Effects of Tree Canopy and Weather on Pesticide Drift from California Orchards and Vineyards

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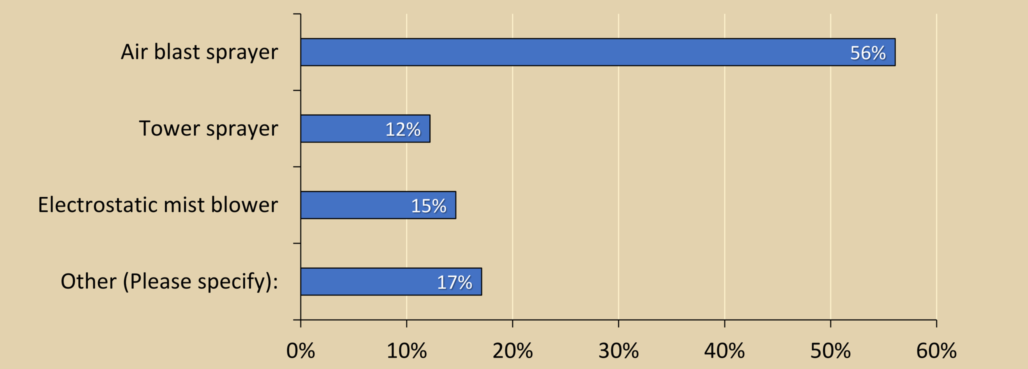
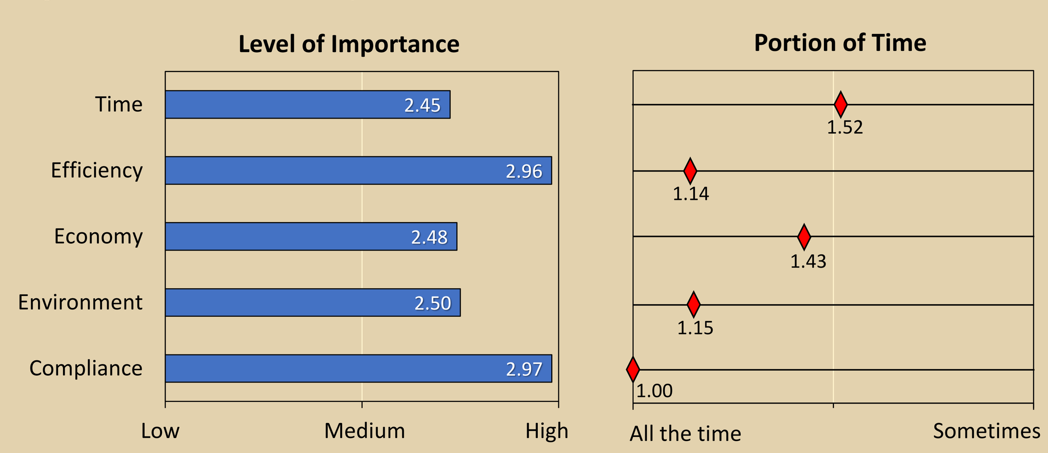
Introduction

Sprayer ownership/use by San Joaquin Valley specialty perennial crop producers (*Source: 2019 Agricultural Application Engineering Program needs assessment*).



Importance of spray related productivity issues to San Joaquin Valley specialty perennial crop producers (*Source: 2019 Agricultural Application Engineering Program needs assessment*).



Needs and Opportunities

- Need to base airblast spray drift estimation on actual application parameters used in real situations.
- Need for new data from orchard/ vineyard field trials to back regulatory estimations.

- Opportunity to improve drift estimation to serve user, registrant, and regulatory community.
- Opportunity to develop best practices for minimizing drift in airblast applications.

