Solid set canopy delivery system: An efficient way to deliver agrochemicals in orchards and vineyards

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Introduction

Washington State (WA) holds **1st** and **2nd** ranks in the US for production of fresh market apples and wine grapes, respectively.

Air-assisted sprayers:

- ❑ Most common spray application equipment in WA orchards and vineyards (Figs. 1a, 1b).
- ❑ Only 29%-56% of applied chemical is deposited onto the canopy.
- ❑ Remaining drifts to off-target locations (Fig. 1c).

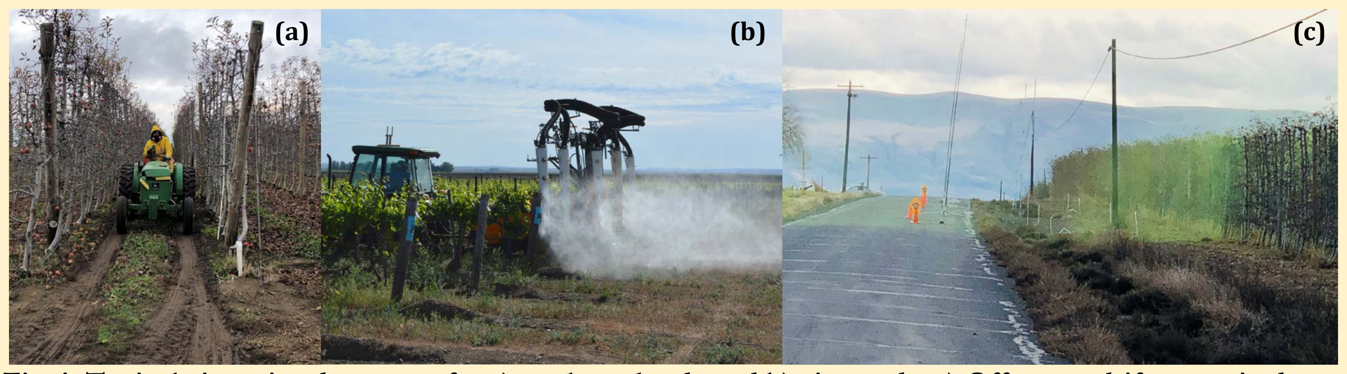

Fig. 1. Typical air-assisted sprayers for a) apple orchards and b) vineyards. c) Off-target drift scenario due to operation of a typical air-assisted sprayer in an apple orchard.

Potential Solution

A solid set canopy delivery system (SSCDS):

- ❑ Variants of fixed spray systems with emitters and spray lines preinstalled in the crop canopy.
- ❑ Spraying is achieved without air-assist, hydraulic spray delivery (HSD).

