

# Factors Affecting Risk for the Whitefly-Transmitted Virus Complex in Fall-Grown Squash in Southern Georgia



A

Healthy plant



B

Crumpling of leaves on virus infected plant



C

Severe stunting of virus infected plant



D

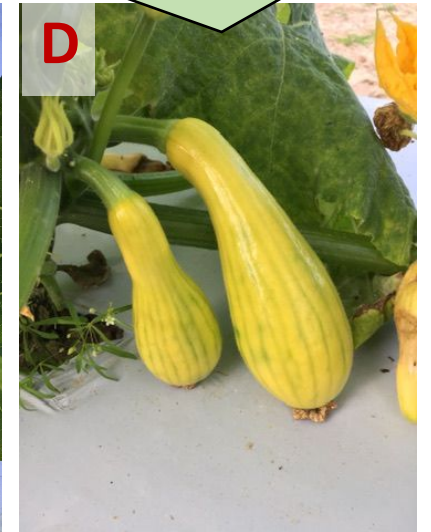
Non-marketable fruits on virus infected plant

# Whitefly-transmitted viruses have emerged as devastating problem in fall grown vegetables particularly squash in southern GA

- ❖ Whitefly-transmitted viruses including cucurbit leaf crumple virus (CuLCrV) and cucurbit yellow stunting disorder virus (CYSDV) cause cucurbit leaf crumple disease complex (CuLCrD).
- ❖ Other whitefly-transmitted viruses that occur in mixed infections include the squash vein yellowing virus (SqVYV) and cucurbit chlorotic yellows virus CCYV)

Increased tolerance in whiteflies to commonly used insecticides and high whitefly populations in fall renders management by insecticide application insufficient

Management of these viruses in fall is challenging as resistance to CuLCrV and CYSDV in commercial cultivars is not available



# Yield losses worth millions of dollars are likely to occur with high whitefly populations and outbreaks of whitefly-transmitted viruses

Example: An estimated **35% reduction in squash crop** value was incurred due to severe occurrence of whitefly-transmitted viruses coupled with dry conditions in 2017 fall growing season.

Major Vegetable Crops	% Reduction in Crop Value	Damage (\$ Millions)	Cost of Control (\$ Millions)	Total (\$ Millions)
Watermelon	10.0	14.2	6.0	20.2
Squash (Yellow and Zucchini)	35.0	18.0	20.0	38.0
Tomato	15.0	6.9	22.3	29.2

Source: Little, 2019. 2017 Georgia Plant Disease Loss Estimates.

UGA Cooperative Extension Annual Publication 102-10



# Development of alternative management strategies are needed to reduce losses from CuLCrD in squash

Identification of factors that reduce the incidence of whitefly-transmitted virus complex in squash



Development of a risk assessment index similar to PEANUT Rx, which was instrumental in the area-wide management of tomato spotted wilt virus (TSWV) in peanuts.



**Develop a PEANUT Rx**  
For each of the following factors that can influence the incidence of tomato spotted wilt virus (TSWV) or fungal diseases, the grower or consultant should identify which option best describes the situation for an individual peanut field. An option must be selected for each risk factor unless the information is "unknown". A score of "0" for any variable does not imply "no risk", but that this practice does not increase the risk of disease as compared to the alternative. Add the index numbers associated with each choice to obtain an overall risk index value. Compare that number to the risk scale provided and identify the projected level of risk.

**PEANUT Rx**

**STEP 1**

PEANUT VARIETY	TSWV Points	Leaf Spot Points	Southern Blight Points	Fungal Diseases Points
Georgia Green	30	20	25	unknown
FloRan 137	25	25	20	unknown
Florida Farm	25	20	20	unknown
TUFRunner 311	20	30	15	unknown
Georgia-09B	20	25	20	unknown
FloRan 107	20	25	20	unknown
Georgia-13M	10	30	25	unknown
TUFRunner 207	10	25	20	unknown
Georgia-06G	10	20	20	unknown
Florida-07	10	20	15	unknown
Georgia-07W	10	20	15	unknown
Sultan	10	20	15	unknown
Tilgaard	10	15	15	unknown
Georgia-14N	10	15	15	unknown
Bobby	10	15	10	unknown
Georgia-12Y	5	15	10	unknown

CLASSIC HERBICIDE	TSWV Points	Leaf Spot Points	Southern Blight Points	Fungal Diseases Points
Yes	5	5	NA	NA
No	0	0	NA	NA

CRIP ROTATION WITH A NON-LEGUME CROP	TSWV Points	Leaf Spot Points	Southern Blight Points	Fungal Diseases Points
0	NA	25	25	20
1	NA	15	20	15
2	NA	10	10	10
3 or more	NA	5	5	5

FIELD HISTORY	TSWV Points	Leaf Spot Points	Southern Blight Points	Fungal Diseases Points
Yes	5	5	5	5
No	NA	0	0	0

PLANTING DATE	TSWV Points	Leaf Spot Points	Southern Blight Points	Fungal Diseases Points
Prior to May 1	30	0	10	0
May 1 to May 10	15	5	5	0
May 11 to May 25	5	10	0	0
May 26 to June 10	10	15	0	5
After June 10	15	15	0	5

PLANT POPULATION (final stand, not seeding rate)	TSWV Points	Leaf Spot Points	Southern Blight Points	Fungal Diseases Points
Less than 3 plants per foot	25	NA	0	NA
3 to 4 plants per foot	15	NA	0	NA
3 to 4 plants per foot	10	NA	0	NA
More than 4 plants per foot	5	NA	5	NA

AT-PLANT INSECTICIDE	TSWV Points	Leaf Spot Points	Southern Blight Points	Fungal Diseases Points
None	15	NA	NA	NA
Other than Thimet 20G	15	NA	NA	NA
Thimet 20G	5	NA	NA	NA

ROW PATTERN	TSWV Points	Leaf Spot Points	Southern Blight Points	Fungal Diseases Points
Single Rows	10	0	5	0
Two Rows	5	0	0	0

TILLAGE	TSWV Points	Leaf Spot Points	Southern Blight Points	Fungal Diseases Points
Conventional	15	10	0	0
Reduced	5	0	5	5

**STEP 2**

**CALCULATE YOUR RISK**  
Add your index values from:

	TSWV Points	Leaf Spot Points	Southern Blight Points	Fungal Diseases Points	Risk Category
Plant Variety	...	...	...	...	...
Planting Date	...	...	...	...	...
Plant Population	...	...	...	...	...
At-Plant Insecticide	...	...	...	...	...
Row Pattern	...	...	...	...	...
Tillage	...	...	...	...	...
Classic Herbicide	...	...	...	...	...
Crop Rotation	...	...	...	...	...
Field History	...	...	...	...	...
Empire	...	...	...	...	...
Your Total Index Value	...	...	...	...	...