Research Objectives

- Provide an evaluation tool that assists user, registrant, and regulatory community
- Support ongoing development of an airblast spray drift model
- Generate spray drift data for aiding airblast spray drift risk assessment model validation

Key: – Specific objective – Short-term goal – Long-term goal

References

1. Larbi, P.A. 2022a. Configuration and Assessment of a Submersible Fluorometer for Evaluating Fluorescent Dye Deposition. *Journal of Testing and Evaluation* 50(3):1286–1298.
2. Larbi, P.A. 2022b. From Flight to Rest – The journey of a droplet. *Agricultural Application Engineering Channel, UC ANR Agricultural Application Engineering Program*. Assessed November 29, 2022. Available online: https://www.youtube.com/watch?v=ylOjgW8D00E.
3. Larbi, P.A., et al. 2022. Evaluation of Downwind Spray Drift from Airblast Spray Applications in Almond, Citrus, and Grape. *ASABE Paper No.* 2200871. St. Joseph, MI.: ASABE.

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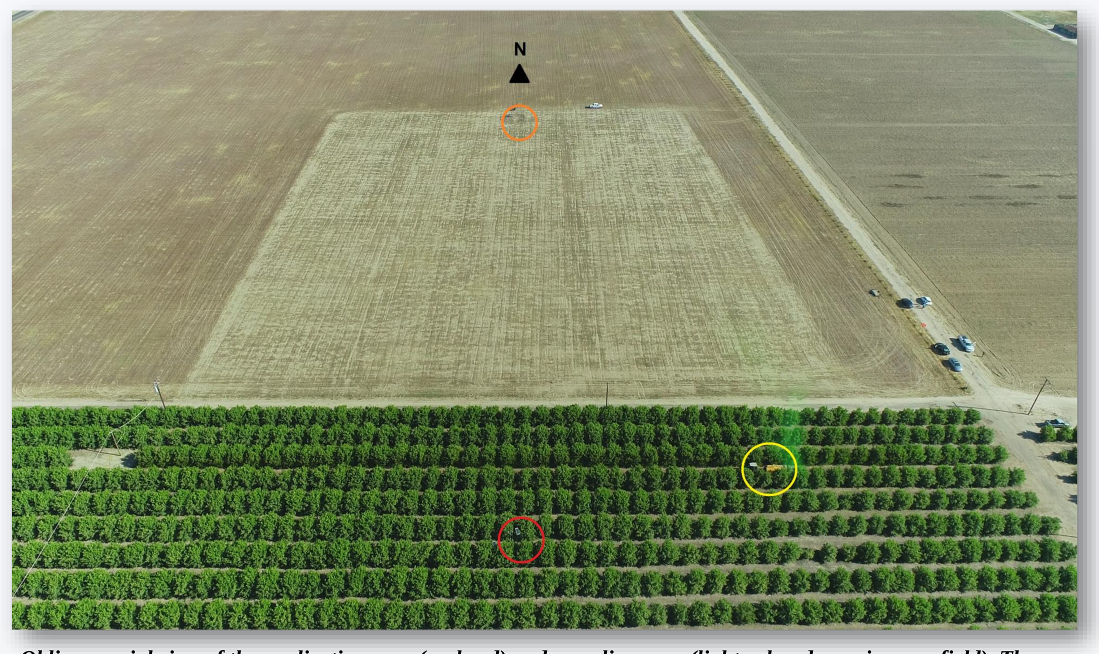
Experimental Methods



Oblique aerial view of the application area (orchard) and sampling area (light colored area in open field). The sprayer (yellow circle) can be seen moving westwards with drifting spray showing as a light green cloud at the rear. The red and orange circles indicate the locations of the weather stations.

