What the Hail?

Effects of Hail on Sunflower Health and Potential Management Strategies

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Introduction

- Hail can directly affect sunflower yields by causing injuries to the plant, reducing the leaf area available for photosynthesis and reducing plant population. The loss in quantity and/or quality depend on the hail storm's intensity, duration and hail size in addition to the growth stage of the sunflower.
- Injuries to sunflower tissue cause yield-limiting stress, and increase the number of potential infection sites for diseases.
- There are fungicide products available to help manage disease, and even some, specifically QoI fungicides, suggested to improve plant health, especially in the presence of abiotic stressors.
- Experimental research data is needed to provide better answers to producers asking the questions…
    1. Will the hail damage continue to affect the crop?
    2. Is it worth the time/money to apply a fungicide product?

Objective

- The objective of this study is to determine the effect of hail and fungicides on sunflower health.

Material and Methods

- For three years (2019-2021), hail trials were conducted in three states (North Dakota, South Dakota and Nebraska), with one trial in each state per year, for a total of nine trials.
- Trials were designed to mimic a scenario where hail causes damage to a sunflower crop shortly after budding (R1) and a producer has about one week to decide to make a fungicide application. The fungicides used vary based on location and year (Tables 1 and 2).
- Trials were synthetically hailed using a backpack leaf blower and a PVC apparatus attachment (Figure 1).
- One to seven days after synthetic hail damage was created, fungicide products were applied using a CO_2 handheld spray boom.
- No artificial pathogen inoculations were used to incite disease. Ratings were dependent on which disease developed in each trial (Table 2).
- Data was analyzed using PROC GLIMMIX procedures in SAS 9.4.

Table 1. The two fungicide designs included in the study.

Treatment Number	Four Fungicide Design		One Fungicide Design	
	Product Name	Active Ingredient	Product Name	Active Ingredient
1 (no hail) & 2 (with hail)	Non-Treated Control	-	Non-Treated Control	-
3 (no hail) & 4 (with hail)	Aproach (6 fl oz/ac)	Picoxystrobin	Headline (6 fl oz/ac)	Pyraclostrobin
5 (no hail) & 6 (with hail)	Revytek (8 fl oz/ac)	Pyraclostrobin, Fluxapyroxad, Mefentrifluconazole		
7 (no hail) & 8 (with hail)	Miravis Neo (13.7 fl oz/ac)	Azoxystrobin, Propiconazole, Pydiflumetofen		
9 (no hail) & 10 (with hail)	Priaxor (4 fl oz/ac)	Pyraclostrobin, Fluxapyroxad		

Table 2. Trial design (**bold)** and disease development (*italics)* for each trial.

	North Dakota	South Dakota	Nebraska
2019	**One Fungicide Design** *Phoma Black Stem Sunflower Rust*	**One Fungicide Design** *Phomopsis Stem Canker*	**One Fungicide Design** *No Disease*
2020	**Four Fungicide Design** *Phoma Black Stem Bacterial Head Rot*	**One Fungicide Design** *Phomopsis Stem Canker*	**Four Fungicide Design** *No Disease*
2021	**Four Fungicide Design** *No Disease*	**One Fungicide Design** *Phomopsis Stem Canker*	**Four Fungicide Design** *Phomopsis Stem Canker*

Results

- Simulated hail significantly affected (α = 0.05) disease, Phoma black stem, in one trial (ND-2020).
- Fungicides reduced disease development in most instances (ND-2019; ND-2020; SD-2019-2021); however, it did not for Bacterial head rot in the 2020 ND trial or for Phomopsis stem canker in the 2021 Nebraska trial.
- Yield was not significantly different (α = 0.05) between any of the hail or fungicide treatments in any trial.