**STEP 3**

**RISK CATEGORY**

Risk Category	TSWV Points	Leaf Spot Points	Southern Blight Points	Fungal Diseases Points
High Risk	≥ 115	65 - 100	55 - 80	TBD
Medium Risk	70 - 110	40 - 60	30 - 50	TBD
Low Risk	≤ 65	10 - 25	10 - 25	TBD

**STEP 4**

**Choose a Peanut Rx Spray Program**  
After determining your risk level for each fungal disease, use the most conservative fungicide program as a base for developing your per-field prescription spray program.

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The Peanut Disease Risk Index, developed by researchers and extension specialists at University of Georgia, University of Florida, Auburn University, Mississippi State University, and Clemson University is officially known as "PEANUT Rx." To view the fully updated 2017 version of Peanut Rx by the authors based upon data and observations from the 2016 season and access the online calculator, visit [www.peanutrx.com](http://www.peanutrx.com).

# How different production practices and pest management tactics affect incidence of whitefly-transmitted virus complex?



Type of squash

Mulch type

Distance to nearest cotton field

Planting material

Number of days from planting to whitefly peak

Use of row cover

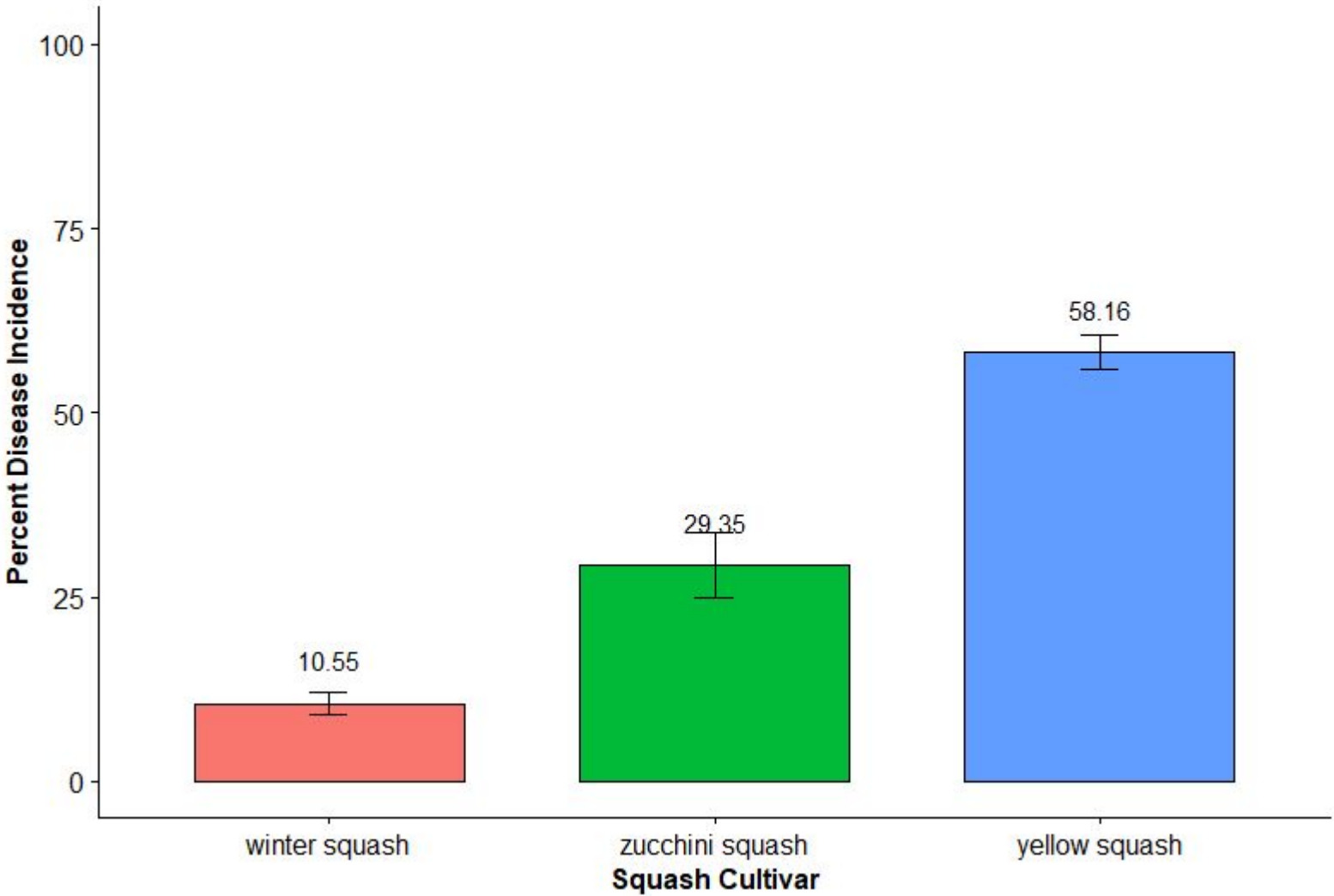
Previous spring crop



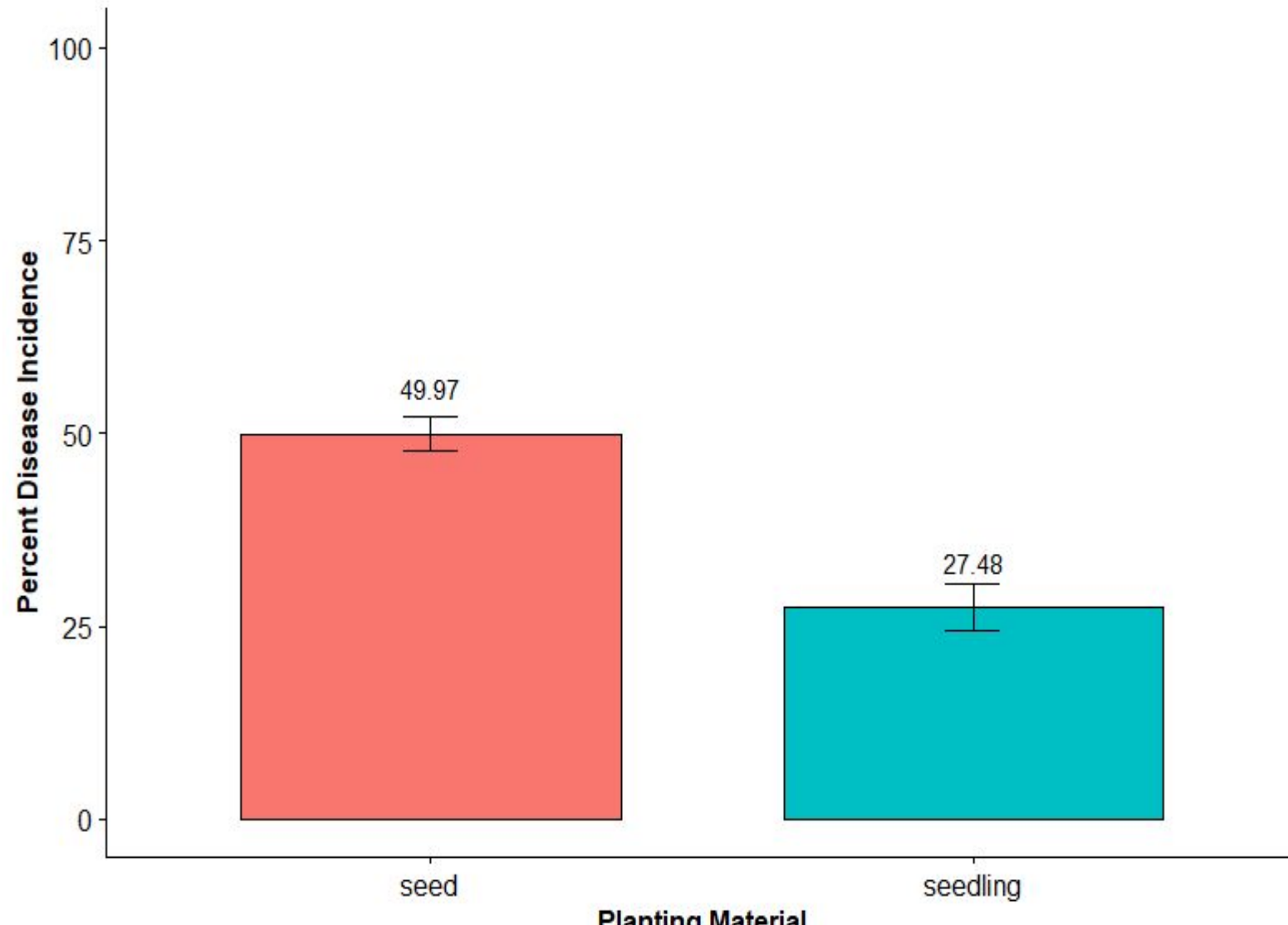
**No to less severe symptoms**

**Severe viral disease symptoms**

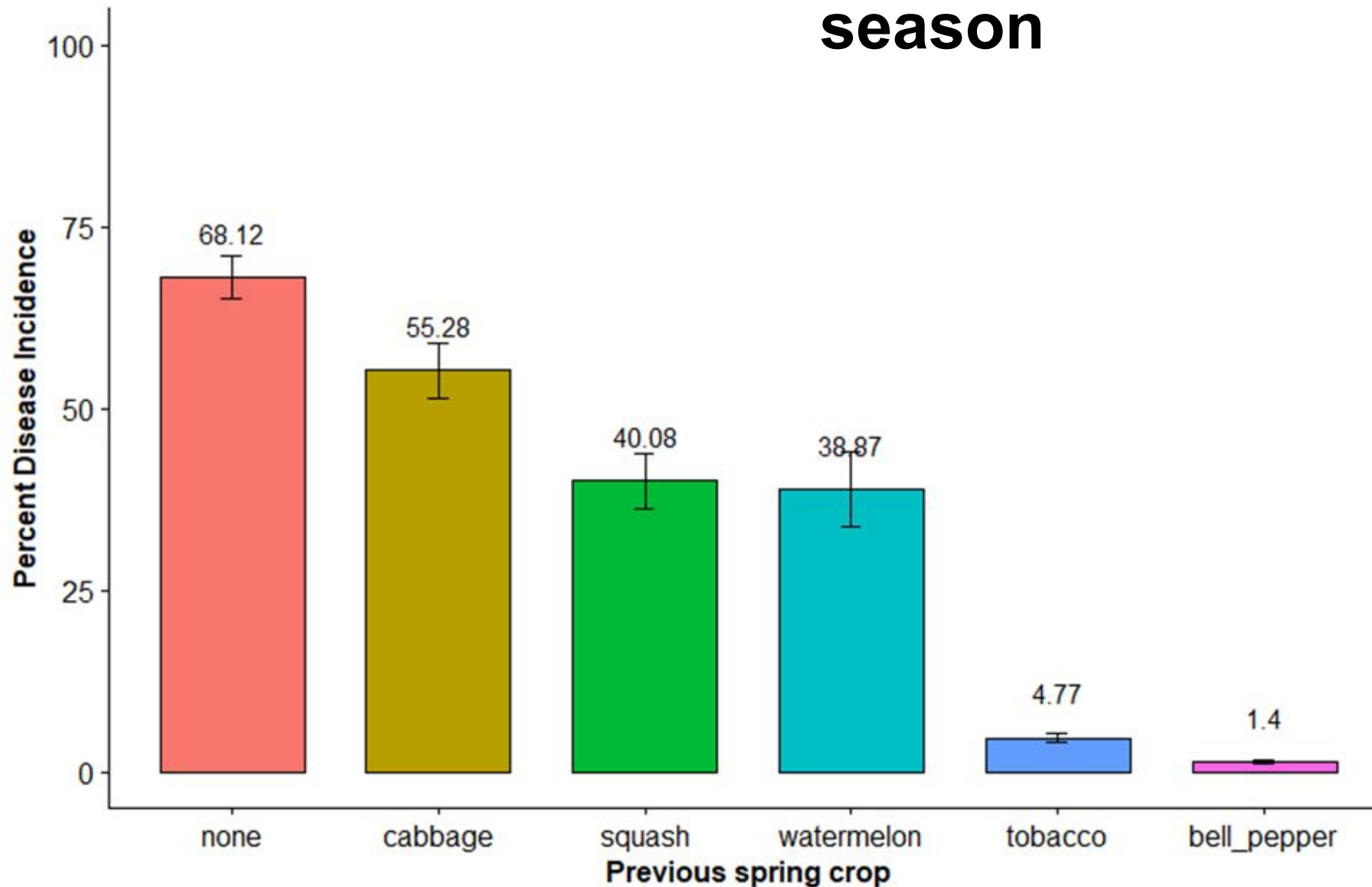
# Lower incidence of CuLCrD observed in winter squash and zucchini squash compared to yellow squash