Orchard and Tree Canopy Characteristics

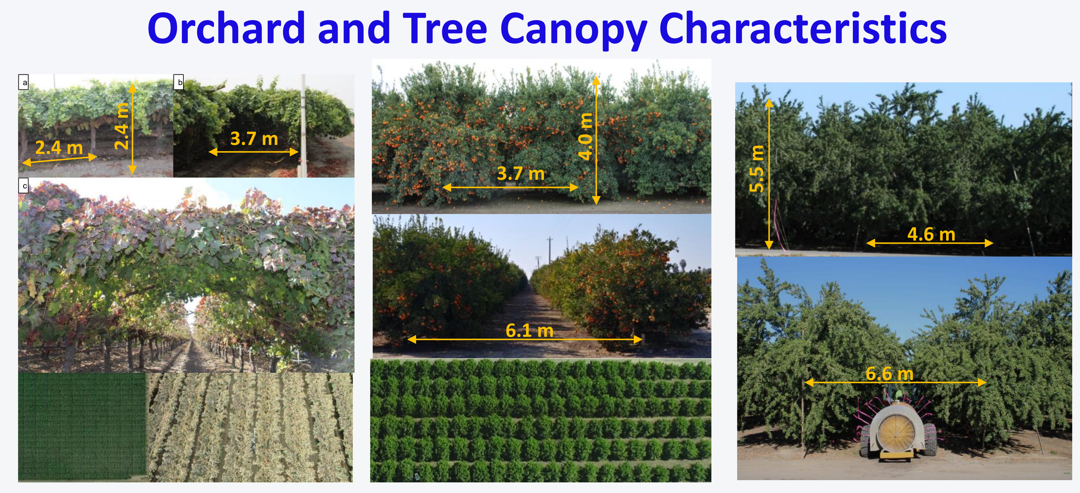
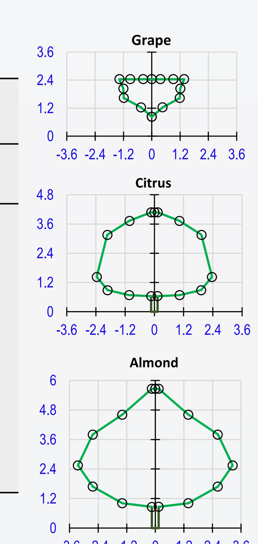


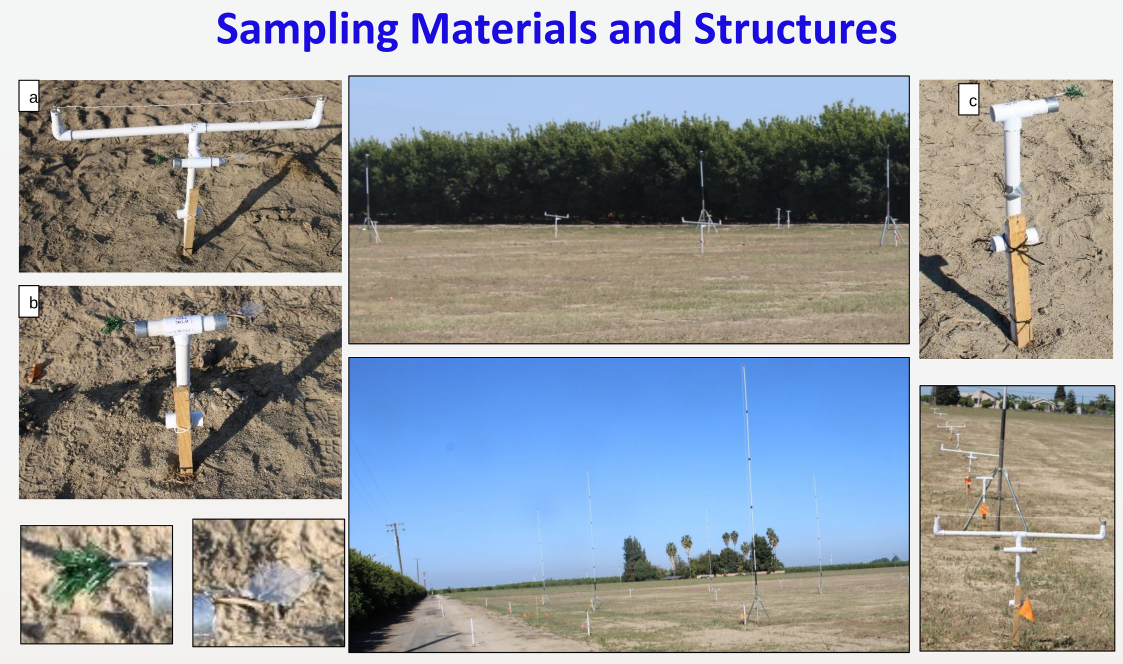
Table. Attributes of target tree/vine and orchard/vineyard used in studies.

