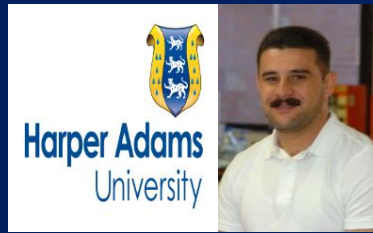


The effect of soil type and bulk density on the above ground properties and the anchorage of winter wheat



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1 Introduction:

Lodging in cereals is a permanent displacement of a free standing plant from its vertical position, The reduction in the wheat yield can reach up to 80% in a severely lodged crop (Acreche and Slafer, 2011). Susceptibility of a crop to lodging is generally influenced by plant height and ear weight together with the soil strength properties (bulk density, soil shear strength and penetration resistance), soil texture, soil moisture content, cultivation process (soil compaction) and root properties (Goodman and Ennos, 1999). There are two main types of lodging: stem buckling or failure, known as stem lodging, and root anchorage failure known as root lodging. Despite root lodging been commonest, stem lodging still occurs and so both need to be considered .

2 Objectives

- To investigate the effect of soil type and bulk density on soil shear strength and penetration resistance.
- To investigate the effects of soil type and bulk density on the above ground properties and the anchorage strength of winter wheat.

3 Methods

Sandy loam and clay loam soils compacted in a pot 20 x 30 cm (height x diameter) to three wet bulk densities. Each pot was sown with one wheat plant on the 21st of May 2012, the treatments arranged in 10 fully randomised complete block design in polytunnel unit at Harper Adams University.

The soil in each pot was brought to field capacity condition and then soil shear strength and penetration resistance were measured.

The above ground properties including stem strength were measured at maturity, plant anchorage strength and self-weight moment measured using the lodging device developed by Crook and Ennos (2000), respectively.

4 Results

Table 1 shows the effect of soil type and bulk density (g cm^{-3}) on soil shear strength and penetration resistance

| | Sandy Loam | | | Clay loam | | | S.E.M (D.F. 99) | P value |
|------------------------------|------------|-------|-------|-----------|-------|-------|-----------------|---------|
| | 1.07 | 1.3 | 1.5 | 1.13 | 1.3 | 1.5 | | |
| Soil shear strength (kPa) | 18.73 | 23.29 | 28.01 | 17.05 | 15.97 | 25.01 | 0.559 | <0.001 |
| Penetration resistance (MPa) | 0.17 | 0.16 | 0.24 | 0.13 | 0.14 | 0.18 | 0.006 | 0.002 |

Table 2 shows the effect of soil type and bulk density (g cm^{-3}) on the coronal root properties of winter wheat

| | 1.1* | 1.3 | 1.5 | S.E.M (55) | P value |
|-------------------------------|-------|-------|-------|------------|---------|
| Stem height (cm) | 69.26 | 72.78 | 73.93 | 1.346 | 0.045 |
| Plant fresh weight (g) | 59.5 | 74.7 | 79.2 | 4.38 | 0.006 |
| Plant ear weight (g) | 40 | 53.5 | 53.6 | 3.16 | 0.004 |
| Number of tillers | 14.8 | 17.56 | 18.04 | 0.614 | < 0.001 |
| Plant self-weight moment (Nm) | 0.296 | 0.405 | 0.393 | 0.0223 | 0.002 |
| Plant safety factor | 2.36 | 2.63 | 3.01 | 0.384 | 0.49 |
| Anchorage strength (N.m) | 0.624 | 1.055 | 1.094 | 0.1 | 0.002 |

* 1.1 g cm^{-3} is representing the low density treatments and is the average value of 1.07 g cm^{-3} for sandy loam soil and 1.13 g cm^{-3} for clay loam soil

References

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C

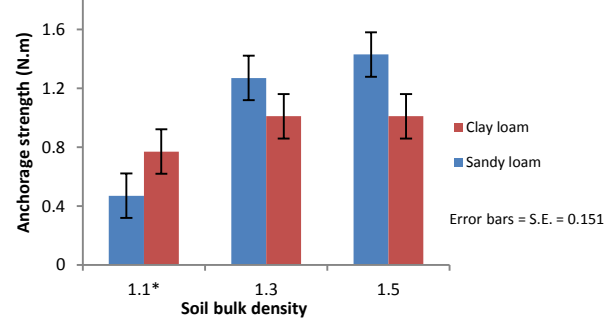


Fig. 1 shows the effect of soil type and bulk density on plant anchorage strength at 45°.

D

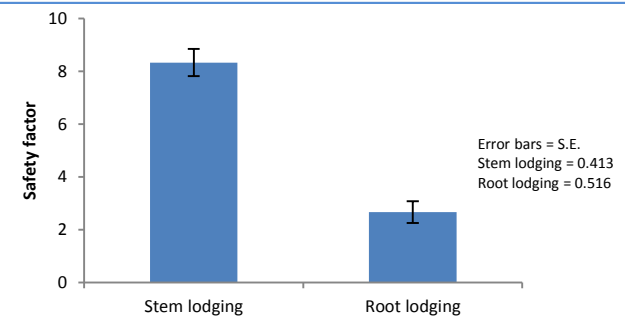


Fig. 3 shows the safety factor against stem lodging and root lodging.

E

During the plant anchorage test, anchorage failure did occur as the plant did not return to its vertical position after the test (Fig.2a, b, c, d).



Fig. 2 (a) Plant at vertical position before the test

Fig. 2 (d) Plant did not return to its vertical position after the test



Fig. d (b, c) Plant pushed with the lodging arm to 45° from vertical axis and soil failure occurred

5 Conclusions

- Soil shear strength and penetration resistance are both proportional to soil bulk density, and both were affected by soil type .
- Plant anchorage strength increased increasing soil bulk density.
- Anchorage failure is predominant in winter wheat, as the likelihood of stem lodging is about 70% less compared to root lodging.