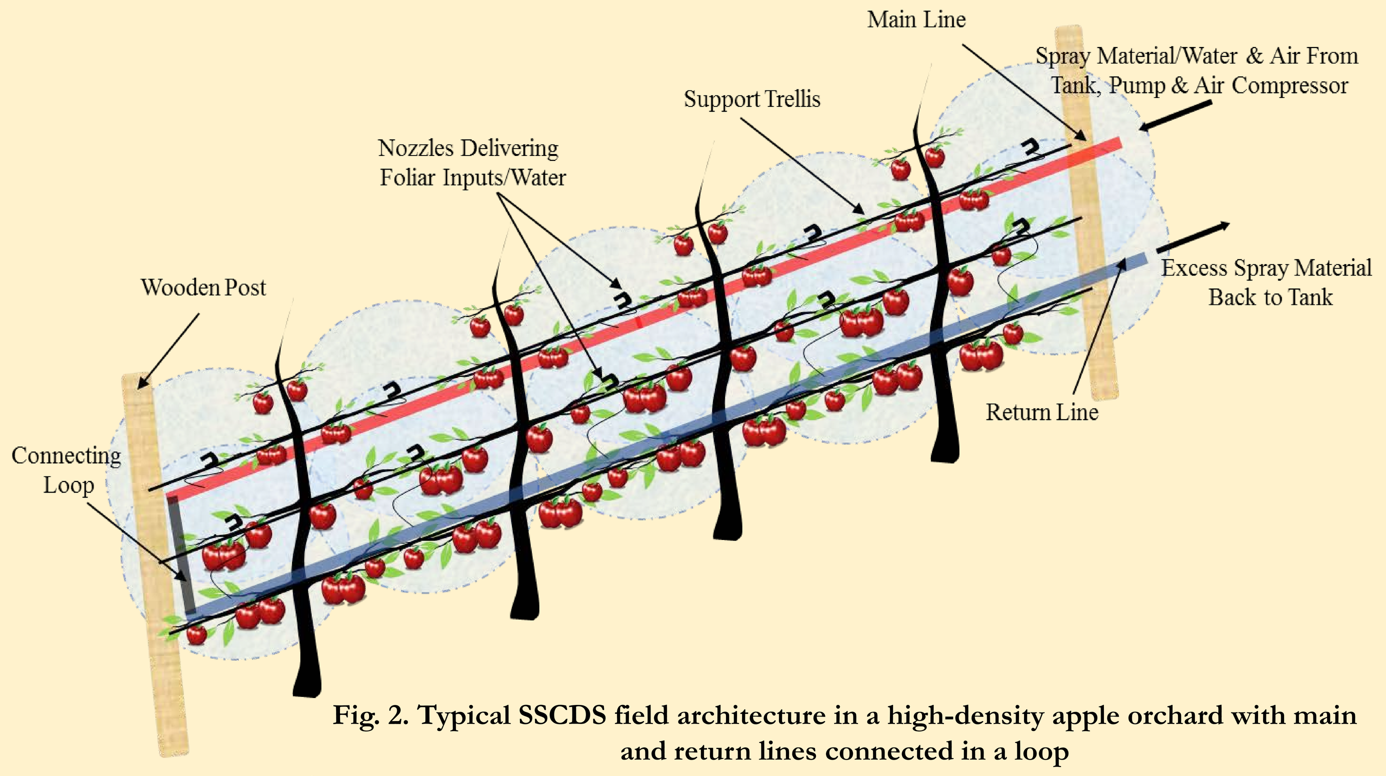

Fig. 2. Typical SSCDS field architecture in a high-density apple orchard with main and return lines connected in a loop

Research gaps

Field scale optimization of SSCDS: Emitter selection, placement and scalability.

Objectives

1. Optimization of SSCDS for high-density apple orchards and vineyards.
2. Development of a reservoir based pneumatic spray delivery (PSD) system for uniform application of chemicals for larger row lengths.