Attribute	Tree and Orchard Characteristics		
	Grape	Citrus	Almond
Crop Type/variety	'Vintage Red' variety	Mandarin	'Independence' variety
Tree/Row Height, m (ft)	2.4 (8.0)	4.0 (13.0)	5.5 (18.0)
Canopy Width, m (ft)	2.8 (9.2)	4.7 (15.5)	6.5 (21.3)
Leaf Area Density[a], m^2/m^3	3.4±0.37	3.4±0.47	1.3±0.26
Row Spacing, m (ft)	3.7 (12.0)	6.1 (20.0)	6.6 (21.5)
Tree Spacing, m (ft)	2.4 (8.0)	3.7 (12.0)	4.6 (15.0)
Row direction	E-W	E-W	E-W
Downwind direction	S→N	S→N	N→S
1-way Length of sprayer path[b], m (ft)	181.4 (595.0)	152.4 (500.0)	152.4 (500.0)

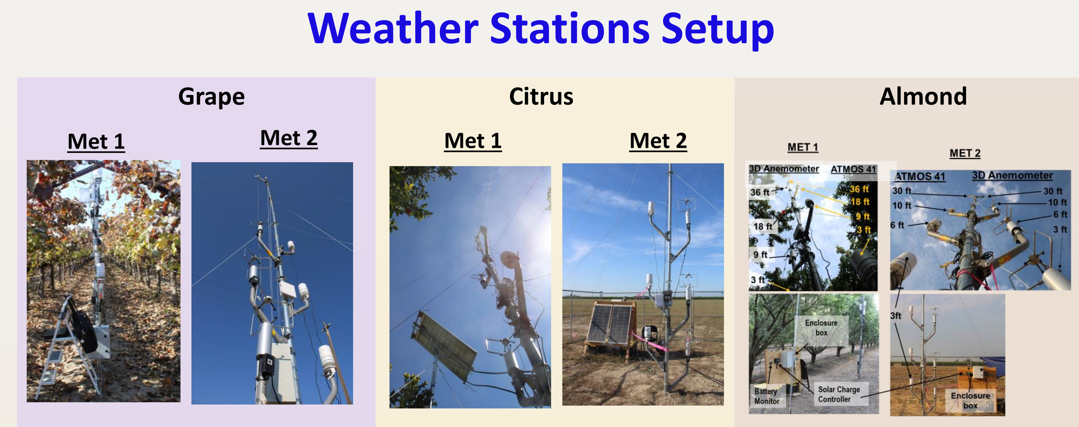
[a] Measurement based on a random sample using a Plant Canopy Analyzer (LAI-2200C, LI-COR, Inc., Lincoln, Nebraska)
[b] Four passes of length considered one run in the study.