ND-2019

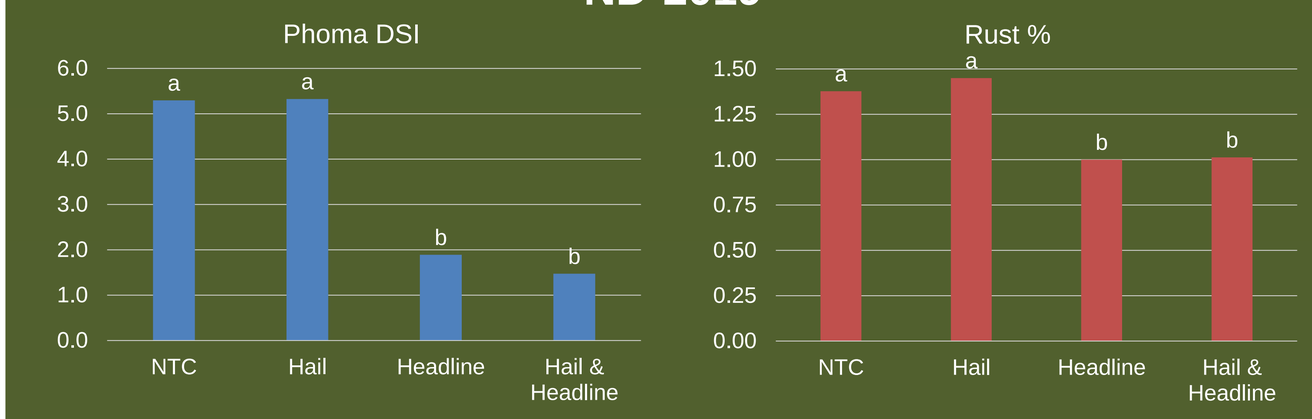

Figure 2. Phoma black stem disease severity index (DSI) for 2019 North Dakota hail trial. Phoma DSI ratings are calculated by taking the number of diseased plants and multiplying by the average number of lesions per diseased plant on ten randomly selected plants. Rust ratings are calculated as the average percent leaf area of the upper four leaves that is affected with rust on ten randomly selected plants. Bars with the same letter are not significantly different (α = 0.05).

ND-2020

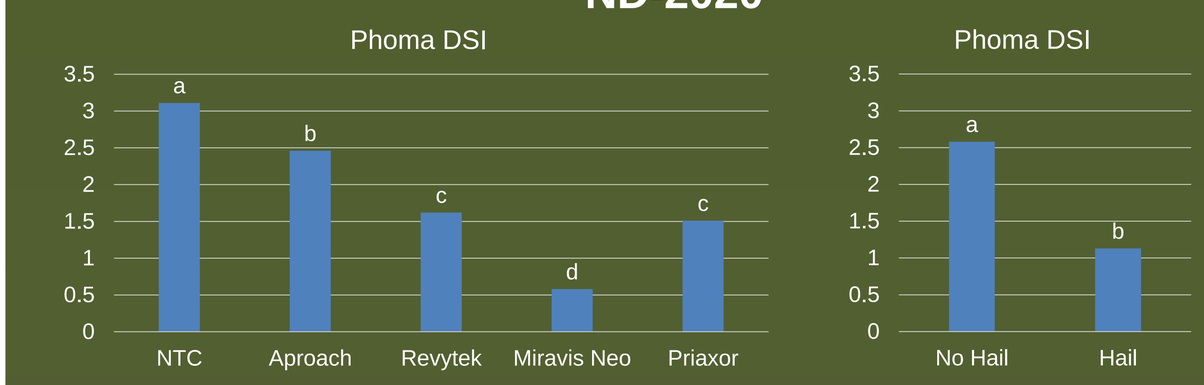

Figure 3. Phoma black stem disease severity index (DSI) for 2019 North Dakota hail trial. Phoma DSI ratings are calculated by taking the number of diseased plants and multiplying by the average number of lesions per diseased plant on ten randomly selected plants. Bars with the same letter are not significantly different (α = 0.05).

SD-2019–2021 Combined

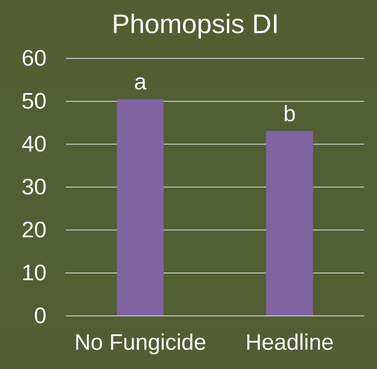

Figure 4. Phomopsis disease index (DI) is calculated by selecting ten random plants from each plot and using the formula $DSI(\%)=\sum[\frac{(P \times Q)}{40} \times 100]$, where P = rating score and Q = rating frequency. Bars with the same letter are not significantly different (α = 0.05).

Figure 1. PVC attachment connected to a backpack leaf blower. The leaf blower creates airflow for a hailing medium (field pea seed) to gain enough force to cause damage to leaf and stem tissue but avoiding lodging issues.

Conclusions

- The impact of hail on disease may be related to the hail's effect on the crop canopy microclimate.
- Yield impacts are difficult to measure but trends may be present.
- Further research will look at hail's effect in confectionary sunflowers.

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