Materials and methods

System development: Objective 1

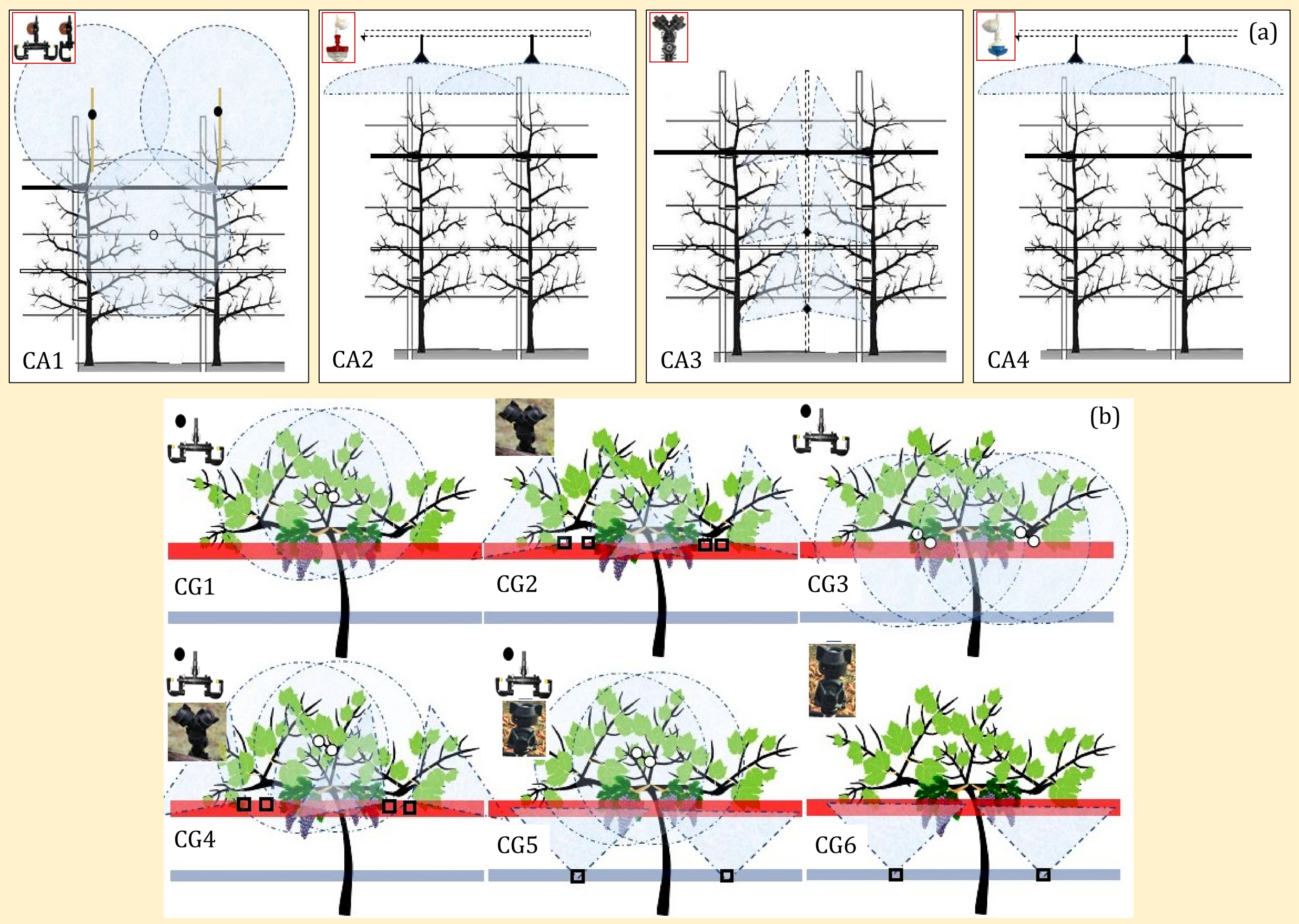

Fig. 3. Schematics (not drawn to scale) of SSCDS configurations evaluated in a) high-density apple orchard and b) vineyard (emitters used are shown in the insets).