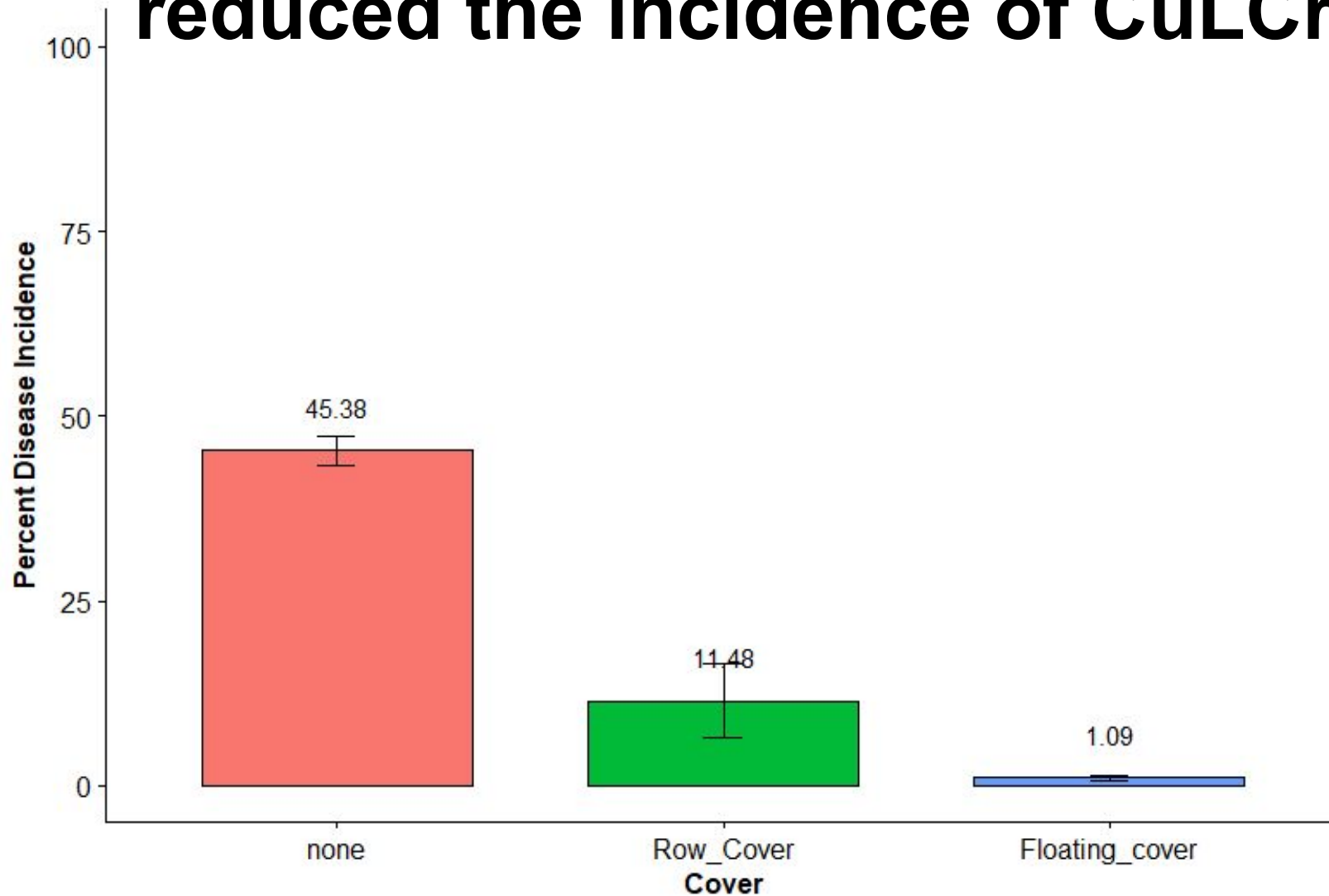
# Seeds vs. Transplants on the incidence of CuLCrD



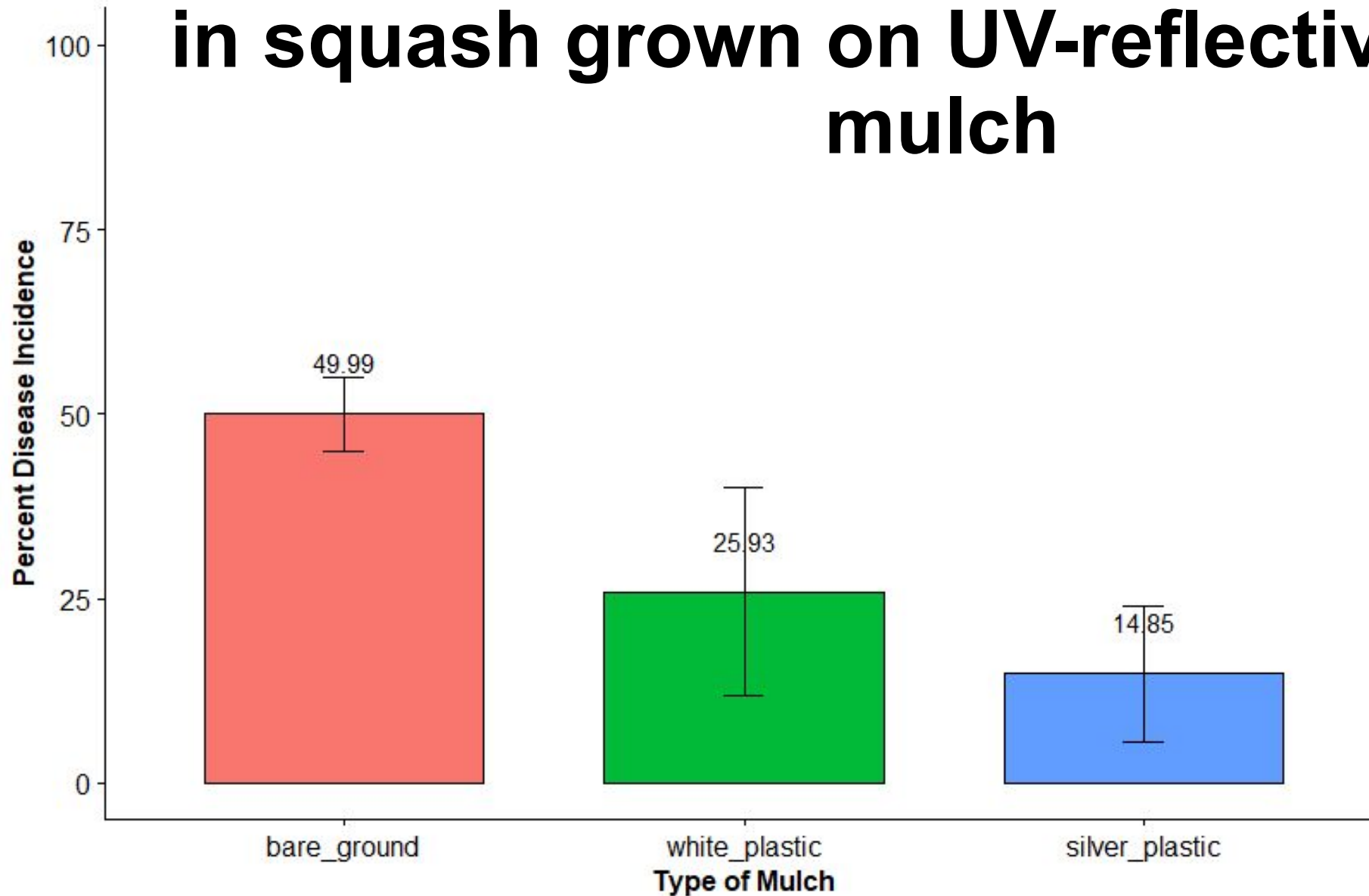
# Previous spring crop affected CuLCrD incidence in squash grown during the fall cropping season



