Sensitivity of a Hand-cranked Nursery Spreader to Operator Variables[1]

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Abstract

Hand-cranked rotary spreaders are used to apply granular pesticides to container crops. Pattern was affected by several variables that are controlled by the operator. A sensitivity study was conducted with a typical hand-cranked spreader to determine which operator variables most affected the distribution pattern. Impeller height had little effect. Pattern slide setting had an important effect. Reducing cranking speed affected the pattern; increasing cranking speed did not. Roll angle affected pattern if the right side was angled down, but not if the left side was angled down. Pitch angle affected the pattern only if the spreader was pitched down. Yaw angle had a major impact on pattern regardless of direction. Width of bed (i.e. distance between spreader passes) affected pattern uniformity.

Index words: herbicide application, granular herbicides, spreaders, distribution uniformity.

Significance to the Nursery Industry

Granular pesticides, particularly herbicides, are applied to container-grown plants with hand-cranked rotary spreaders. Normally, the spreader is angled so that a one-sided pattern is obtained. The operator walks down each side of the container bed and back along the other side. The two resulting patterns overlap to provide fairly uniform coverage of the container bed. Hand-cranked spreaders used in this manner can deliver an acceptably uniform pattern, but are subject to several operator variables including pitch, roll and yaw angles and cranking speed, height, and pattern slide adjustment. Width of the bed of containers also has an effect on pattern uniformity. How sensitive a hand-cranked spreader is to each of these operator variables would be useful for nursery operators to know.

This research demonstrated that the main factors influencing uniformity are pattern slide setting, yaw angle, and bed width. Cranking speed and pitch angle had less influence on pattern. Roll angle and impeller height had very little influence on pattern. This information should be helpful in training operators.

Introduction

Hand-cranked rotary spreaders are normally used to apply granular pesticides. Porter and Parish (11) reported testing of a hand-cranked spreader for nursery use and evaluated the amount of granular material actually retained in nursery containers with this type of application. Gilliam et al. (2) discussed types of applicators used in container nurseries.

Hand-cranked rotary spreaders are governed by the same physical principles as other rotary spreaders. The theory of rotary spreaders has been discussed in detail by Crowther (1), Inns and Reece (3), Mennel and Reece (4) and Patterson and Reece (5). Parish (7) and Parish and Chaney (8, 9) tested small and large rotary spreaders and reported on their sensitivity to changes in drop point of granules onto the impellers. Parish (6) and Parish and Chaney (10) reported on significant effects on rate and pattern from speed variations of both drop and rotary spreaders.

The objectives of the current study were to evaluate and to demonstrate the effects on spreader pattern of changes in the following operator variables:

- Cranking speed
- Impeller height
- Pattern slide adjustment
- Pitch angle
- Roll angle
- Yaw angle
- Bed width

Pitch is rotation about a horizontal axis perpendicular to the direction of travel. Roll is rotation about a horizontal axis parallel to the direction of travel. Yaw is rotation about a vertical axis.

Material and Methods

A typical hand-cranked rotary spreader[3] was mounted on a specially designed test cart. The cart allowed infinite adjustment of pitch, roll and yaw angles and of impeller height. The impeller drive crank was replaced with a sprocket driven from a 62 rpm gearhead electric motor. Changing sprockets allowed crank speeds of 52, 62 and 75 rpm. An adjustable slide that closed off part of the impeller throw opening was available on the spreader.

Tests were conducted in a manner similar to that prescribed by American Society of Agricultural Engineers (ASAE) Standard S341.2, *Procedure for Measuring Distribution Uniformity and Calibrating Granular Broadcast Spreaders*. Deviations from the ASAE standard procedure consisted of the use of #1 nursery containers as catch containers rather than the prescribed flat, subdivided trays and the use of a one-sided pattern rather than the centered pat-

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[3]Spyker Model 75 Spreader, Spyker Spreader Works, N. Manchester, IN. This same model is also sold by Seymour Manufacturing Co., Seymour, IN.

