HortScience 21(2):323–325. 1986.

PVC Roller Conveyor Benches for Seedling Greenhouses

Norman T. Sletteland[1]
College of Agriculture, University of Hawaii–Hilo, Hilo, HI 96720

B.A. Kratky[2]
Beaumont Agricultural Research Center, University of Hawaii, Hilo, HI 96720

Additional index words. greenhouse transport system, moving benches, automated greenhouse system, conveyor bench

There is much current interest in improving materials handling in commercial greenhouses. Two areas of concern are reducing labor costs and maximizing bench growing areas. Transport of materials is labor intensive in the conventional bench-and-aisle greenhouse, and the loss of bench growing area to walkways is costly and inefficient.

Transport of materials in greenhouses has been accomplished with conveyor belts (2), various rail systems (1, 2, 5), and movable growing tables or trays (5, 8). Conveyor rollers have long been used to transport materials for numerous industrial and warehousing operations (3), but corrosive conditions in greenhouses and high cost have discouraged their use. Recently, a sophisticated powered roller conveyor system has been used in a greenhouse operation for centralized shipping (8).

Use of greenhouse space has been improved with methods ranging from simple benching arrangements to the use of complex devices such as the Ferris wheel (6). Laterally moving bench systems have also been devised to eliminate aisles (4, 6, 7).

The intent of this project was to devise an economical, corrosion-resistant greenhouse bench that can be loaded from one end and transport seedling trays to the other and provide maximum use of greenhouse area.

This paper describes the design of a simple roller conveyor bench system constructed with readily available building materials that are corrosion and decay resistant. The bench system is designed to hold and transport a continuous bed of expanded polystyrene seedling trays (34 × 67 cm) loaded to 20 $kg \cdot m^{-2}$, hereafter referred to as a load factor of 1.0.

Illustrations of the roller conveyor bench system are shown in Fig. 1. Seedling trays are placed on one end of the roller bench and pushed down the line by each additional row of trays. Trays are then collected from the opposite end when they are ready for transplanting. Rollers consist of 1.4-m lengths of 10-cm diameter polyvinyl chloride (PVC) drain pipe (ASTM D-2729). End plugs were

Received for publication 27 June 1984. This work was supported in part by a Governor's Agriculture Coordinating Committee grant from the state of Hawaii. We gratefully acknowledge the assistance of L. Child. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

[1]Assistant Professor of Agricultural Engineering.
[2]Horticulturist.