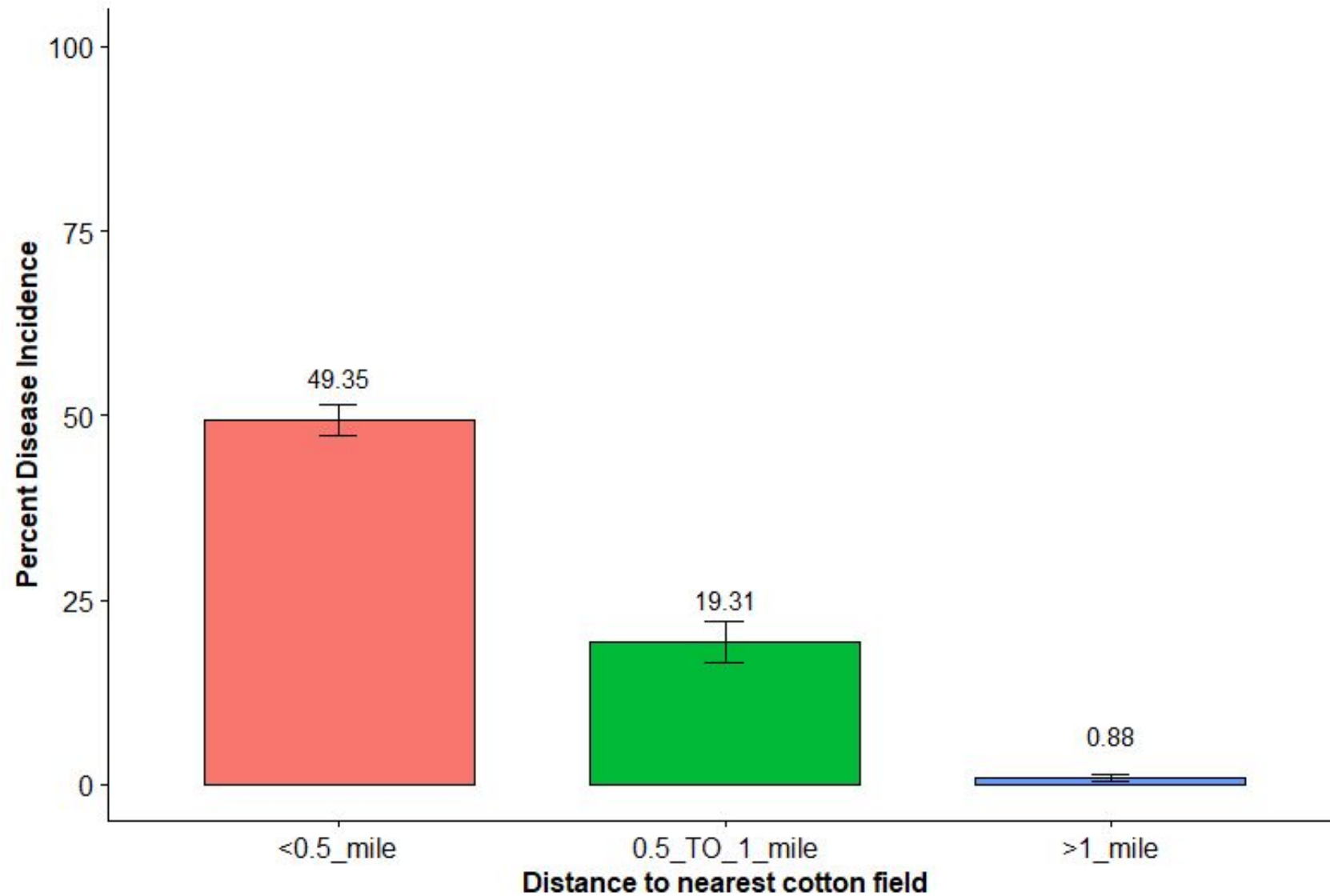
# Use of row-covers effectively reduced the incidence of CuLCrD