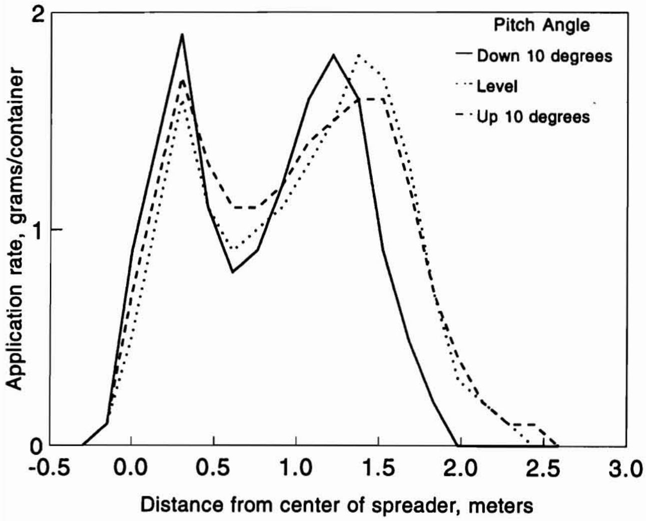

Fig. 1. Effect of pitch angle on distribution pattern of clay granules.

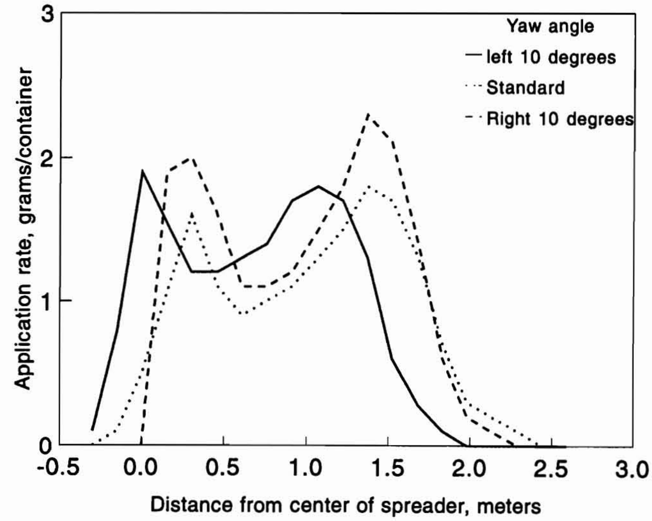

Fig. 2. Effect of yaw angle on distribution pattern of clay granules.

tern assumed by the ASAE standard. The tests were conducted on a smooth floor inside a laboratory.

The material used for the testing was attapulgite clay granules[4] of the type used as a carrier for granular pesticides. The granules had a nominal sieve size of –20/+40. The bulk density of the granules was 539 kg/m^3 (33.7 lb/ft^3).

The cart with the spreader was rolled forward at a constant speed of 4.8 km/h (3 mph) past a single row of #1 nursery containers placed on 15.2 cm (6 in) centers in a line perpendicular to the direction of spreader travel. Enough containers were used to cover the full spread width for each set of operating conditions. Three passes over the containers were made for each test so that the resulting patterns were iterations of three passes. After the material was spread, the granules in each container were weighed and a graph of the pattern was plotted. The graphs indicate distribution in g/container at varying distances from the center of the spreader.

Standard or normal operating conditions were as follows:

- Impeller height—0.76 m (30 in)
- Impeller level in pitch and roll
- Spreader angled 24° right[5]
- Pattern slide—¼ closed
- Cranking speed—62 rpm

An initial run was made under these conditions. Each of the parameters was then varied equally and independently higher and lower than the initial value. Each angle was varied 10° in each direction. Spreader height was set at 12.7 cm (5 in) above and below the standard. Cranking speed was changed to 52 and 75 rpm. The pattern slide was run fully open and half closed. As each variable was investigated, the other variables were held in the standard setting.

The effect of bed width (distance between the centerlines of adjacent spreader passes) was evaluated by calculating overlapped patterns for different widths. The distribution patterns from spreader passes down each side of the various widths of beds were added together to obtain a total distribution pattern for each width of bed.