Sampling Materials and Structures



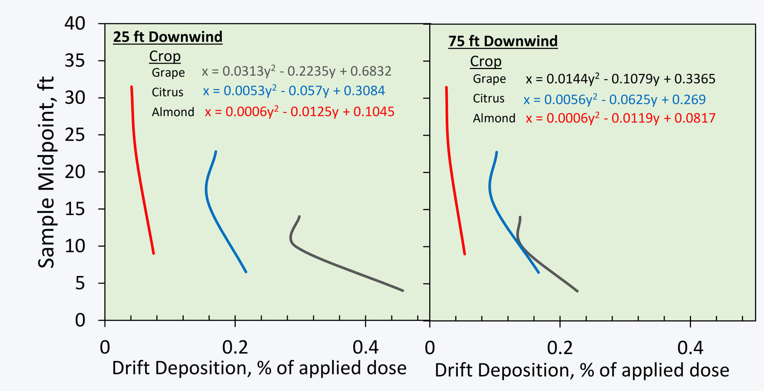
Weather Stations Setup



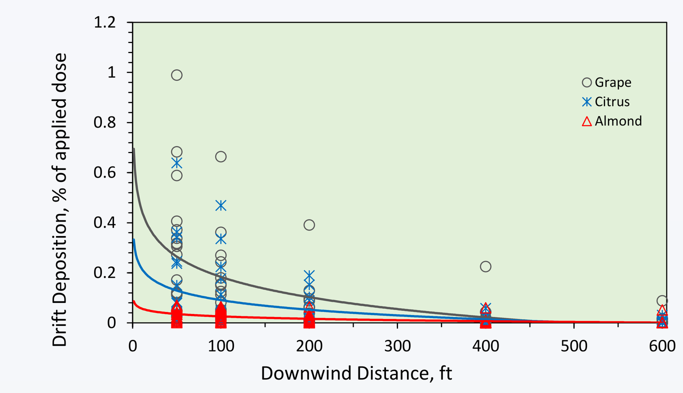
Experimental Results

Off-Target Spray Drift

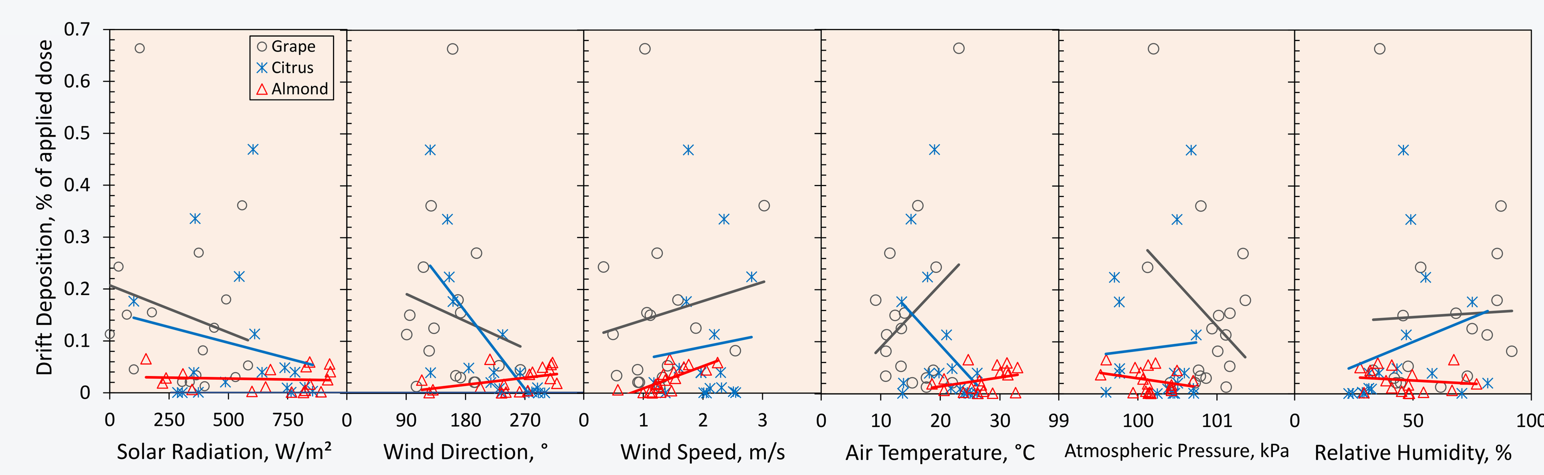
Airborne Drift



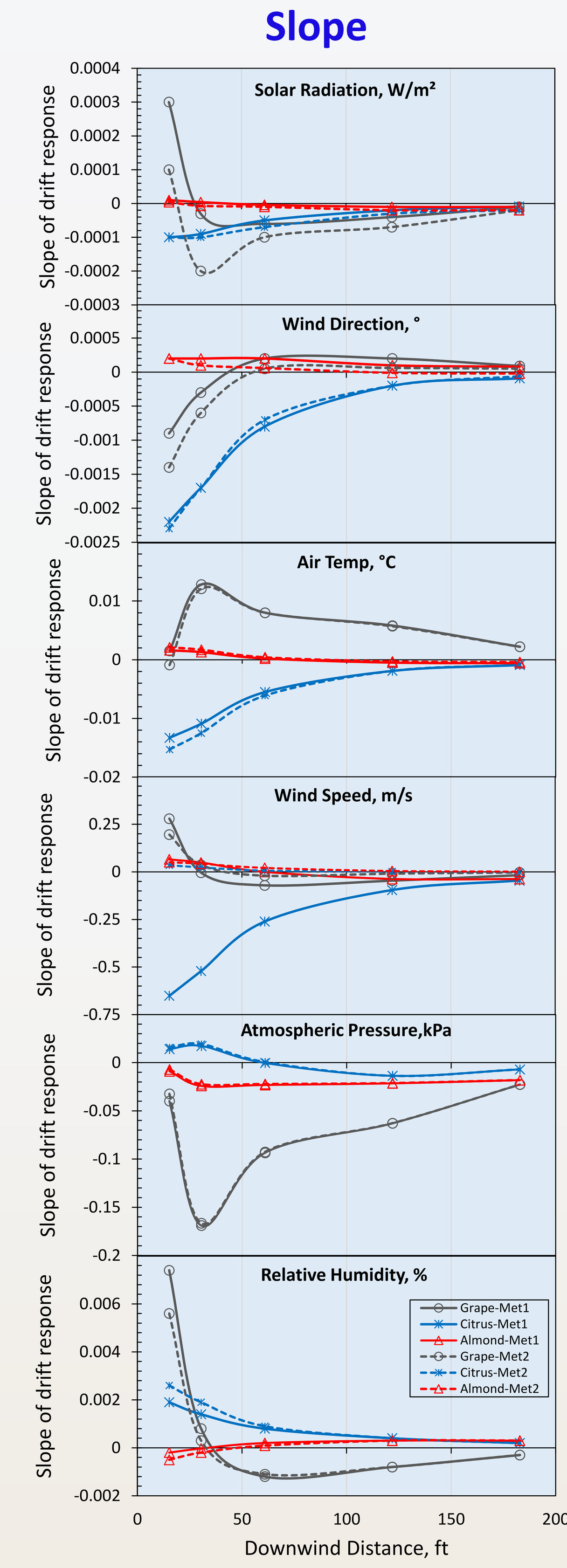
Downwind Drift