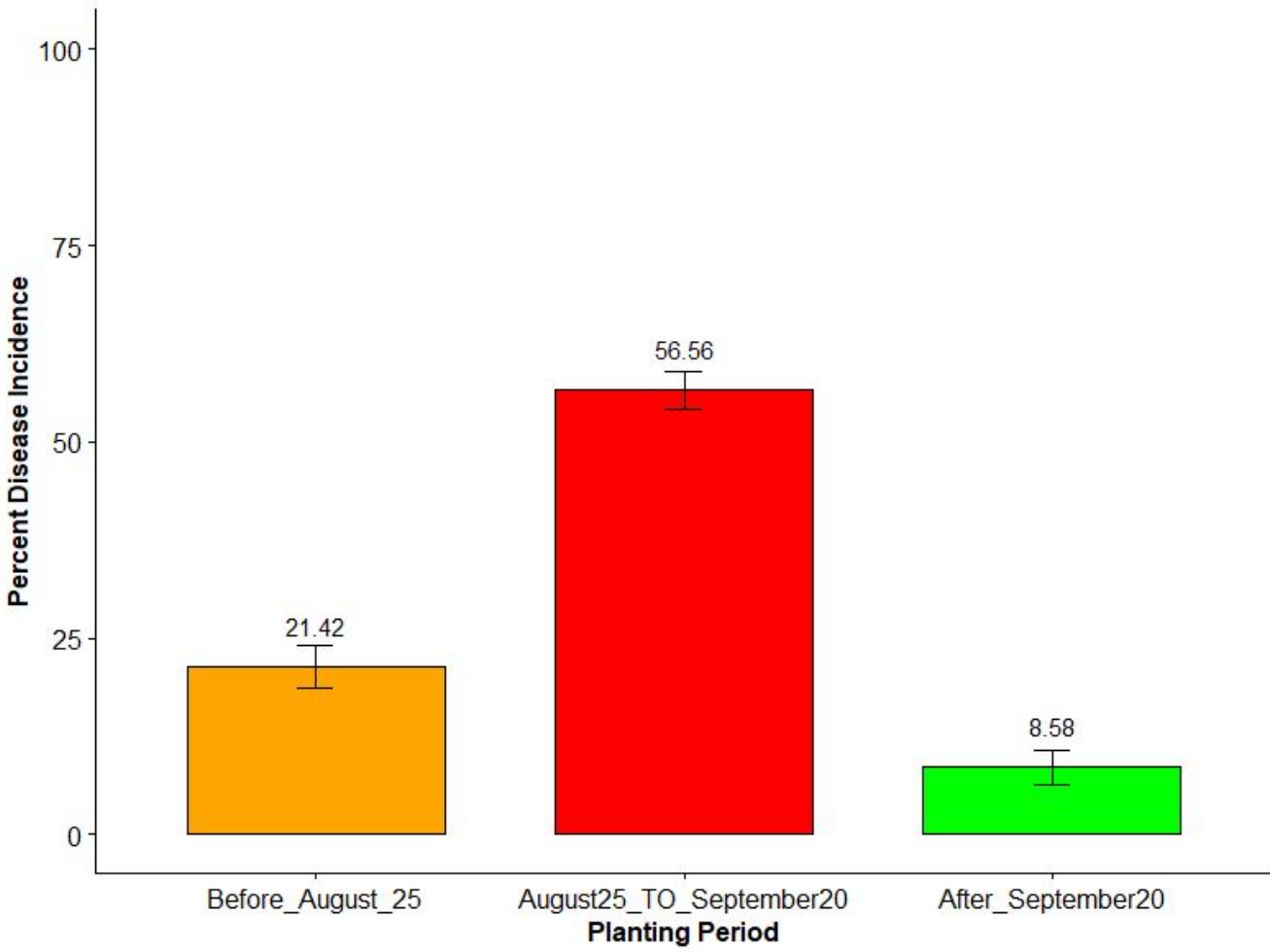
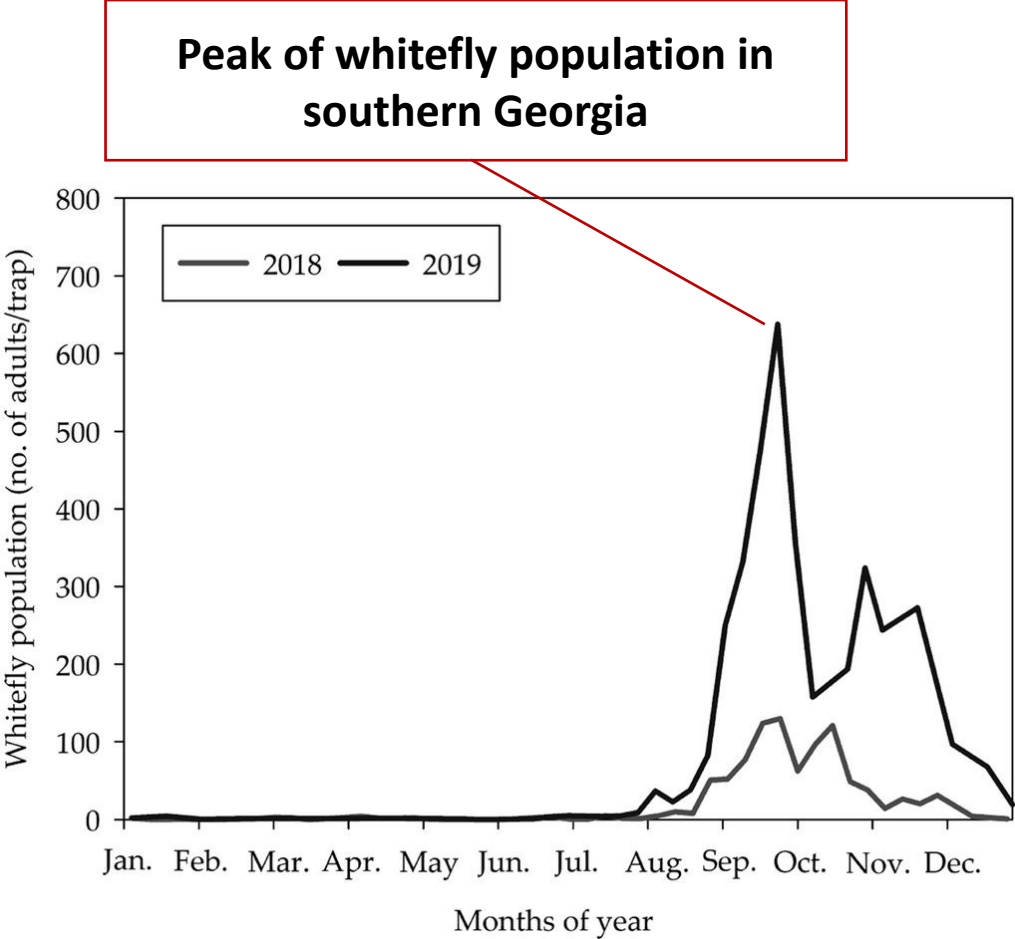
# Lower levels of CuLCrD incidence observed in squash grown on UV-reflective (silver) mulch



# Distance to nearest cotton field impacts the incidence of CuLCrD in squash fields



# CuLCrD incidence was lower among squash planted before August 25 or after September 20



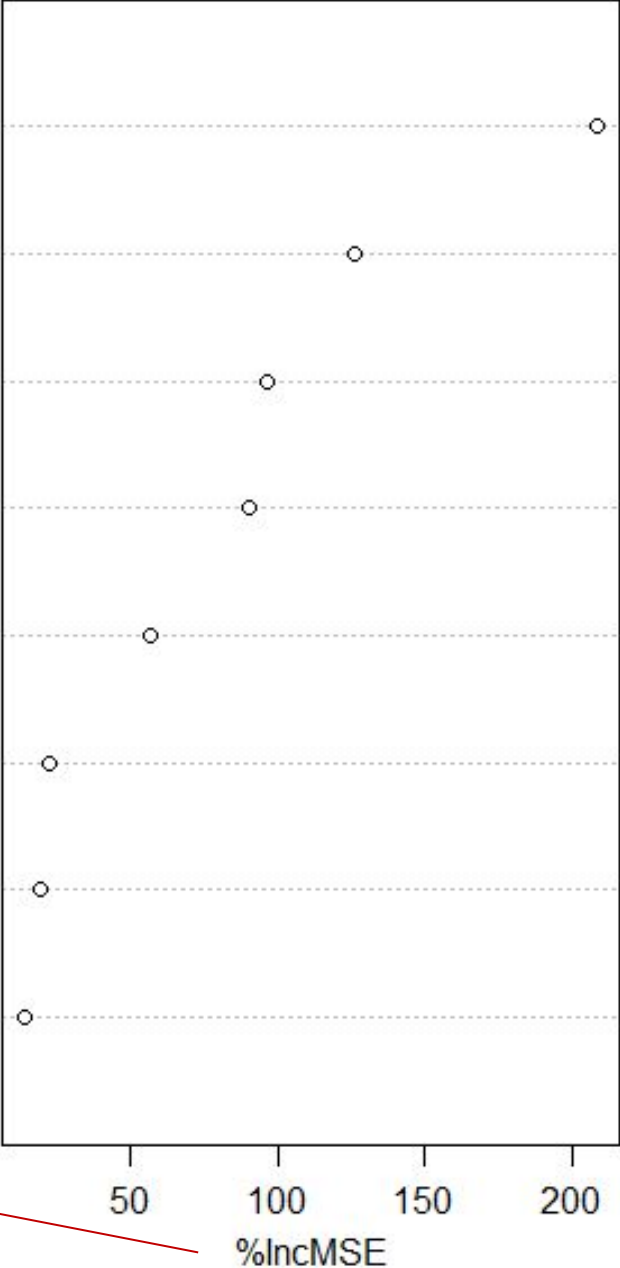
# The predictor variables were ranked according to their importance as predictor of CuLCrD incidence based upon Random Forest analysis

```
call:
randomForest(formula = incidence ~ ., data = TrainSet,
ntree = 1500, mtry = 6, importance = TRUE)
Type of random forest: regression
Number of trees: 1500
No. of variables tried at each split: 6
```