Results and Discussion

The results of the sensitivity analysis are shown in Fig. 1–6. Each figure shows the results of changing one variable while holding the others constant at the standard settings.

Pitching the spreader up 10° had little effect; pitching it down 10° reduced the overall throw width (Fig. 1).

As noted earlier, the standard yaw angle was 24° right of center. Changing the yaw angle either way by 10° made a discernible difference in the pattern (Fig. 2). Angling the spreader left had more effect than angling it to the right. Angling the spreader left shifted the pattern left as would be expected. Angling the spreader more to the right had little effect since the spreader was already throwing granules close to their maximum trajectory to the right at the standard angle.

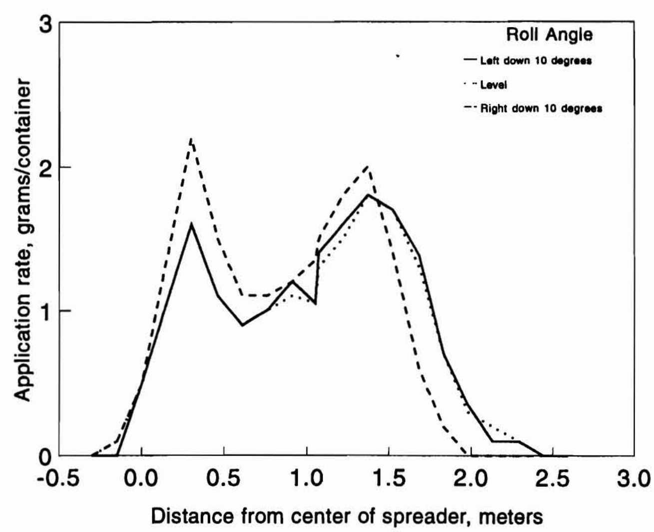

Fig. 3. Effect of roll angle on distribution pattern of clay granules.

[4]Florex LVM 20/40, Floridin, Quincy, FL.

[5]This is the standard operating position for this model of spreader when applying a one-sided pattern to nursery containers.

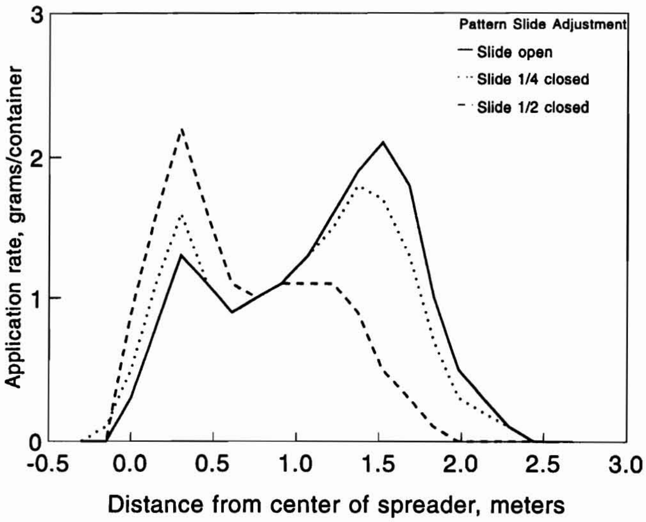

Fig. 4. Effect of pattern slide position on distribution pattern of clay granules.

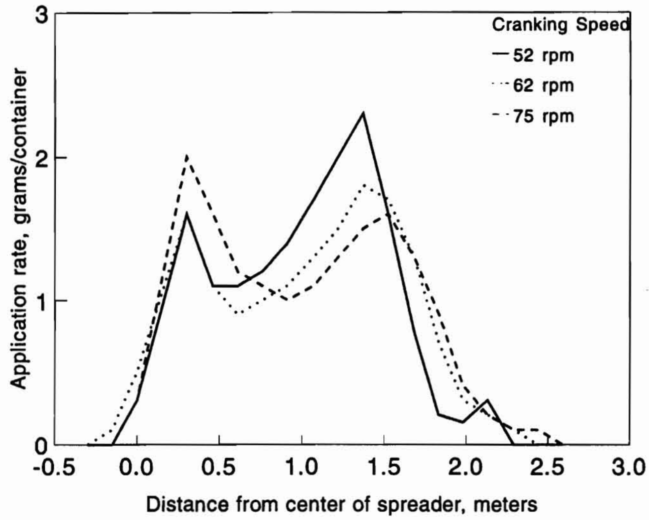

Fig. 5. Effect of cranking speed on distribution pattern of clay granules.