Drift Response to Weather Parameters



Trends of Drift Response Slope

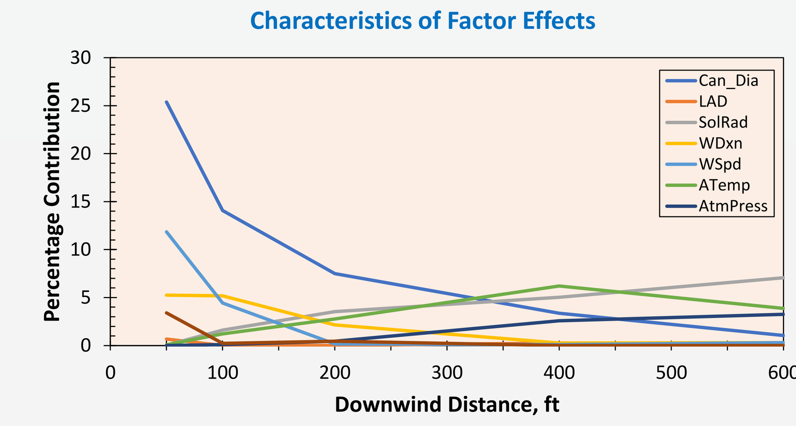


Effects of Crop Characteristics and Weather Parameters

Table. Effects of crop characteristics and weather parameters on drift based on Multiple Linear Regression at 0.05 significance level.

