Effects of seed treatments on germination and growth of maize in the field

P.S. Oliver, E.D. Walker, S.K. Dalgety and D.M. Thomas
H&T Agronomics, P.O. Box 321, Fielding 4740, New Zealand
eddiew@hnt.co.nz

Abstract

The objective of this field trial was to establish whether new seed treatments improve plant population and growth of maize. The trial was carried out in spring 2017. P9400 Maize seed from the same line was sown with H&T Optimised treatment, Poncho + Rancona Dimension treatment and untreated. The seed was planted in a Marton paddock with eight replicates and the height of each plant was measured at 13, 17, 27 and 41 days after sowing (DAS). No difference in plant height was observed at 13 DAS. Measurements 17, 27 and 41 DAS found differences in height. H&T Optimised was higher than all other treatments and Poncho + Rancona Dimension was higher than untreated. The number of plants in each row was counted and H&T Optimised seed treatment had a greater plant population than untreated. Root and shoot weight were measured at 41 DAS. The shoot weight was similar for all treatments. The root weight was greater for H&T Optimised over Poncho + Rancona Dimension and untreated seed treatments. H&T Optimised had 14.3% greater root weight than Poncho + Rancona Dimension. At harvest 173 DAS the grain yield was measured and found greater yield with treated seed compared with untreated.

Additional keywords: Poncho®, Rancona Dimension®, H&T Optimised®, height, weight, yield, root, shoot, *Zea mays* L.

Introduction

Maize (*Zea mays* L.) is a versatile crop grown in New Zealand, which can produce exceptional silage, green feed, or high yields of grain (Booker, 2009). Although maize can be used for food, it is primarily used for stock feed. Agriculture is the biggest user of maize in New Zealand, with a lot of the crops being fed to dairy cows as silage or grain. Cropping farmers grow maize under contract and sell into the dairy and cattle industries as supplementary feed (Hardacre *et al*., 1991).

Maize seed treatments have become a common practice in New Zealand as a means to combat disease, insects, pests and improve early growth and establishment (Oliver *et al*., 2016). Seed treatments can be effective in helping to obtain greater plant population and growth whilst minimizing the impacts of broad acre sprays to animals, humans and the environment (Macfadyen *et al*., 2014).

In New Zealand and around the world, there are a range of maize seed treatment options used, some which include Rancona Dimension (ipconazole 25 g/L + metalaxyl 20 g/L) fungicide, Poncho (600 g/L clothianidin) insecticide and Gaucho insecticide (600g/L Imidacloprid) (Alford and Krupke, 2017).

The uses of additional seed treatment options, including bio stimulants have the potential to enhance crop establishment, growth and yield (Eyheraguibel *et al*., 2008).

In maize, improved stimulation of root and shoot growth by organic compounds has been reported, along with an increase in branching and root hair development of maize roots when plants were grown in a bio stimulant nutrient solution (Lee and Bartlett, 1976).

The purpose of this field trial was to gauge the additional benefit of bio stimulants in maize seed treatment on plant height, root and shoot mass and grain yield in a field situation. This field trial is following on from the benefits found in previous work regarding bio stimulant seed treatment of maize with H&T Optimised in a non-field situation (Oliver *et al*., 2016).

Materials and Methods

Experimental details

A field trial was sown at 352 Jeffersons Line, Marton (40° 0' S, 175° 25' E). On the 4th of November 2017 Plant and Food Research sowed the trial, using a two-row maize trial planter. The trial design comprised of 4, 5.3 metre long rows per treatment plot, with 76cm between rows, replicated 8 times in a randomized complete block design. Each row had 43 maize seeds from the same P9400 line per row (equating to a sowing rate of 107,000 seeds per hectare). The soil type was Kiwitea Loam. The paddock had previously grown maize grain in the season prior. Pre-emergent weed control was boomsprayed, using 3L/ha of 840g/L Acetochlor and 3L/ha of 500g/L Atrazine following sowing. At planting 250kg/ha of Nitrophoska 12-10-10 banded fertiliser was applied. There was no fertiliser side dressing.

The seed was treated with three differing treatments, untreated, Poncho + Rancona Dimension and H&T Optimised. H&T Optimised includes Poncho Votivo (508 g/L clothianidin + 2.0×10^9 cfu/mL Bacillus firmus I-1582), Rancona Dimension (ipconazole 25 g/L + metalaxyl 20 g/L), Genius L439 and L552.

Natural rainfall events occurred on 4th November (5mm), 6th November (11mm), 8th November (15mm) and 9th November (3mm) prior to the final plant height measurement and root/shoot weigh.