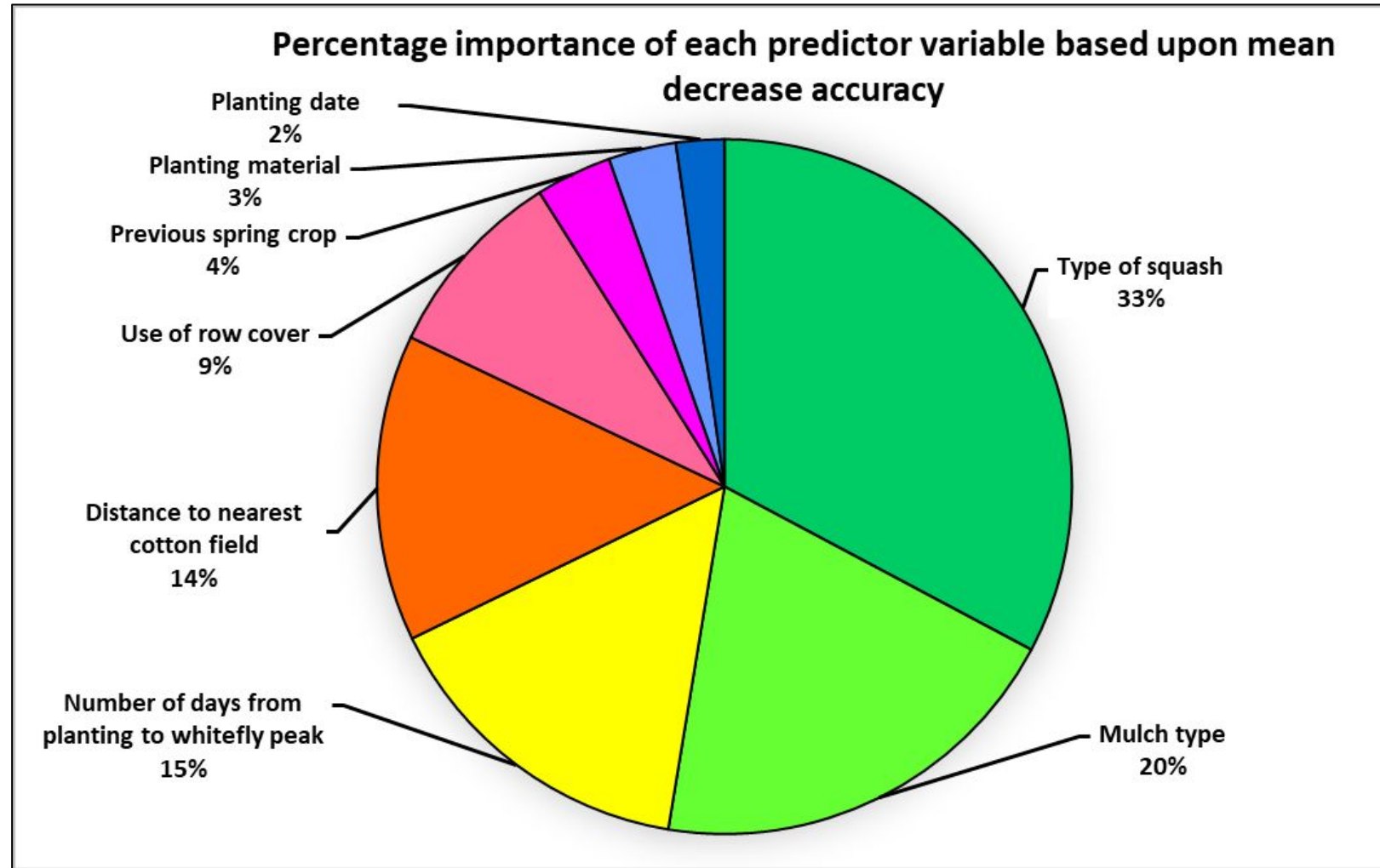
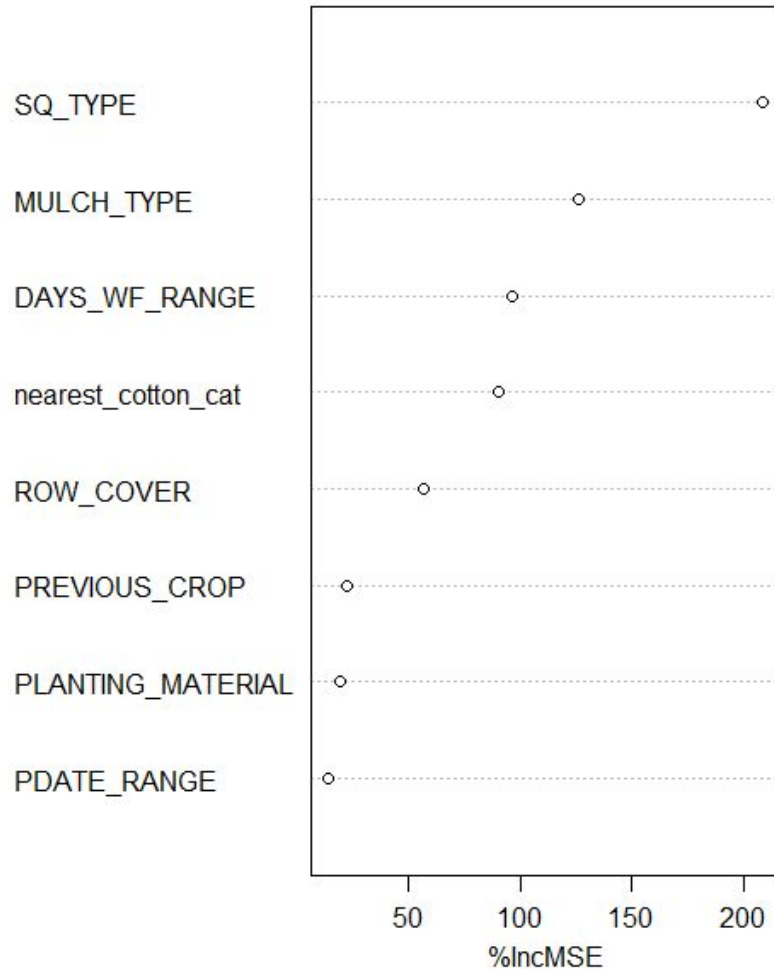
Mean of squared residuals: 218.9407  
% var explained: 85.22

**Mean Decrease Accuracy (%IncMSE)** - how much our model accuracy decreases if we leave out that variable.

- SQ\_TYPE
- MULCH\_TYPE
- DAYS\_WF\_RANGE
- nearest\_cotton\_cat
- ROW\_COVER
- PREVIOUS\_CROP
- PLANTING\_MATERIAL
- PDATE\_RANGE



# Type of squash (winter, zucchini, or yellow squash) and type of mulch are the most important predictors of CuLCrD incidence



## The maximum risk value possible for each predictor variable was assigned based upon their importance as predictors of CuLCrD incidence

Predictor variable	Mean decrease accuracy	Percent importance	Base value	Maximum risk value assigned per variable
Type of squash	208.32	32.78	225	70
Mulch type	125.90	19.81	225	40
Number of days from planting to whitefly peak	96.61	15.20	225	30
Distance to nearest cotton field	90.70	14.27	225	30
Use of row cover	57.18	9.00	225	20
Previous spring crop	22.51	3.54	225	10
Planting material	20.01	3.15	225	10
Planting date	14.26	2.24	225	10