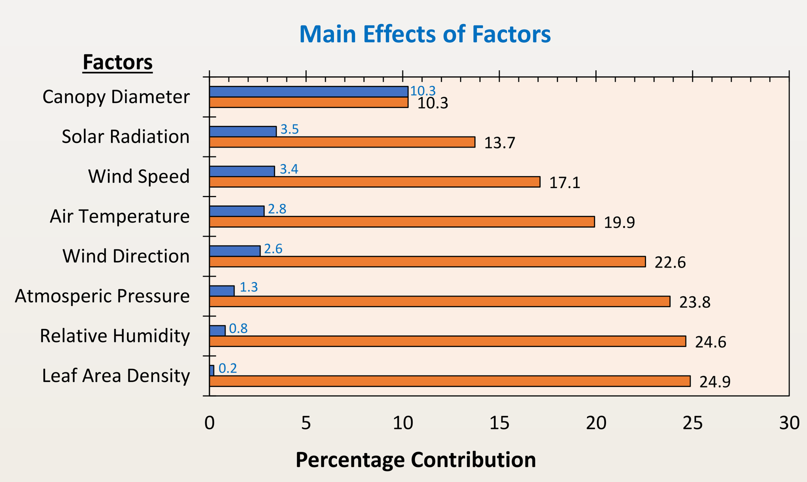
Downwind Distance	Significance of Influence on Spray Drift									
	Crop Characteristics				Weather Parameters					
	Can_Dia	Tree Hght	LAD	Row Spacing	SolRad	WDxn	WSpd	ATemp	AtmPress	RH
15.2 m (50 ft)	S	-	NS	-	NS	S	S	S	NS	S
30.48 m (100 ft)	NS	-	NS	-	S	S	S	NS	NS	NS
60.96 m (200 ft)	NS	-	NS	-	S	S	NS	NS	NS	NS
121.92 m (400 ft)	S	-	NS	-	S	NS	NS	NS	S	NS
182.88 m (600 ft)	NS	-	NS	-	S	NS	NS	NS	S	NS

Characteristics of Factor Effects



Can_Dia = canopy diameter; LAD = leaf area density; SolRad = solar radiation; WDxn = wind direction; WSpd = wind speed; ATemp = air temperature; AtmPress = atmospheric pressure; and RH = relative humidity

