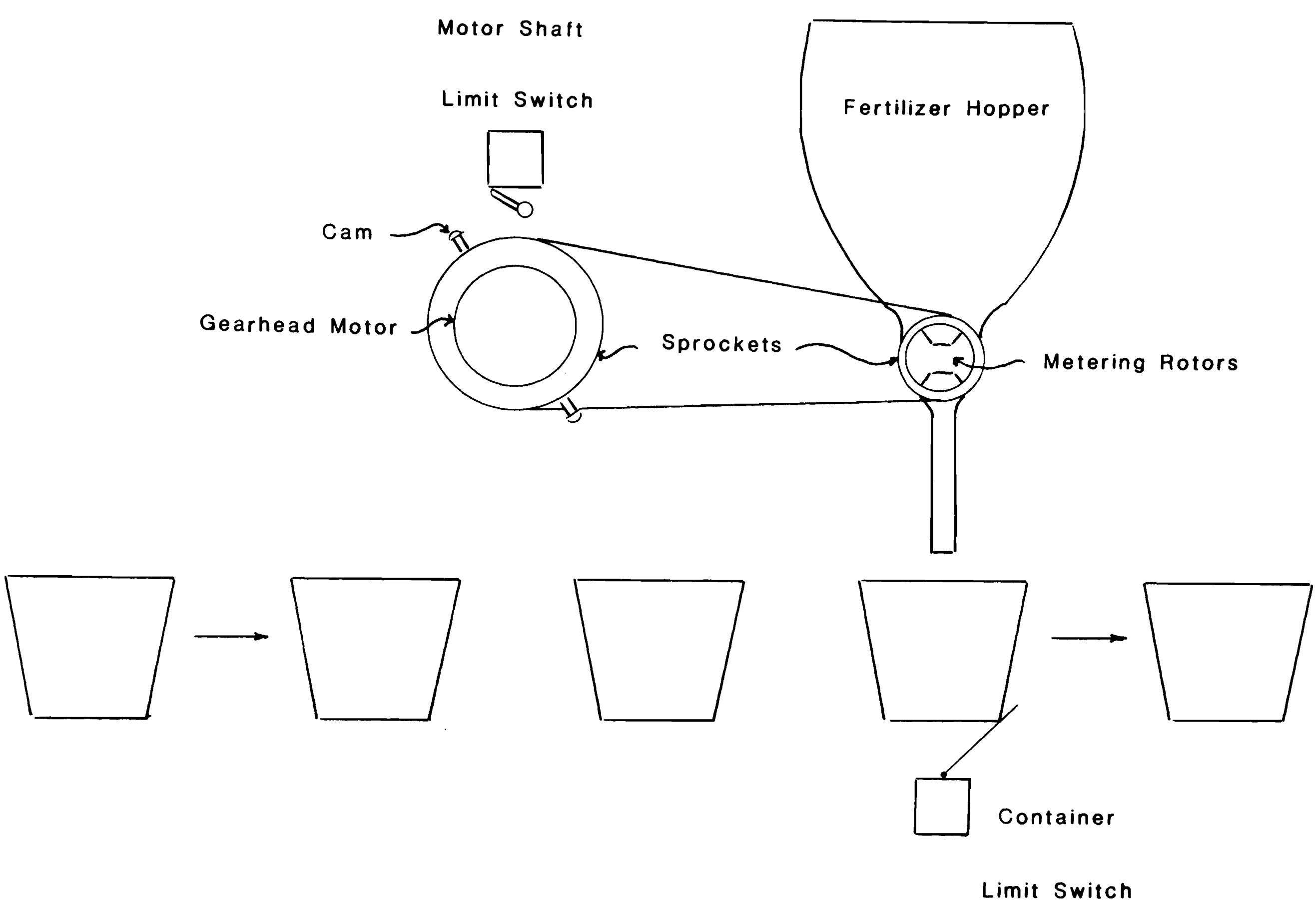

Fig. 1. Schematic drawing of automatic fertilizer metering system for dibble application on a potting machine.

2.54 cm [1 in]). A flexible metal tube (cut from the spout of an old fuel can) was mounted over the plastic tube and secured with a hose clamp. The flexible metal spout held the plastic tube in position once it was aimed properly at the hole in the potting medium in the container.