# Squash Rx: a risk assessment index for CuLCrD in squash

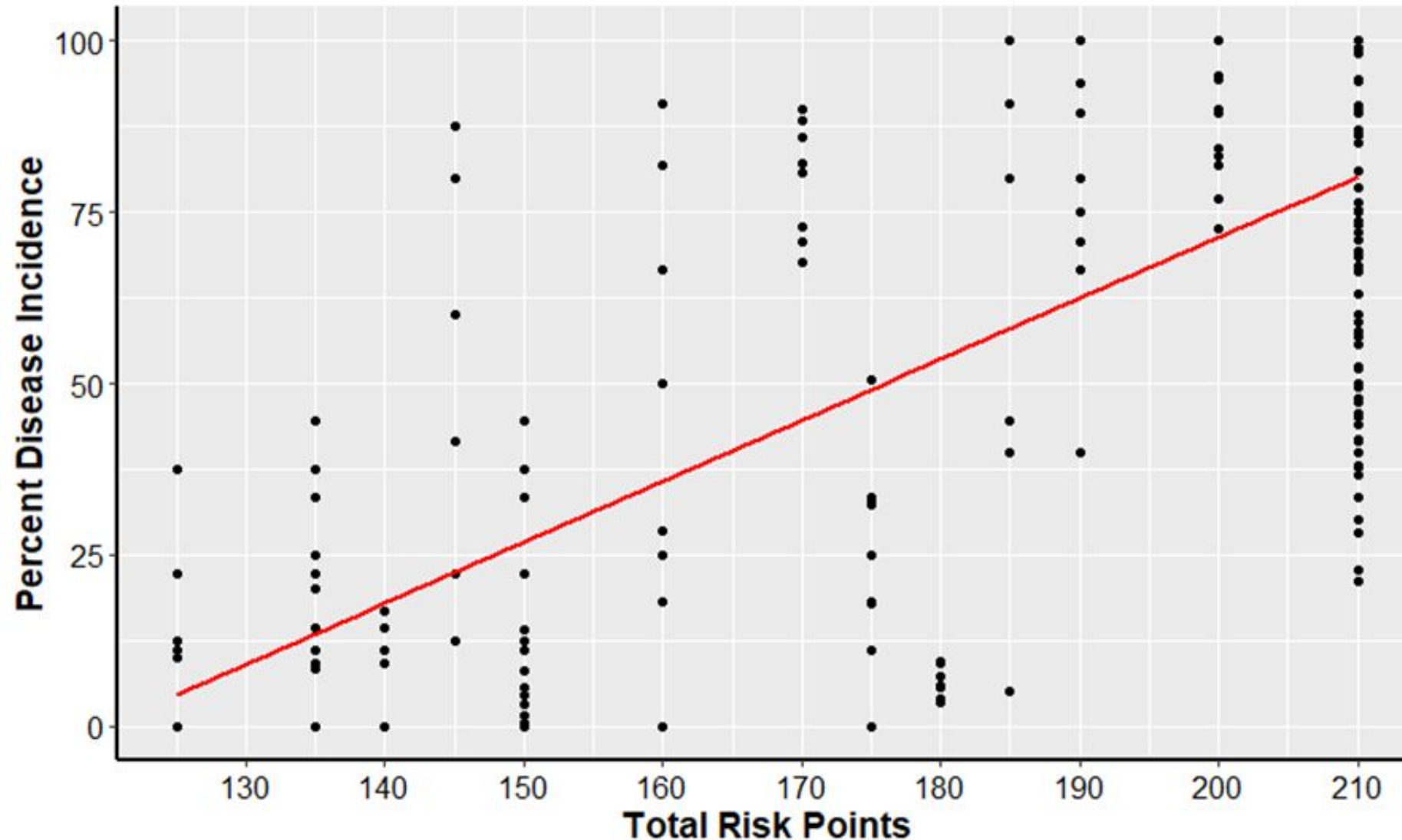
Risk point values assigned to each categories under each predictor variable

Variables	Categories	Risk point value
Type of Squash		
	Winter squash	10
	Zucchini squash	30
	Yellow squash	70
Mulch Type		
	Silver plastic	20
	White plastic	30
	Bare ground	40
Distance to cotton field		
	>1 mile	10
	0.5 to 1 mile	20
	<0.5 mile	30
Days from planting to WF peak <i>*NOTE: WF Peak = Sept 15</i>		
	>35 days before peak	10
	>5 days after peak	10
	21-35 days before peak	20
	20 days before to 5 days after peak	30

Insect Proof Cover		
	Floating cover	5
	Row cover	5
	No cover	20
Planting Date		
	After Sept 20	5
	Before Aug 25	5
	August 25 to Sept 20	10
Planting Material		
	Seedlings	5
	Seeds	10
Previous crop		
	Bell pepper	5
	Tobacco	5
	Watermelon	10
	Squash	10
	Cabbage	10
	None	10
Interpretation of summed risk values		
	<b>Low Risk</b>	<b>70 - 130</b>
	<b>Moderate Risk</b>	<b>135 - 175</b>
	<b>High Risk</b>	<b>180 - 220</b>

**Evaluation of Squash Rx:** A significant positive linear relationship was detected between total risk point values and the percent CuLCrD incidence

Adj R2 = 0.48388 Intercept = -106.62 Slope = 0.88976 P = 1.4712e-37



# Conclusions:

Variables	Categories	Risk based on combined data
<b>Type of Squash</b>		
	Winter squash	10
	Zucchini squash	30
	Yellow squash	70
<b>Mulch Type</b>		
	Silver plastic	20
	White plastic	30
	Bare ground	40
<b>Distance to cotton field</b>		
	>1 mile	10
	0.5 to 1 mile	20
	<0.5 mile	30
<b>Days from planting to WF peak <i>*NOTE: WF Peak = Sept 15</i></b>		
	>35 days before peak	10
	>5 days after peak	10
	21-35 days before peak	20
	20 days before to 5 days after peak	30
<b>Insect Proof Cover</b>		
	Floating cover	5
	Row cover	5
	No cover	20
<b>Planting Date</b>		
	After Sept 20	5
	Before Aug 25	5
	August 25 to Sept 20	10
<b>Planting Material</b>		
	Seedlings	5
	Seeds	10
<b>Previous crop</b>		
	Bell pepper	5
	Tobacco	5
	Watermelon	10
	Squash	10
	Cabbage	10
	None	10
<b>Interpretation of summed risk values</b>		
	Low Risk	70 - 130
	Moderate Risk	135 - 175
	High Risk	180 - 220

❖ Production practices influence the incidence of CuLCrD in squash.

❖ Some production practices had greater impact on CuLCrD incidence than others

The risk point values from Squash Rx are basis for assessing risk to CuLCrD in squash

The Squash Rx could potentially be a promising risk assessment tool that growers can use to achieve a minimal risk-level based on a set of production practices