Measurements

At 13, 17, 27 and 41 days after sowing (DAS) the height of each maize plant was recorded in centimetres using a steel tape measure, by measuring from the soil surface to the tallest leaf tip. The measurement dates were chosen to align with prior work on maize seed treatments by Oliver *et al*. (2016). The root/shoot weigh was completed at V7 growth stage as the root system is well distributed in the soil at this stage (Ransom, 2013).

At 41 DAS the numbers of plants in each row were counted. After the plant count (41 DAS) ten consecutive plants were dug out at random from each replicate, the soil was removed carefully from the roots. The plants from the same row were placed in a sack. The roots were cut from each shoot and weighed separately on scales on a concrete floor in a shed nearby the paddock. All rows from each treatment plot were harvested individually, weighed and dry matter calculated on the 26th April 2018, using a Wintersteiger two-row maize grain harvester by Genetic Technologies Limited. Yields were calculated from the wet weight and a sample of the moisture was taken using a bulk density sensor in a High Capacity Grain

Gage. The grain yield was calculated at 14% moisture.

Statistical analysis

The results were analysed using Minitab 18. A one-way ANOVA was completed on plant heights at each measurement, plant number, fresh shoot weight, fresh root weight and grain yield. Additionally root:shoot ratios were calculated. A Fishers protected LSD test was also performed on the data.

Results

At 13 DAS, there was no difference in plant height among the three treatments (Table 1). At 17, 27 and 41 DAS there was a difference among treatments ($P<0.05$). H&T Optimised was taller than both untreated and Poncho + Rancona Dimension (Poncho + R) throughout all the measurements, Poncho + R was taller than untreated throughout all the measurements (Table 1).

At 41 DAS, H&T Optimised had greater plant number than untreated (Table 2). H&T Optimised had 5.46% greater plant population than untreated, relative to the number of seeds planted. Poncho + R had similar plant population to H&T Optimised and untreated.

H&T Optimised had the greatest wet root mass compared to Poncho + R and untreated ($P<0.05$) at 41 DAS. Poncho + R and untreated had similar wet root mass (Table 3). All treatments had similar wet shoot mass at 41 DAS (Table 3). H&T Optimised had the highest root:shoot ratio 0.156 of the three treatments. Treated seed had greater grain yield than untreated seed, however there was no difference in grain yield between H&T Optimised and Poncho + R (Table 3).

Table 1: Mean plant height (cm) over time after sowing, for three different seed treatments. Means that do not share a letter are significantly different ($P<0.05$) using a Fishers protected LSD test.

Treatment	13 DAS	17 DAS	27 DAS	41 DAS
H&T Optimised	5.12a	10.28a	27.46a	85.45a
Poncho + R	5.13a	10.09b	26.86b	83.21b
Untreated	5.01a	9.38c	25.31c	81.48c
Grand Mean	5.09	9.92	26.54	83.38
Standard Deviation	1.99	1.89	3.42	8.54
P	0.26	0.00	0.00	0.00

Table 2: Mean plant population per row at 41 DAS for three different seed treatments. Means that do not share a letter are significantly different (P<0.05) using a Fishers protected LSD test.

Treatment	Plant Number	Counted : Planted
H&T Optimised	40.5a	94.19%
Poncho + R	39.3ab	91.50%
Untreated	38.3b	88.73%
Grand Mean	39.55	
Standard Deviation	3.65	
P	0.041	

Table 3: Mean wet weight of plant root and shoot mass (g) 41 DAS and the mean dry grain weight at harvest (t) per hectare, for three different seed treatments. Means that do not share a letter are significantly different (P<0.05) using a Fishers protected LSD test.

Treatment	Root	Shoot	Root : Shoot Ratio	Grain
H&T Optimised	143.75a	923.0a	0.156	16.82a
Poncho + R	125.75b	860.5a	0.146	16.57a
Untreated	121.75b	817.8a	0.149	15.46b
Grand Mean	130.42	867.1		16.28
Standard Deviation	13.4	158.5		0.94
P	0.008	0.43		0.02

Discussion and Conclusions

In the field, plants are faced with environmental challenges throughout the growing season, including insect, pest, fungi and climatic, which have an effect on the performance of a maize plant (Cook and Gore, 2018).

The Untreated seed showed a decrease in shoot height and grain yield in comparison to H&T Optimised and Poncho + R seed treatments. Untreated seed had a decrease in root mass and plant number compared to H&T Optimised seed, but not compared to Poncho + R.

The reduction in grain yield from untreated to treated maize seed was 1.24tDM/ha on average. At the current market price of $410/t of grain the disadvantage from untreated maize seed is $506/ha. Based on the current seed treatment prices the net benefit of treating maize seed is $398/ha over untreated maize seed.