The basic installation is shown in Figure 2. A whisker-activated limit switch that senses the presence of a container is shown in the lower left hand corner of Figure 2. A cam-follower type limit switch is mounted above the sprocket

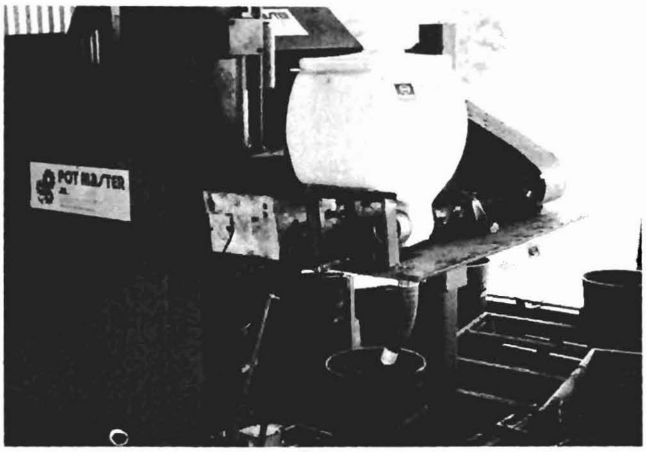

Fig. 2. Automatic fertilizer metering system installed on container filling machine. Note the limit switch at the lower left that senses containers and the commercially-available metering unit.

on the motor output shaft to sense the motor shaft position, and thus indirectly sense the metering rotor position. This limit switch is activated by cams consisting of carriage bolts inserted into drilled and tapped holes in the sprocket hub.

The simple control circuit for the applicator is shown in Figure 3. The circuit contains the motor, 2 limit switches, and one relay. When a container activates the container limit switch, the motor rotates until the next cam hits the motor limit switch. This motor rotation drives the applicator through a roller chain and results in a discharge of fertilizer. Depending on the sprockets chosen and the number of cams (carriage bolts) used, a metering rotor rotation of 180 to 720 degrees per container can be obtained.

Overall function was evaluated under actual use conditions at the Hammond Research Station by using the automatic metering system (mounted on a container-filling machine) to fertilize containers to be used in research programs. Metering consistency was evaluated by catching and weighing 10 discharges from each of the available metering rotor combinations.

Results and Discussion

The automatic fertilizer metering unit operated well and dependably dropped fertilizer into dibble holes in containers. This system reduces the labor requirement by one person for potting with dibble-applied fertilizer.

Table 1 shows the metering performance obtained with the applicator using Osmocote 17N-3.0P-9.9K (17-7-12). These data were obtained by rotating the metering rotor 360