Materials and methods

System development: Objective 2

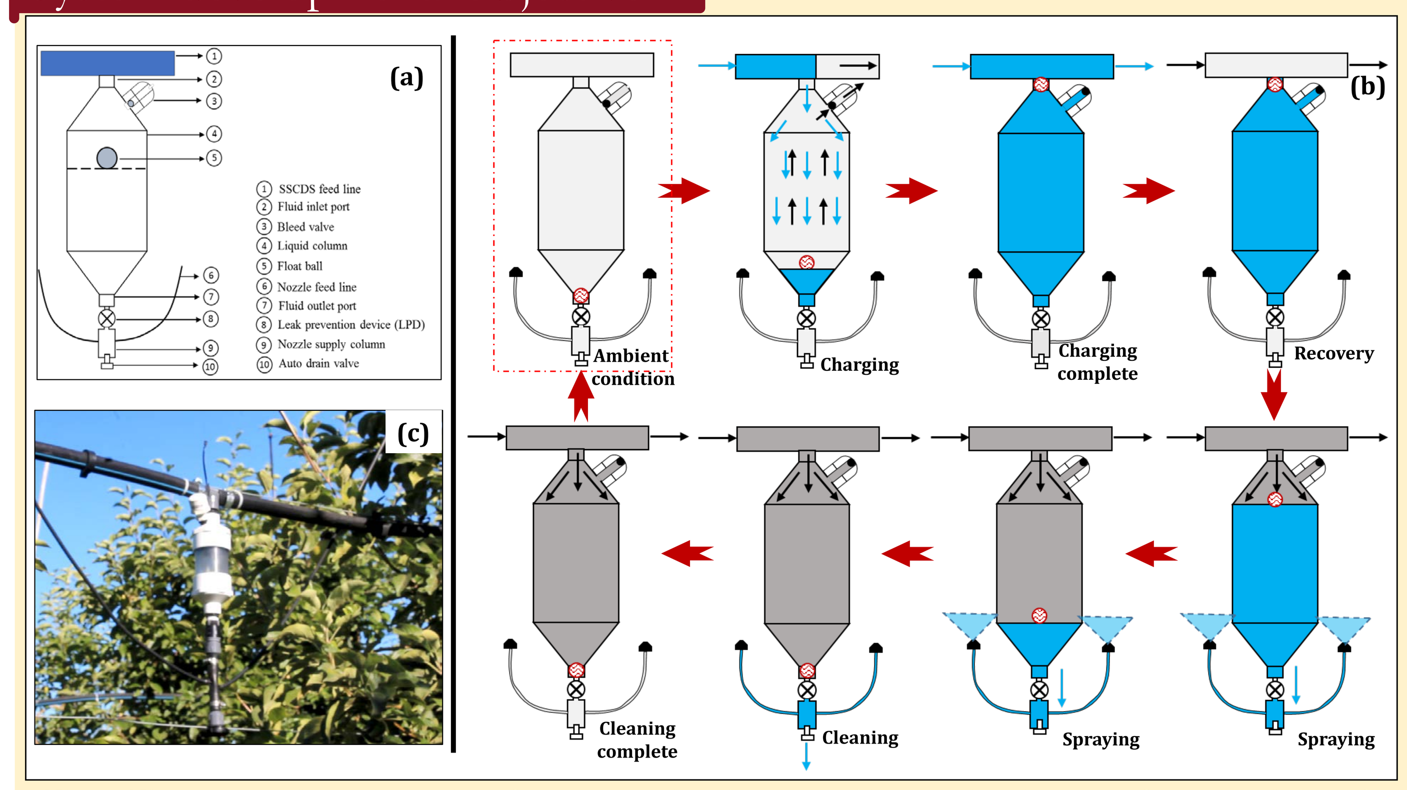

Fig. 4. Figures showing schematics of a) a reservoir sub-system, b) operational stages of a reservoir based PSD system and c) field installation of a PSD based SSCDS

Experimental protocol

- ❑ **Treatments**: SSCDS configurations (different emitter types and mounting), airblast as a control.
- ❑ **Response variable**: Spray deposition (Mylar cards: Fig. 5a) and coverage (WSP: Fig. 5b) at different canopy zones and leaf surfaces.
- ❑ **Mylar cards and WSPs**: Fluorometry (Fig. 5c), image processing (Fig. 5d).
- ❑ **Experimental design**: Randomized split-split-plot/CRD

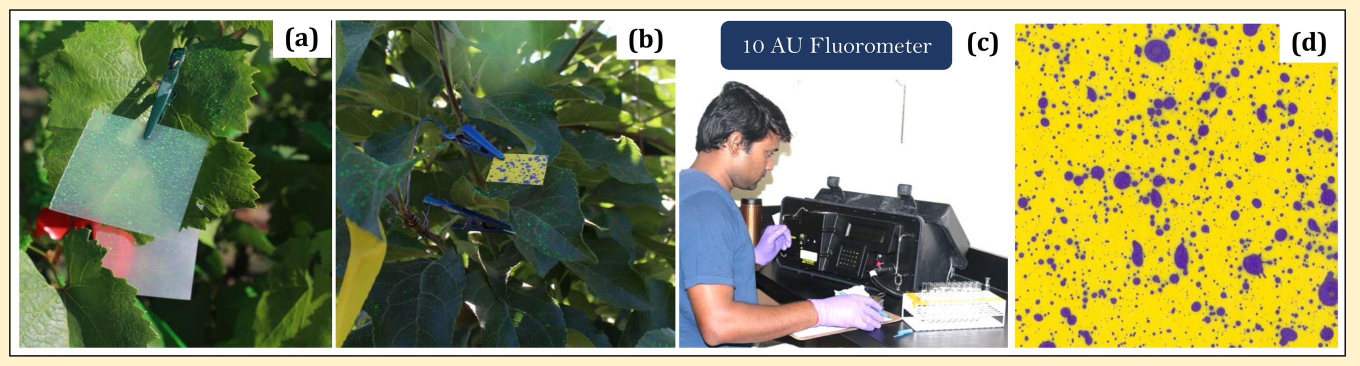

Fig. 5. a) Mylar cards and b) water sensitive paper (WSP) samplers for quantifying spray deposition using c) fluorometry analysis, and spray coverage using d) image processing technique, respectively.