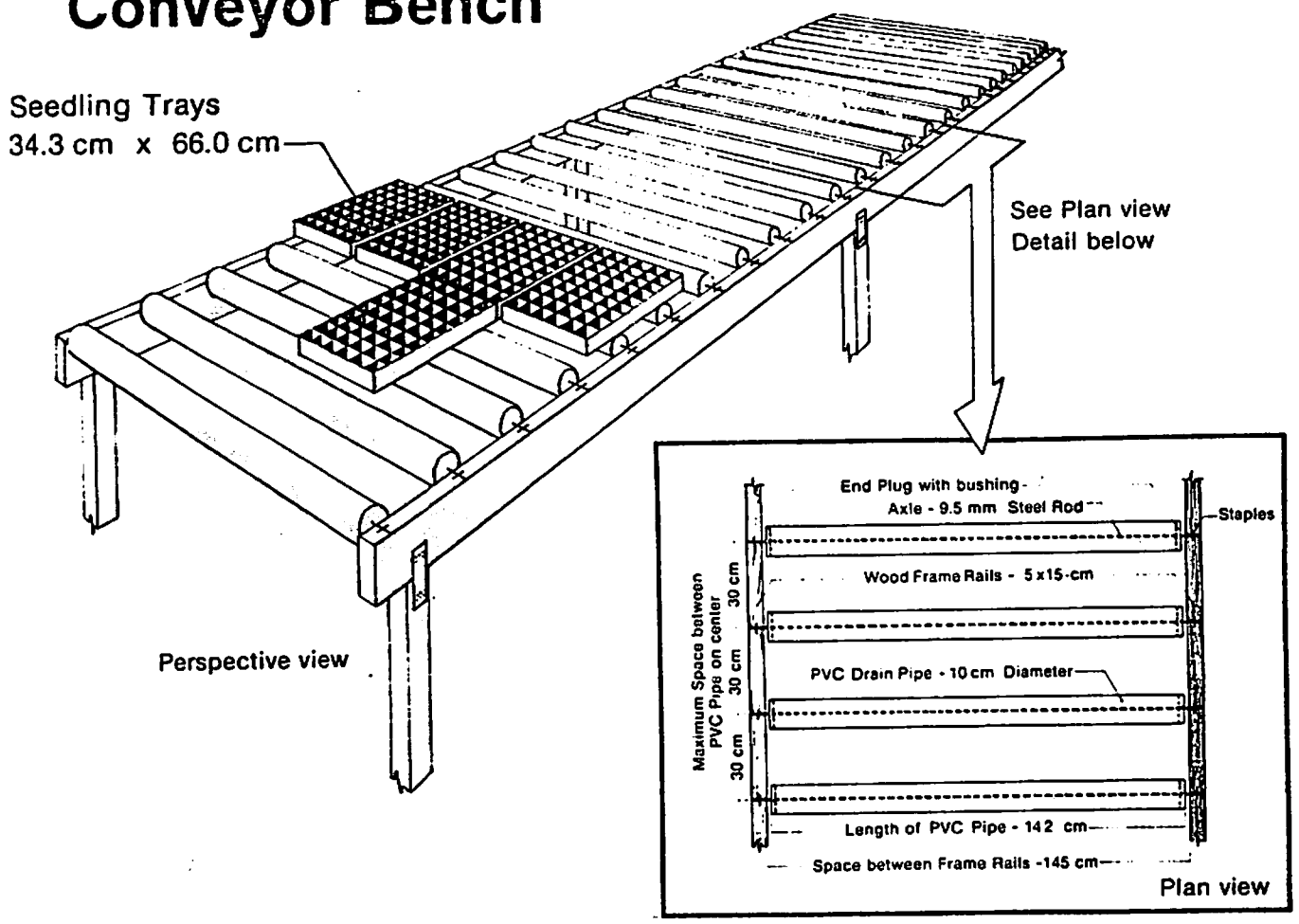

Fig. 1. An illustration of a polyvinyl chloride (PVC) roller conveyor bench.

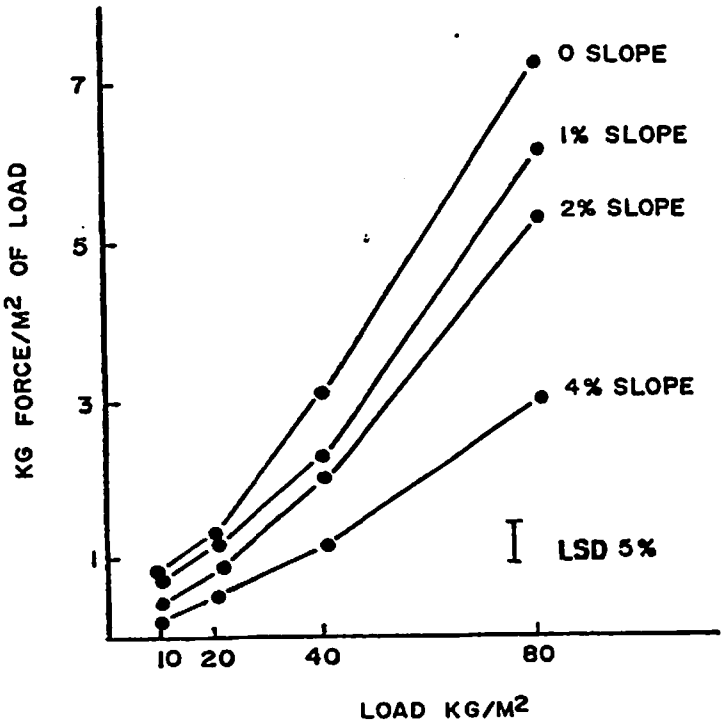

Fig. 2. Breakaway forces required to move 10–80 kg·m^{-2} loads on 10-cm diameter PVC rollers at 0–4% bench slopes.

fabricated from 1.9-cm thick treated plywood, with drilled holes (1.3 cm) as the bearing surface. Plastic end plugs with bushings were commercially available only for schedule 80 pipe with diameters up to 7.5 cm (Ralphs-Pugh Co., Benecia, Calif.). Rollers were suspended between wooden frame rails with 9.5 mm × 1.5-m long, cold-rolled steel axles. The 5 × 15-cm treated frame rails were supported by wooden posts at 3-m intervals. To eliminate upsetting of the trays between rollers, the maximum satisfactory spacing between rollers was determined to be 30 cm, since this distance ensured that the loaded tray was supported by at least 2 rollers at all times. This roller spacing and tube length performed acceptably through a load factor of 4.0 (80 kg·m^{-2}).