Rolling the left side down 10° had little effect, but rolling the right side down 10° shortened the overall throw distance (Fig. 3).

The effect of adjusting the spreader pattern slide position is shown in Fig. 4. The effect of making this adjustment is significant. An attempt was made to run the spreader with the slide closed further, but material built up in the impeller housing and stalled the impeller. Significant buildup of granules inside the housing occurred even with the slide half closed.

The effect of impeller cranking speed is shown in Fig. 5. This is the cranking speed, not the speed of the impeller itself. Increasing the speed had little effect, but decreasing the speed reduced throw width. This parameter, too, is affected by particle size and density. Larger and/or heavier granules would be capable of being thrown farther and thus would probably respond more to an increase in impeller speed. The cranking speed normally recommended for this spreader in nursery use is 60 rpm.

A slight reduction in throw distance occurred when the spreader was lowered 127 mm (5 in), but little change occurred when the spreader was raised to 1016 mm (40 in). This lack of sensitivity to height is due to the low particle density and small particle size. These small particles reach an almost vertical trajectory within a relatively short horizontal distance. This trajectory was visually obvious during operation. Larger and/or heavier particles (such as fertilizers) would have a more horizontal trajectory and would thus be more sensitive to impeller height.

The overlapping patterns resulting from different bed widths (i.e. distances between spreader passes) are shown in Fig. 6. Each line on the graph was obtained by adding the results from complementary passes from each side of a bed of containers. These graphs are all based on the 'standard' operating conditions as defined in this article. A compound effect would occur when other operating conditions are varied along with bed width.

A hand-cranked spreader of the type tested is sensitive to a number of operator parameters. The operator may need to adjust some of the parameters depending on the width of the bed of containers and the properties of the material being applied. Because material properties, bed widths, environmental conditions, etc. vary considerably, it is impossible to make blanket recommendations for spreader operating parameters. This study serves to identify which of the operating variables are most critical and thus should be most tightly controlled by the operator(s). The most important factors influencing uniformity are pattern slide setting, yaw angle, and bed width. Cranking speed and pitch angle had less influence on pattern. Roll angle and impeller height had very little influence on pattern.

Once the operator has established standard operating parameters that give the desired pattern under the local conditions, he or she should not deviate from them.

Literature Cited

1. Crowther, A.J. 1958. Distribution of particles by a spinning disc. J. Agri. Eng. Res. 3:288–291.

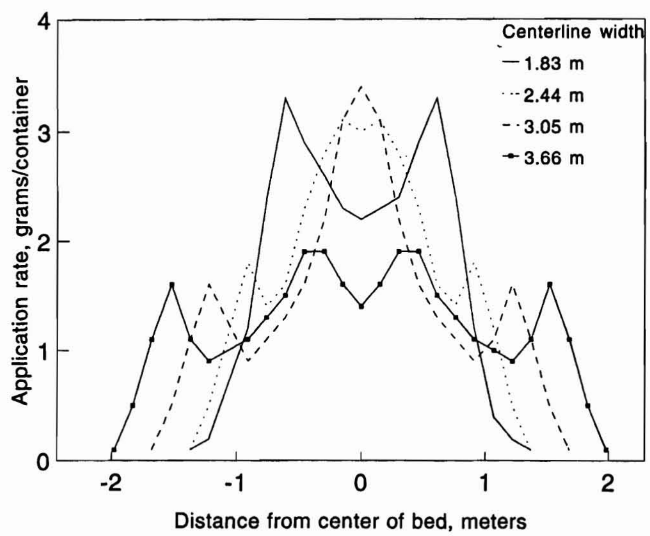

Fig. 6. Overlapped patterns with clay granules under 'standard' conditions for a range of container bed widths. Widths shown are distances between spreader centerlines.

