Effect of Load & Air Temperature on Aerial Application Ground Speed

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Introduction

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Why should we be concerned about streaks?

- Looks Bad!
- Leaf greenness has been highly correlated with yield of maize. (Ma et. al., 1996)
- Yield variability is often associated with the availability of nutrients.

Introduction

Streaks across a field following fertilizer application could occur for several reasons

- Inappropriate swath widths resulting in overlap or skips
- Non-uniform delivery from the hopper
- Ground speed increase as load decreases

Introduction

This study focuses on ground speed changes as a cause for streaks.

Assumptions:

- Constant power settings (torque and rpm)
- Uniform fertilizer delivery from the hopper
- Constant temperature during each application

Introduction

Factors that affect aerial ground speed

- Type of aircraft
- Engine Power settings
- Aircraft trim
- Wind speed and direction relative to direction of flight
- Degree of climb/descent
- Load
- Air Temperature

Materials and Procedures

- Applications were made with an Air Tractor 402B equipped with a SATLOC M3 swath guidance system and an AutoCal automatic flow control system
- Water was used to simulate a fertilizer load
- Each application load was established by metering 275 gallons of water (2300 lb.) to the hopper and topping off the fuel tanks

Materials and Procedures

- Application parameters were 135 mph air speed (nominal), 5 gpa, 60 ft swath.
- Each application was applied in alternating directions along the same flight line using 10 spray passes with a 20 s duration.

Materials and Methods

- A total of 27 applications were made at times selected to provide a range of air temperatures.

- Data collected included:
  - ➔ (from SATLOC) ground speed, altitude, time of day, and duration of spray passes
  - ➔ (from AutoCal) actual flowrate delivered to spray boom

Materials and Procedures

- Wind effects nullified by
  - ➔Computing average speed for each pass
  - ➔Then average the average speed from two successive passes flown in opposite directions
- Air Temperature logged on weather station in vicinity of application area

Materials and Procedures

- Load was computed by
  - ➔ Averaging flowrate during each spray pass
  - ➔ Load Change (lb) = Avg flowrate * spraytime*8.345
  - ➔ Total load = sum of load changes
  - ➔ Synchronize load data with speed data by summing successive pairs of loads
  - ➔ Beginning with total load, decrease load by the pair totals (in order) to generate the five loads associated with the 5 speed values.

Materials and Procedures

- Altitude data was used to evaluate the degree of climb or descent (Slope) while spraying
  - Height = altitude while spraying – altitude on runway
  - Plot Height vs Time and fit a linear regression trendline to the data
  - The slope of the trendline was used as an indicator of Slope

Results and Discussion

Multiple Regression analysis was used to fit the data to a polynomial of the form