At a 30-cm roller spacing and load factor of 1.0, the maximum uniform load on any individual roller was 13.5 kg. This load caused a midpoint deflection of only 1.5 mm. After 18 months in a greenhouse, where daytime temperatures of 30° to 38°C were common, a midpoint sag of 5 mm was noted and resulted in only a negligible bobbing effect of the trays as they passed over the rollers. However, the sag was only 1.5 mm for rollers outside the greenhouse, where temperatures usually reach 21° to 27°.

Performance data were obtained under laboratory conditions at a temperature of 25°C. Maximum force required to move the bed of trays occurred as the roller initiated rotation (breakaway force). Breakaway forces were determined by measuring the force required to initiate movement of a 12-tray bed (2.8 m^2) with uniform loads ranging from 10 to 80 $kg \cdot m^{-2}$. As expected, breakaway forces decreased as the downward slope of the bench increased. At a load factor of 1.0 (20 $kg \cdot m^{-2}$), the breakaway forces required to move the load were 1.36, 1.18, 0.86, and 0.57 $kg \cdot m^{-2}$ of bed for 0%, 1%, 2%, and 4% bench slopes, respectively (Fig. 2). Also, the force required to move a load factor of 4.0 was more than 4 times the force required to move a load factor of 1.0 for a given bench slope. Some of this decreased efficiency was due to increased midpoint flexing of the rollers at the heavy loads. Trays were required to travel in a slightly uphill fashion when they boarded the next roller that was carrying a smaller percentage of tray load and therefore was flexed less at that moment.

The breakaway force required to move a longer bed of trays (10 m long × 1.4 m wide) on a roller conveyor with 2% slope in a seedling greenhouse was 22% greater than in the laboratory. A slight binding of the trays, due to a variable alignment of axles, was a probable contributing factor.

Copper bushings consisting of 2-cm lengths of 1.3-cm diameter copper tubing were inserted into the wooden end plugs in an attempt to improve the bearing surface between the axle and the plug. The improved bearing surface reduced breakaway force by 30%. Once person could then move a 10-m bed of trays easily and may be able to move beds of trays up to 30 m long without a mechanical drive system.

Given acceptance of this roller conveyor design, manufacturers will likely produce PVC end plugs with bushings for the 10-cm diameter PVC drain pipe roller tubes. This production, along with improvements in axle coatings, will provide reduced breakaway forces and a high degree of corrosion resistance to fertilizers, pesticides, and high moisture conditions.

The PVC roller conveyor bench system has several noteworthy advantages: a) it serves to transport and support seedling trays that are loaded from one end and removed from the opposite end when the seedlings are ready to transplant; b) the need for aisles is eliminated as is the labor required to carry the trays to a bench location; c) PVC rollers and end plugs with bushings are resistant to corrosive conditions found in greenhouses; and d) a PVC roller conveyor bench is relatively inexpensive and can be fabricated with readily available materials by greenhouse workers.

Literature Cited

1. Damen, P.C. 1979. A new internal transport system in spray carnation growing. Vakblad Voor De Bloemisterij 34:26–27.
2. Hendrix, A.T.M. 1975. Transport systems in glasshouse horticulture. Netherlands J. Agr. Sci. 23(3):2231–237.
3. Kulevie, R. 1974. Package and unit handling conveyors. Plant Eng. 28(12):122–128.
4. Labowsky, H.J. 1977. Mobile glasshouse benches. Deutsch. Gartenbau 31:1372–1373.
5. Onstenk, R. 1979. Internal glasshouse transport need not always be expensive. Vakblad Voor De Bloemisterij 34:68–73.
6. Poole, H.A. and P.C. Badger. 1980. Management practices to conserve energy in Ohio greenhouses. Ohio Agr. Res. Dev. Ctr. Spec. Circ. 104.
7. Wlowski, J. 1978. A mobile greenhouse bench. Ogrodnictwo 15(7):181–183.
8. Young, R.E. and D.D. Murphy. 1982. Centralized shipping for an ornamental greenhouse. Trans. Amer. Soc. Agr. Eng. 25:872–875.