Traction Improvement: Ballasting, Tires, & Inflation Pressure

Michelin/Purdue Performance Improvement Day
2009
Purdue University

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Outline

• WHY (background information)
  ◦ Introductory (miscellaneous) information
  ◦ Speed & implement size
  ◦ Ballasting (weight & placement)
  ◦ Tire size
  ◦ Tire pressure
• HOW & WHAT (getting it right on your farm)
  ◦ Spreadsheet demonstration
  ◦ Specific example
Let me confuse you first

- Tire load affects slip
- Slip affects pull
- Axle loads change
- Pull determines speed
- Implement draft changes

Tractive efficiency affects

- Tire wear
- Fuel consumption
- Time for the work
  - Machine time
  - Labor
  - Timeliness
On Slip …

- Some is good
- Optimal level depends on
  - Tires
  - Soil
- Controlled by
  - Pull/weight ratio
  - Tire selection & inflation

Speed & Implement Size

- Implement too large
  - Power limited, so you go slow
  - Traction limited, so you ballast too heavy
  - More soil compaction than you ought to have
  - Continual high torque, high force situation causes too much stress (premature failures)
- Implement too small
  - You tend to go too fast
  - Wasted power
  - Might be okay if you shift up, throttle back
2. P/W ratio is similar at peak efficiency

3. Max P/W ratio is different

4. Optimal slip is 8 to 12%

Agricultural & Biological Engineering

Soil conditions

- Affect maximum pull, slip, & tractive efficiency
- Do not significantly affect (near peak efficiency) the pull/weight ratio
- At 8-12% slip, with other conditions correct (tire size, inflation pressure, ballast), responses are relatively flat.

- Why is 12% slip better than 8%?
What is the best operating point on tilled soil?

I would choose C ... about 20% more field capacity with only a slight efficiency reduction.

Figure 27. Performance of 20.8R42 dual tires on three surfaces (8300 kg axle load, 83 kPa tire pressure).
Typical operating ranges

- 8-23% SLIP -- soft
- 8-20% SLIP -- medium
- 8-15% SLIP -- firm

Figure 27. Performance of 20.8R42 dual tires on three surfaces (8300 kg axle load, 83 kPa tire pressure).

Improper weight

- The ideal situation is to be power, traction, and speed limited simultaneously
- Improper weight (or implement size) wastes at least one dimension
  - Too much weight:
    - Excessive rolling resistance
    - Excessive compaction
  - Too little weight:
    - Excessive slip
    - Insufficient pull
**Different weight (tire load) & pressure**

Figure 30. Performance of single tire (Goodyear 20.8R46 DTR) at two weights with correct pressures in tilled (loose) tractor conditions.

**Improper weight location**

TE jump from 66 to 72% is nearly a 10% improvement
Slip drop from 17% to 12% is a 30% improvement.
Tire selection

- Radials
- Bigger is better
- Diameter helps more than width
  - Larger footprint (longer, not wider)
  - Less rolling resistance

Different tire size (with correct pressure)

Figure 29. Performance of two sizes of single tires at correct inflation pressures in tilled (loose) tractive conditions.

1. Little effect on max pull
2. 10% boost in efficiency due to tire selection
Improper tire inflation

- Inflation too low
  - Bust a bead
  - Rim slip
  - Tire failure
- Inflation too high
  - Excessive soil compaction
  - Lower pull
  - Higher slip
  - Lower tractive efficiency

Different tire pressure & load

Figure 28. Performance of single tire (Firestone 710/70R38 ATR) at two inflation pressures in tilled (loose) traction conditions.
Summary (especially in soft or tilled soil)…

- Proper
  - Weight (& location of weight)
  - Tire size
  - Tire pressure
- Leads to:
  - Lower slip (higher capacity, less time)
  - Higher tractive efficiency (lower fuel usage)
  - More pull (larger implements, higher capacity, less time)

On the web…

https://engineering.ecn.purdue.edu/~dbuckmas/

On the “OUTREACH RELATED” tab

- This presentation
- Ballast Assistant spreadsheet
- Ballast Assistant “tutorial video”
An Example

- 180 HP MFWD
- Towed implement
- 5 mph
- 12,650 lb static rear weight target
- 8450 lb static front weight target

From: Michelin load/inflation tables

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520/85R42 (20.8R42) 157A8/157B TL AGRIBIB®
MSPN: 63687
CAI: 122791

Rolling Circumference

Equivalent Load a Actual Load Per Tire 9.56

Equivalent Load a Actual Load Per Tire 9.02

Duals

Rear 20.8R42, 3160 lb (3600 lookup), 6 psi

Rear 20.8R42, 6320 lb, 13 psi

Singles
If the speed limit is 65 mph, do you go …
- [ ] 65 mph or less
- [ ] 68 mph
- [ ] 75 mph

Should I …
- [ ] use tabled values for inflation pressure
- [ ] add 2 psi to tabled values

Will you check pressure frequently?

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