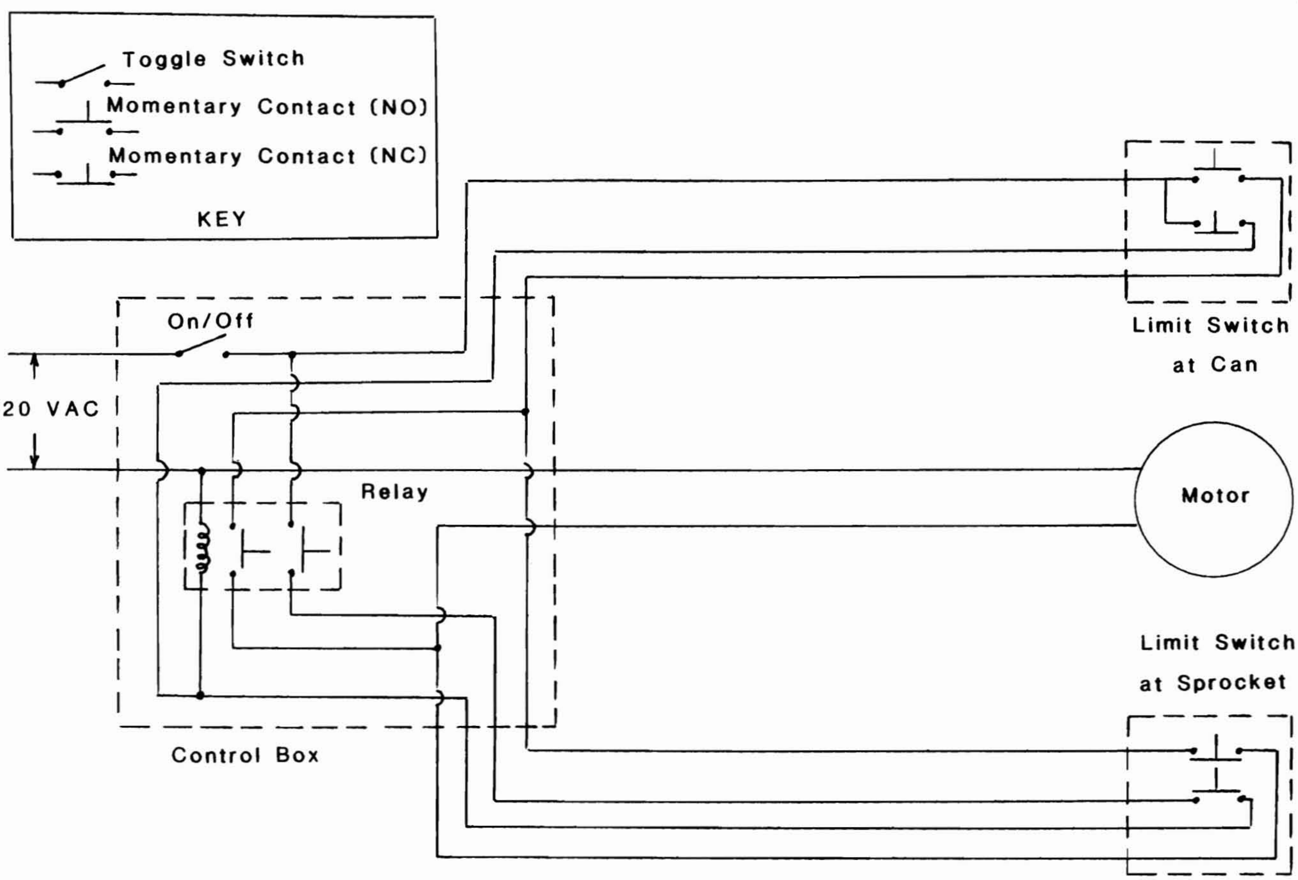

Fig. 3. Automatic control circuit for fertilizer metering system.

Table 1. **Rates and consistency of rates obtained when testing applicator with Osmocote 17N-3.0P-9.9K (17-7-12) fertilizer. During this test, 2 charges (i.e. 360 degrees of rotor rotation) were used. If the cams or sprockets were adjusted for a single charge (180 degrees of rotor rotation), the rates would be half those shown.**

Rotor number(s)	Mean rate g/360 degrees	Coef. of variation %
A-1	6.4	2
A-1, 3	9.1	1
A-1, 2	12.2	1
A-1, 2, 3	15.8	1
A-1, 4	19.9	1
A-1, 3, 4	23.8	1
A-1, 2, 4	27.7	1
A-1, 2, 3, 4	31.2	1

Rotor numbers refer to the number(s) of metering rotor(s) used to obtain the rates shown. The numbers are molded into the rotors.

degrees per container. Rates will vary with fertilizer density. Multiples of one half or twice these rates can be obtained by using 180 or 720 degrees of rotor rotation per container. The coefficients of variation for the metering system, based on 10 samples with each rotor combination, were low, indicating very consistent metering. Previous extensive testing of the basic metering system has given similar results for a wide range of products.

It was noted that the container speed on the filling machine must be reduced to the minimum obtainable if multiple discharges (more than 180 degrees of rotor rotation) are required. This limitation could be avoided by using a higher speed motor (i.e. lower gearhead reduction ratio) or by using a basic metering unit capable of delivering the high rates required with 180 degrees of rotation.

It was also noted that cleanliness of the metering unit is essential, particularly under humid Louisiana conditions. If the metering unit is not thoroughly cleaned after each use, damp fertilizer will build up in the metering mechanism and can stall the system. If the metering unit is disassembled and washed after each use, there are no problems.

Significance to the Nursery Industry

An automatic fertilizer metering system to dibble-apply fertilizer on a container-filling machine was built and successfully operated. The system is easy to build using readily available commercial components. It offers both precision metering and automatic operation.

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