H&T Optimised maize seed showed advantages in shoot height at 17, 27 and 41 DAS and root mass at 41 DAS, over the other two maize treatments. By promoting and maintaining a healthy root system plants are more likely to have less problems and larger yields during stressful periods (Weaver & Bruner, 1927).

Root mass within a maize plant is important to secure uptake of water and nutrients, in an efficient manner (Pace *et al.*, 2014). H&T Optimised had 14.3% greater root weight than Poncho + R and 18.1% greater root weight than untreated (Table 3). The extra root mass measured may have transferred into a higher shoot height due to enhanced water and nutrient uptake. An increase in shoot height may also provide enhanced sunlight interception, which increases photosynthetic rate, and therefore plant biomass (Richards, 2000). However light interception was not measured in this trial.

A sowing rate is used to produce a targeted number of plants per area, with the aim to provide optimal space for each plant to access the required nutrients, light and water. This reduces intense competition to maximize yield (Houck, 2009). Of the 43 plants sown in each row, both the H&T Optimised and Poncho + R seed treatment had the greatest plant survival with 94.19% and 91.5% respectively (Table 2). This demonstrates that these two seed treatments have no detrimental effect on germination. The more plants that germinate and survive may lead to a greater yield, as the targeted plant population is achieved to contribute to the final yield (Stone *et al.*, 2000).

The Rangitikei region experienced favorable sunshine hours and rainfall throughout the 2017/18 maize growing season. These conditions helped lead to a very strong year for maize grain and silage, with some excellent yields recorded across the area. The historical average grain yield of the trial paddock from 2014-17 was 14.9 t/ha (R. Harding, pers. comm., 2018). The final grain yield shows that H&T Optimised and Poncho + R maize treatments are superior to untreated seed. However in a typical season, drought conditions can often occur during January, February and/or March in the Rangitikei. It would be interesting to see if there is a notable yield difference between seed treatments in a more challenging season. Future work and trials could be performed to measure the difference early root mass delivers in final grain yield during a season that experiences a dry summer period. In future work, it may be of interest to quantify the dry matter of the root and shoot harvests.

References

Alford, A. and Krupke, C.H. 2017. Translocation of the neonicotinoid seed treatment in maize. *PloS one* 12(3), e0173836.

Booker, J.W. 2009. Production, distribution and utilisation of maize in New Zealand. Lincoln University.

Cook, D.R. and Gore, J. 2018. Impact of Selected Insecticide Seed Treatments on Field Corn Yield, 2017. *Arthropod Management Tests* 43(1) tsy024.

Eyheraguibel, B., Silvestre, J. and Morard, P. 2008. Effects of humic substances derived from organic waste enhancement on the growth and mineral nutrition of maize. *Bioresource Technology* 99(10): 4206-4212.

Hardacre, A., Sinclair, K. and van Tilberg, M. 1991. Commercial maize production in New Zealand. *Agronomy Society of New Zealand.*

Houck, M.J. 2009. Understanding Seeding Rates, Recommended Planting Rates, and Pure Live Seed (PLS). *USDA NRCS* Technical Note No. 11.

Lee, Y.S. and Bartlett, R.J. 1976. Stimulation of plant growth by humic substances 1. *Soil Science Society of America Journal* 40(6): 876-879.

Macfadyen, S., Hardie, D.C., Fagan, L., Stefanova, K., Perry, K.D., DeGraaf, H.E. and Umina, P.A. 2014. Reducing insecticide use in broad-acre grains production: an Australian study. *PloS one* 9(2), e89119.

Oliver, P., Harvey, S. and Thomas, D. 2016. The effects of maize seed treatments on establishment and development. *Agronomy New Zealand* 46: 45-48.

Pace, J., Lee, N., Naik, H.S., Ganapathysubramanian, B. and Lubberstedt, T. 2014. Analysis of maize (*Zea mays* L.) seedling roots with the high-throughput image analysis tool ARIA (Automatic Root Image Analysis). *PloS one* 9(9), e108255.

Ransom, J. 2013. Corn Growth and Management Quick Guide A1173.

Richards, R. 2000. Selectable traits to increase crop photosynthesis and yield of grain crops. *Journal of Experimental Botany* 51: 447-458.

Stone, P., Pearson, A., Sorensen, I. and Rogers, B. 2000. Effect of row spacing and plant population on maize yield and quality. *Agronomy New Zealand* 30: 67-75.

Weaver, J.E. and Bruner, W.E. 1927. Root Development of Veretable Crops. 1st Edn. *McGraw-Hill Book Company Incorporated; London*. 351pp.