Results

Objectives 1

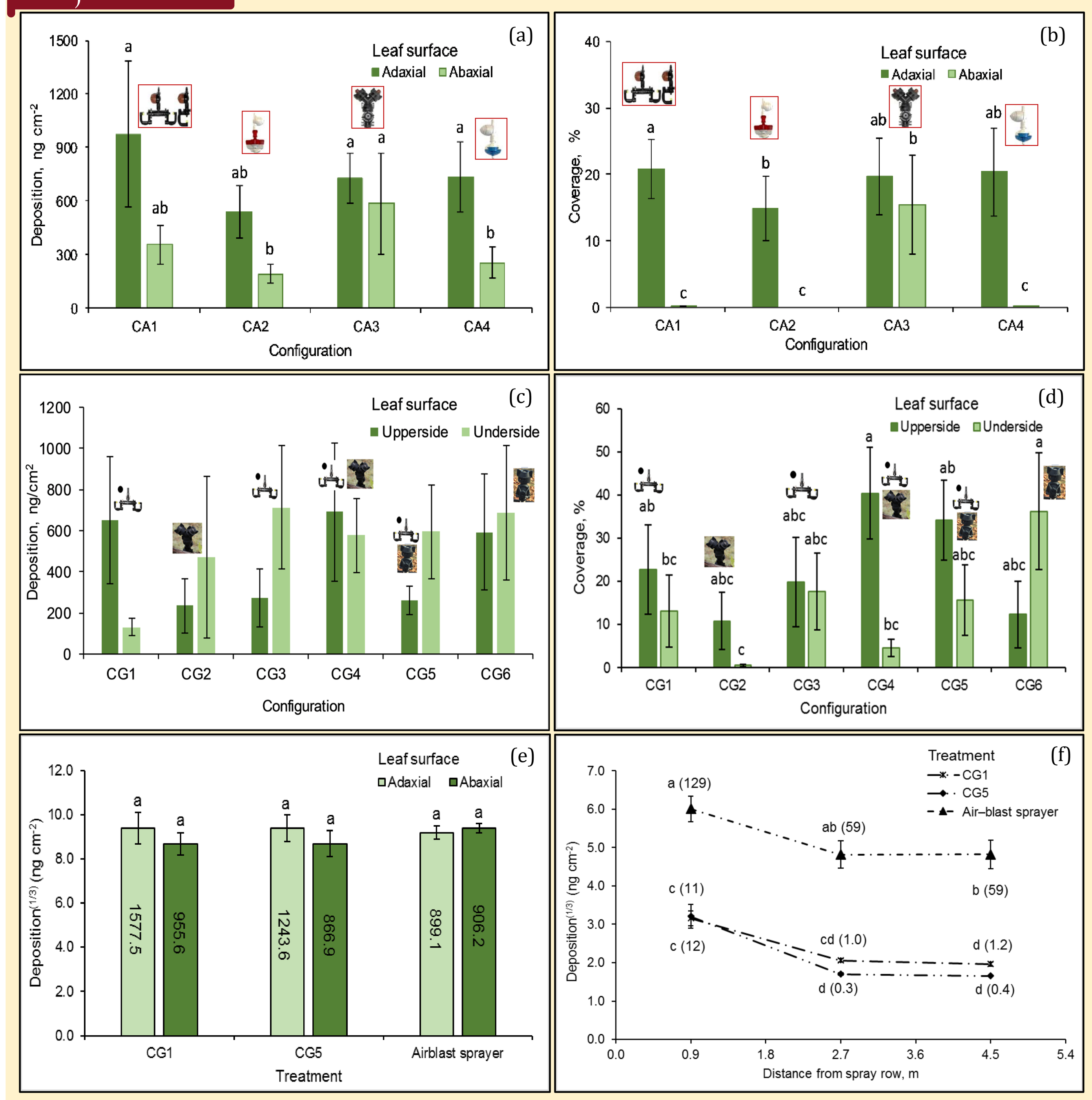

Fig. 6. Mean spray deposition and coverage for SSCDS configurations in apple (a, b) and grapevine (c, d). Mean e) spray deposition and f) off-target drift for optimized SSCDS configurations and an airblast sprayer.

- ❑ **CA3 (hollow cone emitters in 3-tier)**: Adequate spray performance.
- ❑ **CG5 and CG1**: Most optimal and simplest grapevine configuration.
- ❑ **SSCDS configuration**: Similar deposition, significantly lower drift compared to an airblast sprayer.