$$Speed = A0 + A1*S + A2*T + A3*L + A4*L^2$$

S = Slope*20

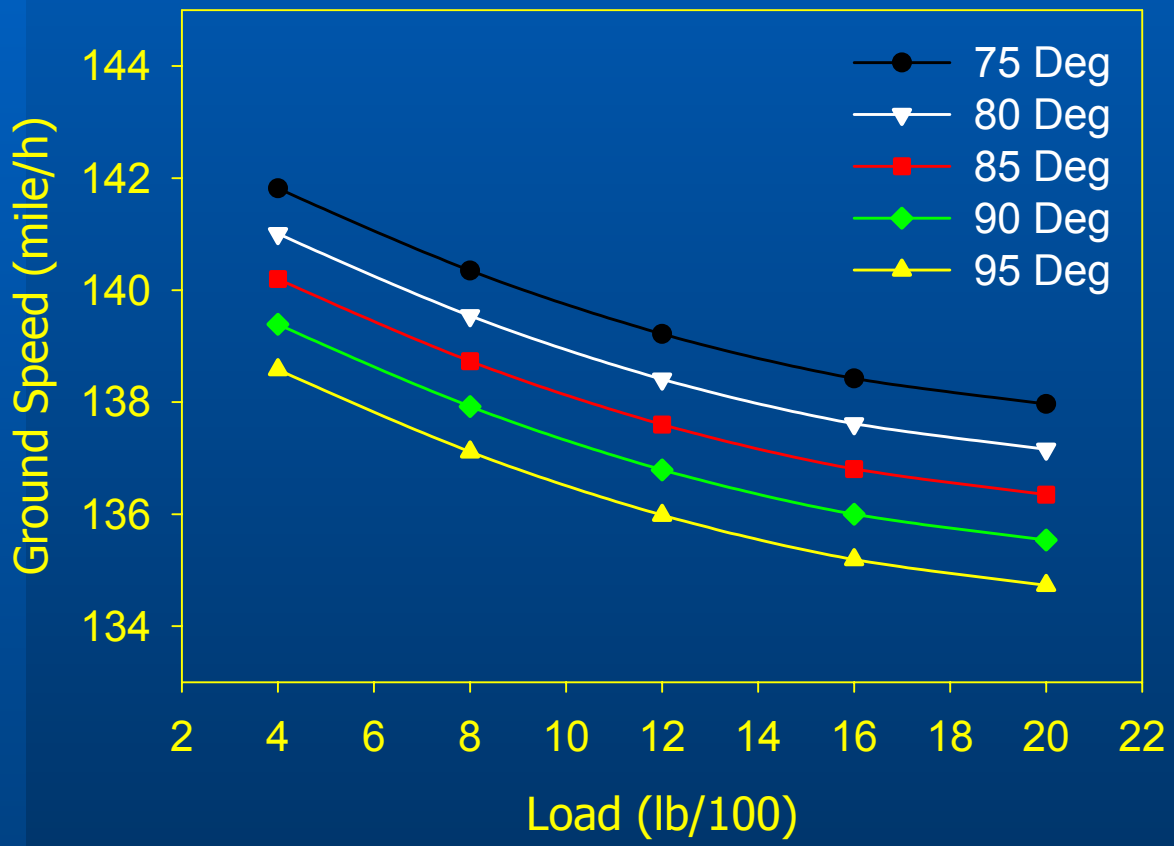
T = Air Temperature

L = Load/100

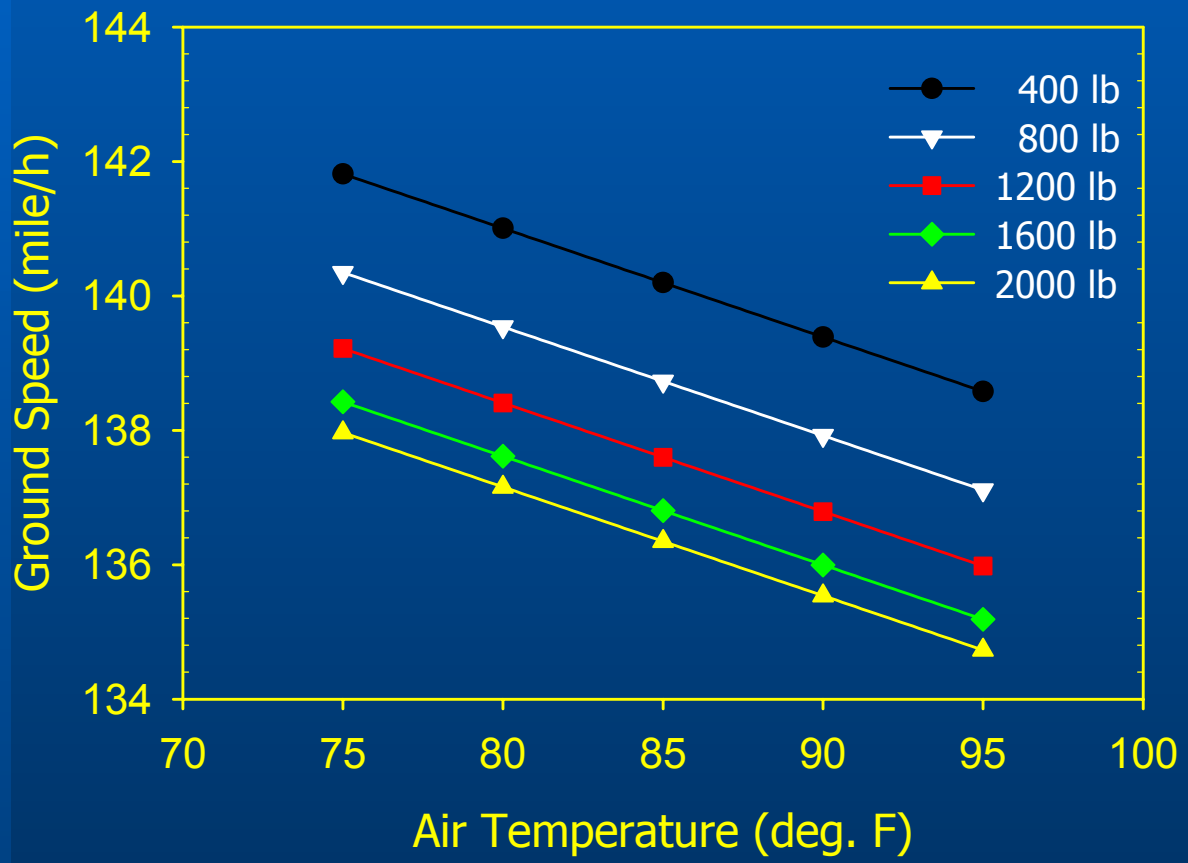
Results and Discussion

Term	Value	Units	F-Value	Pr > F
A0	155.75	mph		
A1	-0.1553	ft/s	5.86	0.0174
A2	-0.1618	^{o}F	10.96	0.0030
A3	-0.4930	lb_f	25.29	<.0001
A4	0.01052	lb_f	7.67	0.0070