2. Gilliam, C.H., W.J. Foster, J.L. Adrain, and R.L. Shumack. 1990. A survey of weed control costs and strategies in container production nurseries. J. Environ. Hort. 8:133–135.

3. Inns, F.M. and A.R. Reece. 1962. The theory of the centrifugal distributor II: motion of the disc, off-center feed. J. Agri. Eng. Res. 7:345–353.

4. Mennel, R.M. and A.R. Reece. 1963. The theory of the centrifugal distributor III: particle trajectories. J. Agri. Eng. Res. 8:78–84.

5. Patterson, D.E. and A.R. Reece. 1962. The theory of the centrifugal distributor I: motion on the disc, near-center feed. J. Agri. Eng. Res. 7:232–240.

6. Parish, R.L. 1987. The effect of speed on performance of a rotary spreader. Appl. Eng. Agri. 3:17–19.

7. Parish, R.L. 1991. Effect of an adjustable drop point on turf fertilizer spreader patterns. Appl. Eng. Agri. 7:5–9.

8. Parish, R.L. and P.P. Chaney. 1985. Evaluation of a rotary spreader with a helical cone for drop point control. Trans. ASAE 28:1440–1444.

9. Parish, R.L. and P.P. Chaney. 1986. Pattern sensitivity to location of fertilizer drop point on a rotary spreader impeller. Trans. ASAE 29:374–377.

10. Parish, R.L. and P.P. Chaney. 1986. Speed effects on drop-type spreader application rate. Appl. Eng. Agri. 2:94–96.

11. Porter, W.C. and R.L. Parish. 1993. Nontarget losses of granular herbicide applied to container-grown ornamentals. J. Environ. Hort. 11:143–146.

Advantages of Using Selected Seed Sources of Sycamore and Sweetgum for Field Nursery Production and Transplant Establishment[1]

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Abstract

Adaptability of forest tree improvement program seed sources to landscape nursery production and subsequent bare-root transplanting were investigated. Growth during two years of field production of seedlings from two elite half-sib families of sycamore (*Platanus occidentalis* L.) and a bulk open pollinated seed orchard mix of sweetgum (*Liquidambar styraciflua* L.) were compared with a commercially available seed source of sweetgum and a locally collected half-sib family of sycamore. Utilization of select half-sib families of sycamore resulted in 11% to 19% increases in height and an 11% increase in caliper during field production compared to the local seed source. Seedlings from elite half-sib families of sycamore resumed limited height and caliper growth during the year following transplanting while seedlings from the local seed source did not. Less pruning cuts were required to remove multiple leaders and large basal suckers on elite sycamore and sweetgum seedlings during production.

Index words: field production, transplant establishment, provenance, seed source, bare-root, genetic improvement, technology transfer.

Species used in this study: American sweetgum (*Liquidambar styraciflua* L.); sycamore (*Platanus occidentalis* L.).

Significance to the Nursery Industry

Simply changing the genetic source of seeds used to produce sycamore and sweetgum seedlings can significantly improve seedling growth and/or may reduce pruning requirements under field nursery conditions. Larger plants should command premium prices. Reduced pruning could mean fewer person-hours resulting in potential labor cost savings. In addition to increased growth during production, this study demonstrates that improvement in initial post-transplant establishment of large bare-root trees may be possible with appropriate seed source selection. Post-transplant performance is the ultimate measure of the post-harvest quality of nursery stock. While these early results are promising, many questions remain unanswered. For example, provenances, seed sources, and selected half-sib families need to be tested in each geographical area and production regime in which they are used as their relative performance may vary depending on environmental conditions (10, 11). Additionally, this paper deals only with the production and initial transplant establishment phases and should not be used as an indication of long term landscape performance of the seed sources.

Introduction

Use of genetically improved seed sources is common practice in the production of agronomic and floricultural crops (4), while such resources are not generally utilized in sexually reproduced nursery crops. Superior clonal selections of many nursery crops are widely use in the nursery trade, but many desirable landscape trees cannot be easily vegetatively propagated (3). Nurserymen typically collect seed of these

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