Results

Objectives 2

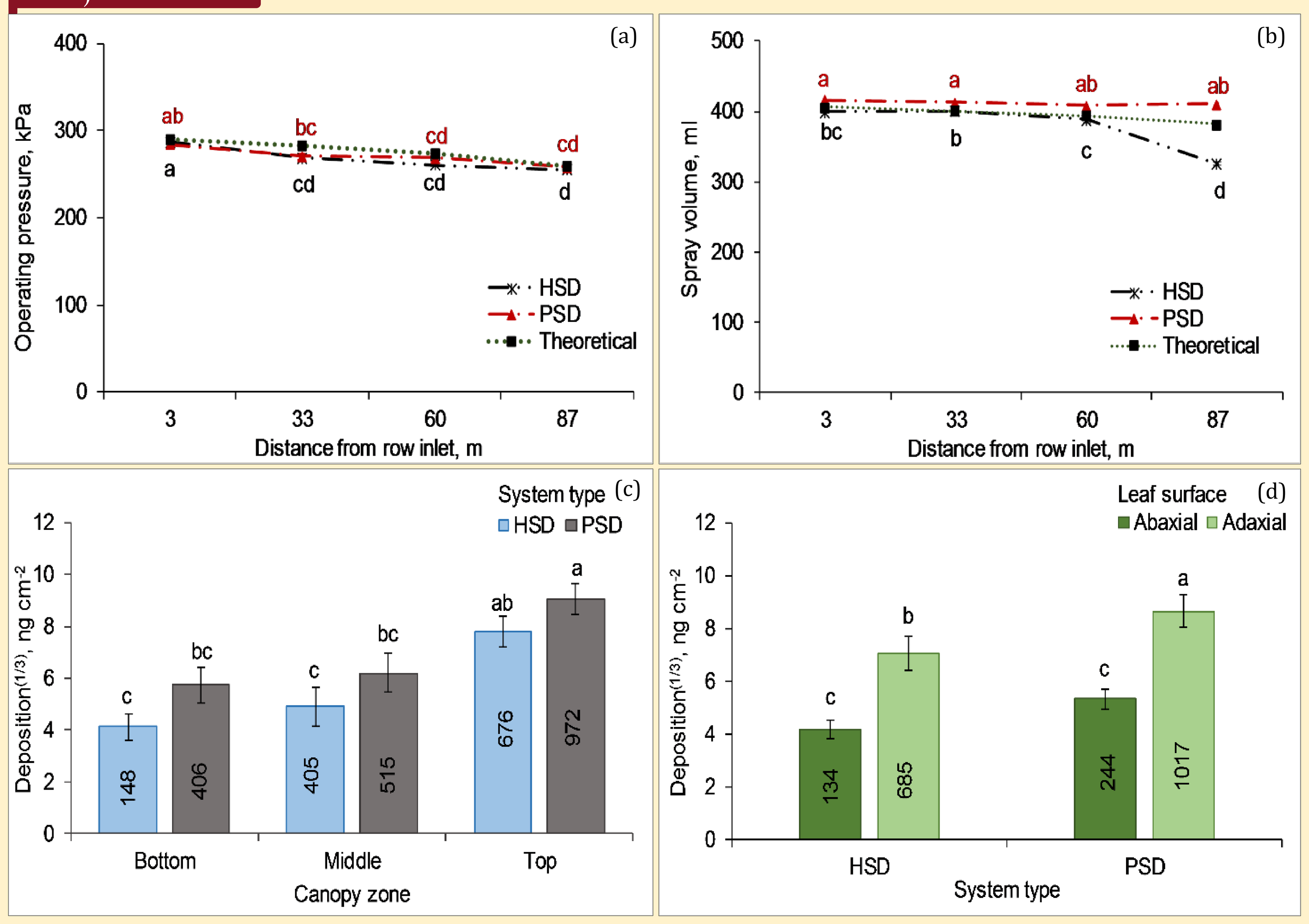

Fig. 7. Variation in a) operating pressure and b) spray output at different distances from the row inlet and mean spray deposition in different c) canopy zones and d) leaf surfaces for the PSD and HSD based SSCDS.

PSD and HSD systems: Similar drop in system operating pressure.

PSD system:

- ❑ Uniform spray output at different locations in the tree row.
- ❑ Consistently higher spray deposition in different canopy zones and leaf surfaces compared to the HSD system.

Conclusions

- ❑ **Optimal SSCDS for high-density apple orchards**: Emitters at multiple canopy locations, spraying upward.
- ❑ **Optimal SSCDS for vineyards**: Emitters in two tier, upper canopy emitters spraying down and below canopy emitters spraying up.
- ❑ **Hollow cone emitters**: Finer droplets, better penetrability.
- ❑ **PSD system**: Uniform spray application even under reduced system operating pressure.
- ❑ **Optimized SSCDS**: A pneumatic spray delivery (PSD) with emitters at multiple canopy locations.

Future directions

- ❑ Modification of low-cost irrigation emitters to mimic the spray profile of relatively expensive hollow cone emitters.
- ❑ Season long pest management in orchards and vineyards with optimized SSCDS.
- ❑ Further optimization of SSCDS in different tree-fruit and berry crop architectures.

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