Results and Discussion



Results and Discussion



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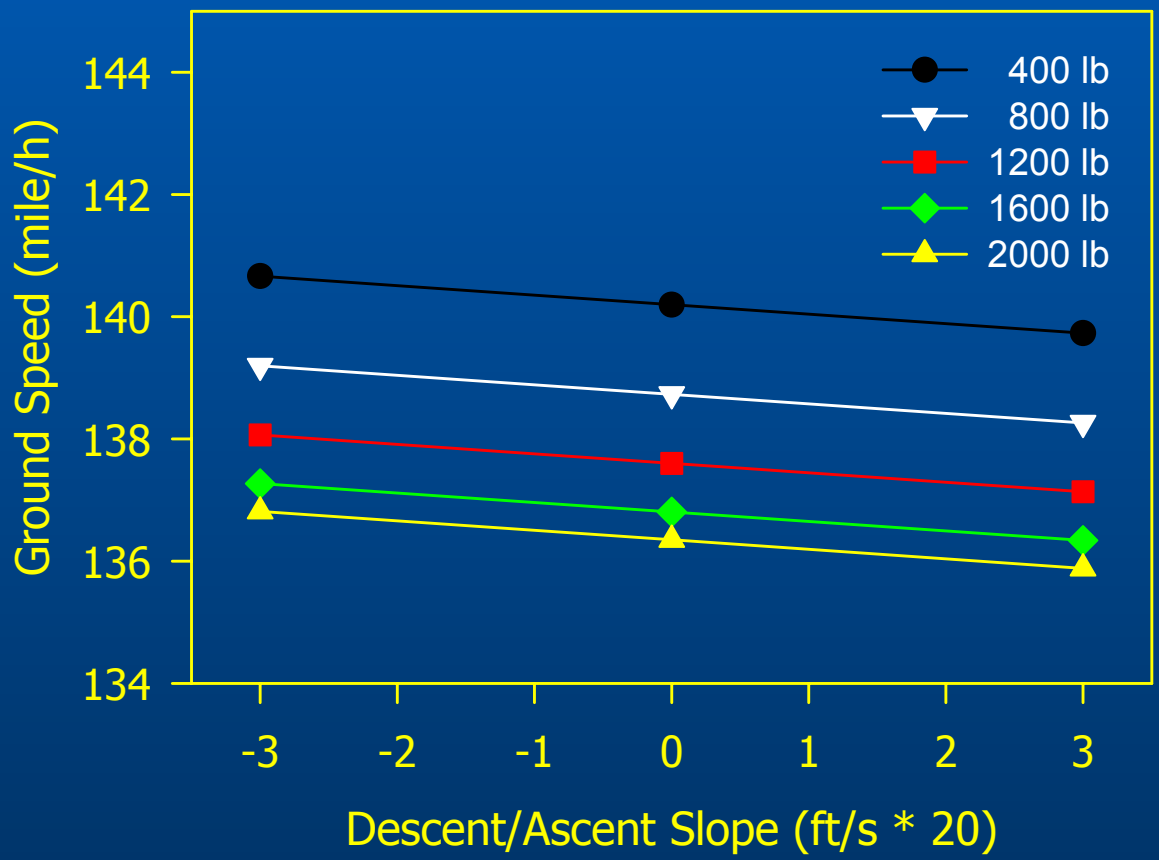

Conclusions

- A load reduction of 1600 lbs caused ground speed of an AT402B to increase about 4 mph (constant air temperature and level flight).
- For any specific load, an increase in air temperature of 5^{o}F caused ground speed to decrease by 0.8 mph (level flight).
- A positive slope of 0.15 ft/s decreased ground speed by 0.5 mph (constant load and air temperature)

Conclusions

- A speed increase of 4 mph (3% of 135 mph nominal speed) would decrease application rate by 3%. It is unlikely that a gradual 3% change (beginning to end of load) would cause dramatic swath-to-swath streaks.


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