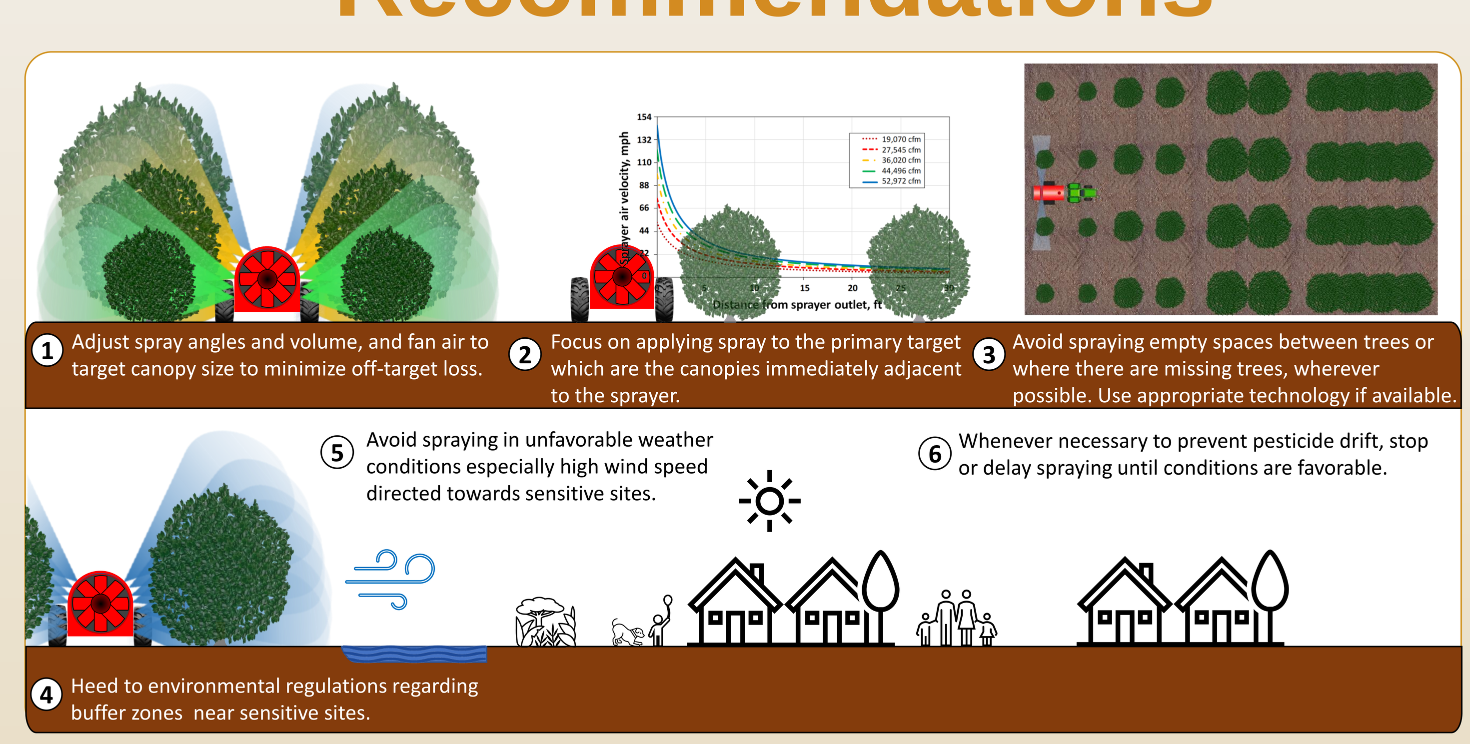
Main Effects of Factors



Conclusions

1. The crops represented three canopy sizes: small – grape; medium – citrus; and large – almond.
2. Airborne drift at downwind distances of 25 ft and 75 ft was greatest in grape, then citrus, and then almond. Airborne drift in grape at the bottom sampling height was significantly greater than both mid height ($p=0.036$) and topmost height ($p=0.045$). Sampling height generally did not have a significant effect on airborne drift.
3. Drift deposit decayed over downwind distance in all crops under varied prevailing weather conditions due to a reduction in the amount of material in the spray cloud as it deposits while dispersing or moving downwind.
4. Drift deposition was highest in grape, then citrus, and then almond, in conformity with the trends in airborne drift. However, based on data from artificial foliage (AF) and horizontal string (HS) samplers, downwind drift deposit completely decayed first in grape (AF – 105.5 m (346.1 ft); HS – 159.8 m (524.3 ft)), then citrus (AF – 129.4 m (424.5 ft); HS – 178.6 m (586.0 ft)), then almond (AF – 531.1 m (1,742.5 ft); HS – 232.8 m (763.8 ft)).
5. Canopy diameter, wind direction, wind speed, air temperature, and relative humidity were significant nearer the orchard/vineyard but the significance dwindled to different extents farther downwind.
6. Solar radiation and atmospheric pressure were initially insignificant until further downwind.
7. Main effect of leaf area density was not significant at all downwind distances.
8. Altogether, all eight factors cumulatively explain about 25% of the variation in downwind drift deposit while the remaining 75% are ascribable to factor interactions (not included in analysis) and uncertainty.
9. Ultimately, canopy diameter emerged as the most influential factor, followed by solar radiation, wind speed, air temperature, etc., in decreasing order of influence.

Recommendations



1. Adjust spray angles and volume, and fan air to target canopy size to minimize off-target loss.
2. Focus on applying spray to the primary target which are the canopies immediately adjacent to the sprayer.
3. Avoid spraying empty spaces between trees or where there are missing trees, wherever possible. Use appropriate technology if available.
4. Heed to environmental regulations regarding buffer zones near sensitive sites.
5. Avoid spraying in unfavorable weather conditions especially high wind speed directed towards sensitive sites.
6. Whenever necessary to prevent pesticide drift, stop or delay spraying until conditions are favorable.

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